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Beyond installation: How pre-adoption advertising drives post-adoption retail app usage

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ABSTRACT

Retail mobile applications have emerged as critical touchpoints for customer engagement, yet high abandonment rates limit their strategic value. While advertising traditionally targets either retail app installation or user re-engagement independently, this research examines the cross-stage effects of pre-adoption advertising on post-adoption usage behavior. Drawing on cognitive dissonance theory, we propose that pre-adoption advertising exposure reduces post-adoption dissonance, thereby enhancing sustained use of retail apps. We further identify three boundary conditions at the ad, consumer, and market levels. First, the effectiveness of pre-adoption advertising in reducing post-adoption dissonance depends on advertising content, with functional appeals amplifying the effect. Second, consumers with a higher need for control exhibit greater usage following exposure to pre-adoption advertising than those with a lower need for control. Third, competitive intensity shapes this process, as the dissonance-reducing effects are more pronounced in less competitive environments. We evaluate this framework across eleven studies ($N = 11{,}272$) using multiple methodologies, including a field study analyzing behavioral data from a Dutch retail app, a critical incident study, and controlled experiments. We conclude by outlining both theoretical and managerial implications.

1. Introduction

Retailers invest heavily in app-install advertising, yet rapid post-installation disengagement means installations often fail to translate into economic returns. Spending on app-installation campaigns reached $78 billion in 2025, resulting in 32 billion installations (Rosenfelder, 2026). Yet 25 percent of apps are opened only once, and average retention plummets from 17 percent three days post-installation to just 6 percent after 30 days (Statista, 2024; Statista, 2024). Because retail apps create value primarily through post-adoption usage rather than installation counts, this drop-off represents a critical disconnect between what retailers pay to acquire users and what they ultimately recover from them.

We define a retail app as a consumer-facing mobile application through which consumers search for, engage with, purchase and/or pay for access to goods and services offered by a retailer. This definition encompasses three types: (i) marketplace apps that intermediate exchange among multiple buyers and sellers (e.g., eBay), (ii) subscription and digital-catalog retail services where the app is both delivery mechanism and product (e.g., Audible), and (iii) branded retail channel apps that function as transactional facilitators for

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an offline or online retail brand (e.g., H&M). Although these app types differ in business model, they share a common strategic feature: without sustained post-adoption usage, the app cannot fulfill its commercial purpose. Our empirical studies focus primarily on the first two types of retail apps, where the link between post-adoption usage and commercial value is most direct and observable.

Post-adoption usage is strategically important because it is the behavioral gateway through which retail apps generate revenue: in marketplace apps by enabling the transactions from which platform revenue flows, and in subscription services by driving the recurring engagement that sustains revenue directly. App usage drives retailer revenue through multiple mechanisms, including higher purchase incidence and spending, feature-based interactions (e.g., lookups, check-ins), personalization, and loyalty programs that heighten shopper response (Wang et al., 2015; Liu et al., 2019; Van Heerde et al., 2019;). Higher purchase quantity, cross-category buying, and shifts in spending toward higher-margin product lines further amplify these effects (Liu & Sese, 2022; Narang & Shankar, 2019). Van Heerde et al. (2019) show, in the context of a service retailer's app, that, for a cumulative user base of 100 K, each additional day customers open the app generates incremental sales of USD 2.3 million. By enhancing convenience, enabling dynamic interactions, and delivering personalized content, apps build consumer trust and engagement (Tiongson, 2015; Tong et al., 2020). In subscription settings, consistent usage signals ongoing perceived value and encourages continued commitment, translating engagement into recurring revenue streams.

As retail continues to evolve, consumers spend substantial time in shopping-related apps (Data.ai, 2023). Seventy percent of internet users report using shopping apps (Griffith, 2024), and retail app conversion rates exceed those of the mobile web by more than threefold (Criteo, 2018). However, consumers' paths to installing retail apps vary: some users download apps after advertising exposure, others discover them in the App Store, and still others adopt them due to existing brand relationships or word-of-mouth, including in-store employee persuasion. Yet the ad-driven path lies squarely within firms' control, making acquisition advertising a central lever in practice. Despite this, the mobile retail literature has treated customer acquisition and post-adoption engagement as largely separate phenomena. Acquisition research has focused on what brings users to install (e.g., Gokgoz et al., 2021), while post-adoption research has focused on in-app features, personalization, and loyalty mechanisms that sustain usage once users are already engaged (e.g., Furner et al., 2014; Kang, 2014; Tarute et al., 2017). What remains unexamined is whether pre-adoption advertising exerts any influence beyond the installation itself. This paper addresses this gap by examining whether pre-adoption advertising exposure affects post-adoption retail app usage, and, if so, through which mechanism and under what conditions.

We define post-adoption usage as sustained behavioral engagement with the adopted retail app following installation, encompassing usage frequency (the number of times the app is used), usage intensity (the time spent in the app), commitment to the app, and willingness to spend via the app. Importantly, this definition accommodates heterogeneity in retail app monetization models: for subscription-based retail services in particular, post-adoption usage can manifest not only as more frequent and intensive engagement but also as higher-value commitment decisions (e.g., longer subscription choices), which we capture in our empirical package. Drawing on cognitive dissonance theory (Festinger, 1957), we propose that advertising can transcend the initial installation decision by reducing consumer uncertainty about the retail app's usability and value proposition, thereby minimizing post-adoption dissonance; in turn, lower dissonance should support sustained usage.

Building on this logic, we posit that the strength of this relationship is contingent on three boundary conditions governing the dissonance-reduction process. At the content level, functional ads provide concrete information that affords straightforward post-adoption justifications, strengthening the dissonance-reducing impact of ad exposure and increasing post-adoption app usage. At the individual level, consumers with a higher need for control are psychologically predisposed to reframe advertising as autonomous decision support; this internal validation process more effectively neutralizes post-purchase doubt, leading to sustained usage. Finally, at the market level, high competitive intensity introduces "attractive rejected alternatives," which creates external pressure that complicates the justification process and weakens the dissonance-reducing efficacy of pre-adoption advertising.

Following Blanchard et al. (2022), we draw on several data sources to test our propositions. Across large-scale field data from a retail app installation campaign (Study 1), a critical incident study spanning 26 app categories that provides evidence of broader generalizability across app types (Study 2A), and two controlled experiments (Studies 2B and 2C), we find a consistent pattern: exposure to advertising *before* retail app adoption boosts after-adoption app usage. This uplift appears in weekly app open events, screen-time minutes, voucher allocation decisions, and longer subscription choices, and remains significant under robustness checks. Process evidence shows that the effect occurs via pre-adoption advertising that offers "wisdom-of-install" logic, thereby lessening post-adoption dissonance and boosting retail app usage. This mechanism is confirmed through both measured mediation (Study 3A) and experimental moderation (Study 3B). Finally, we find evidence that message content and context matter across three boundary studies; such that functional vs. experiential ad messages reduce dissonance (Study 4), users with a high need for control experience less dissonance (Study 5), and ad exposure generates greater dissonance in highly competitive markets (Study 6).

Our research makes three contributions to the retailing and marketing literature. First, we extend research on retail advertising effectiveness by demonstrating that pre-adoption advertising influences post-adoption app usage, challenging the conventional separation between customer acquisition and retention in the mobile retail literature. This spillover effect reveals advertising's broader role in the retail customer lifecycle beyond initial app installation decisions. Second, we establish cognitive dissonance reduction as the psychological mechanism linking pre-adoption advertising exposure to sustained engagement with retail apps, thereby contributing to theory on post-purchase consumer behavior in mobile retail environments. This mechanism explains how advertising continues to shape customer relationships after the initial transaction in digital retail contexts. Third, we identify systematic boundary conditions across the content, consumer, and market levels that determine when this spillover effect operates most effectively in retail app contexts. These findings suggest that retail advertising strategy should integrate acquisition and retention objectives, with functional messaging being most effective for sustaining customer engagement among high-need-for-control consumers in less competitive retail markets.

The remainder of this paper is organized as follows: We begin by reviewing the extant literature on mobile app usage in retail. We then present our dissonance-based theoretical framework, which explains the link between pre-adoption ad exposure and post-adoption retail app usage. We test this framework in a field study, a critical incident study, and nine controlled experiments (seven in the main paper and two in the Web Appendix). We conclude with a discussion of the theoretical contributions and managerial implications.

2. Retail app usage

An extensive body of research has examined the factors that drive continued mobile app usage (e.g., Gill et al., 2017; Tarute et al., 2017). Key areas of investigation include app-level design characteristics (Furner et al., 2014; Kang, 2014), timing of app adoption (Liu & Sese, 2022), emotional connections between users and brands through apps (Tseng & Lee, 2018), and contextual market factors such as local retail density (Cui et al., 2024). However, a critical knowledge gap exists in understanding how pre-adoption advertising influences post-adoption retail app usage. Most research on advertising in mobile apps centers on in-app advertising outcomes such as attitudes, purchase intentions, and click-through rates, rather than app usage patterns following installation (Bart et al., 2014; Rafieian & Yoganarasimhan, 2021). The broader digital advertising literature examines ad effectiveness across the customer journey but is somewhat siloed into three streams: one examines how pre-adoption ad exposure drives adoption-related outcomes; a second considers how the timing of ad exposure relative to adoption affects outcomes; and a third studies how the timing of adoption itself shapes subsequent usage. The intervening link, namely whether pre-adoption ad exposure impacts post-adoption usage, remains underexplored. We review each stream in turn, as summarized in Table 1.

2.1. Ad exposure and adoption

The first literature stream on digital advertising has concentrated on pre-adoption outcomes such as click-through behavior (Chatterjee et al., 2003; Drèze & Hussherr, 2003; Yang & Ghose, 2010), search behavior (Lewis & Nguyen, 2015; Li & Kannan, 2014), and search and sales (Hu et al., 2014). Prior studies also explore adoption and cross-channel sales impacts of advertising (e.g., Breuer & Brettel, 2012; Breuer et al., 2011; Dinner et al., 2014). Blake et al. (2015) likewise focus on adoption, demonstrating that keyword advertising primarily increases purchases among the least active customers. Across this stream, the dependent variable is adoption or purchase rather than post-adoption usage.

2.2. Ad exposure timing

The second stream examines the impact of advertising's timing relative to adoption. Manchanda et al. (2006) study the impact of

Table 1
Summary of selected relevant literature.

Research Theme	Study	Independent Variable	Dependent Variable	Key Focus	Link: Pre-Adoption Ads & Usage
Ad Exposure & Adoption	Breuer, Brettel and Engelen (2011)	Pre-adoption ad exposure	Adoption	Focuses on the short and long-term impact of ad exposure on adoption	No
	Breuer and Brettel (2012)	Pre- and post-adoption ad exposure	Adoption	Focuses on the short and long-term impact of ad exposure on adoption	No
	Hu, Du and Damangir (2014)	Pre-adoption ad spend	Adoption	Focuses on pre-purchase search activity and interest generation	No
	Dinner, Van Heerde and Neslin (2014)	Pre-adoption ad exposure	Adoption	Focuses on cross-channel or mediated sales outcomes	No
Ad Exposure Timing	Manchanda et al. (2006)	Post-adoption ad exposure	Adoption	Focuses on repeat purchase behavior, of post adoption ad exposure	No
	Burmester et al. (2015)	Pre- and post-ad exposure	Adoption	Explores interactions and timing effects between publicity and advertising	No
Adoption Timing & Usage	Prins and Verhoef (2007)	Direct marketing, service- and brand-level advertising (own and competitors')	Adoption timing	Focuses on adoption timing among existing customers using granular telecom data	No
	Prins, Verhoef and Franses (2009)	Adoption timing	Post-adoption usage patterns and dis-adoption behavior	Analyzes how timing of adoption affects engagement trajectory and churn	No
Pre-adoption Ad Exposure & Post-adoption Usage	Current study	Pre-adoption ad exposure	Post-adoption App usage	Explores how exposure to pre-adoption advertising reduces dissonance and increases usage	Yes

banner advertising on current customers' probability of buying again, while Burmester et al. (2015) compare pre-launch and post-launch advertising effectiveness on new product sales. These studies illuminate timing effects on adoption and repeat purchase but do not address post-adoption usage behavior.

2.3. Adoption timing and usage

The third stream shifts attention to the timing of adoption itself. Prins and Verhoef (2007) show that advertising exposure accelerates e-service adoption, particularly among loyal customers. Prins et al. (2009) study the influence of adoption timing on subsequent usage patterns and disadoption behavior. This stream comes closest to our concern with post-adoption usage, but its independent variable is adoption timing rather than pre-adoption ad exposure.

Taken together, none of these studies specifically examine whether advertising exposure prior to adoption creates lasting effects on post-adoption usage behavior, which is a critical missing link for retailers seeking to maximize customer value. Table 1 summarizes key studies examining advertising's influence on adoption and post-adoption behaviors, highlighting the novelty of the current research.

3. Post-adoption dissonance and advertising

Our theoretical framework examines how advertising effects spill over from pre-adoption to post-adoption stages of the customer journey, a connection that has been largely overlooked in a literature that treats acquisition and retention as separate phenomena. We propose that pre-adoption advertising exposure reduces post-adoption cognitive dissonance, specifically, doubts about the "wisdom of purchase," thereby increasing subsequent retail app usage. The concept of doubts about the wisdom of purchase captures people's "recognition after the purchase has been made that they may not have needed the product or may not have selected the appropriate one" (Sweeney et al., 2000, p. 380). For the sake of simplicity, we refer to this concept as *post-adoption dissonance* hereafter. Prior research associates cognitive dissonance with negative emotions, such as anxiety, uncertainty, and doubt (Menasco & Hawkins, 1978; Montgomery & Barnes, 1993; Mowen, 1995). These negative emotions can emerge specifically after consumers have made a purchase decision and now doubt the wisdom of their purchase (Walsh et al., 2007).

In the context of retail apps, consumers may question the wisdom of downloading one. While downloading is straightforward, installing apps involves costs such as storage space, attention demands through notifications, and privacy concerns (Degirmenci, 2020; Xu et al., 2015). These costs can lead users to question the wisdom of installing the app, resulting in cognitive dissonance. Dissonant consumers tend to be less satisfied and often engage in behavior intended to reduce discomfort, such as returning products (Lee, 2015; Powers & Jack, 2013). In the app context, this manifests as app abandonment and uninstallation.

Extant research also demonstrates that exposure to pre-adoption information shapes post-adoption dissonance. When consumers receive quality-related information before purchase, whether through strategic website design (Clark & Das, 2009) or comprehensive product details (Li & Choudhury, 2021), post-adoption dissonance decreases by reducing uncertainty about the product's usability and value. However, negative information, such as unfavorable online reviews, produces the opposite effect by heightening the likelihood of dissonance (Weathers et al., 2007).

We contend that advertising exposure prior to adoption creates a similar dissonance-reducing effect through a justification mechanism. Pre-adoption advertising provides consumers with accessible post hoc rationalizations for their installation decisions. When consumers experience doubt after downloading an app, they can draw upon their memory of advertising exposure as evidence supporting their choice ("I remember seeing this advertised, so it must be worthwhile"). This process aligns with cognitive dissonance theory, which shows that people tend to adjust their attitudes to be consistent with decisions they have already made (Brehm & Cohen, 1962). Without such advertising exposure, consumers have fewer accessible justifications for their decision, increasing the likelihood of post-adoption doubt about the wisdom of their installation. We hypothesize that by providing these readily available justifications, pre-adoption advertising reduces cognitive dissonance and facilitates greater app usage.

H1. Users exposed to pre-adoption advertising engage in higher post-adoption app usage than users who were not exposed to the advertising prior to adoption.

H2. The effect of pre-adoption advertising on post-adoption app usage is mediated by post-adoption dissonance, such that advertising reduces dissonance, which in turn increases usage.

To provide a systematic understanding of when pre-adoption advertising influences post-adoption behavior, we identify several boundary conditions to this effect and anchor them in Cognitive Dissonance Theory (Festinger, 1957). Dissonance occurs when the 'negative' aspects of a chosen app or the 'positive' aspects of rejected alternatives create psychological discomfort. We theorize that the strength of the ad-usage link depends on three factors that govern the dissonance reduction process at different levels: (1) the availability of justificatory information (Functional Ad Appeals) at the ad level, (2) the individual's psychological drive to maintain consistency (Need for Control) at the consumer level, and (3) the external pressure of competing alternatives (Competitive Intensity) at the market level.

3.1. The role of functional appeals at the ad level

Our central hypothesis predicts that pre-adoption advertising can reduce post-adoption dissonance, but which type of advertising does so most effectively? Festinger (1957) posits that one of the primary ways to reduce psychological discomfort is by adding new

consonant cognitions (i.e., favorable information that supports the original decision). We propose that functional advertising appeals serve this specific role more effectively than non-functional appeals. Functional advertising appeals emphasize product attributes, features, and tangible benefits (Zarantonello et al., 2013). These ads inform consumers by providing clear, factual details about product functionality and benefits. Such appeals are also referred to in the advertising literature as rational (Heath, 2011), informational (Rossiter & Percy, 1987), or utilitarian (Johar & Sirgy, 1991).

Functional appeals stimulate consumers' cognitive processing (Laskey et al., 1994; Mick, 1992). These ads reduce uncertainty and increase consumers' confidence in their ability to assess the merits of buying the brand after seeing the ad (Abernethy & Franke, 1996; Ducoffe, 1995), effectively reducing doubt about their wisdom in purchasing. By providing clear, factual details, ads using functional appeals thus arm consumers with consonant cognitions which consumers can retrieve to rationalize their choice when post-adoption doubts arise (Sweeney et al., 2000). In contrast, experiential appeals often lack the concrete and utility-based information necessary to resolve post-adoption dissonance. Unlike functional appeals, experiential claims centered on intangible lifestyle imagery are more subjective and fleeting. Consequently, experiential content offers fewer justifications when consumers encounter the functional realities of a new app, making it a less robust driver of long-term engagement compared to functional content. As a result, we expect that post-adoption dissonance can be reduced more effectively by introducing functional cues that explain the app's usability in ad copy relative to other ad copy.

H3. Exposure to pre-adoption functional advertising will lead to lower post-adoption dissonance and higher app usage compared to exposure to pre-adoption experiential advertising.

3.2. The role of need for control at the consumer level

Individual psychological traits can fundamentally shape consumer motivation to engage in dissonance reduction. Among these traits, need for control represents individuals' desire to perceive themselves as capable agents who can effectively control their environment (Burger & Cooper, 1979). This psychological orientation generates distinct attribution patterns in how consumers interpret and respond to external stimuli. Research demonstrates that need for control systematically affects consumer shopping behavior and purchase decisions, moderating responses to retail environments (Lunardo & Mbengue, 2009). This desire for control significantly influences how people make attributions about their experiences and outcomes (Burger, 1987; Kelley, 1973), with high need-for-control consumers being more likely to attribute their behavior to internal factors rather than external influences. When encountering pre-adoption advertising, these consumers will likely cognitively reframe this exposure as information that supports their autonomous decision-making rather than as external persuasion attempts. High need-for-control individuals tend to interpret advertising as "gathering relevant information to make an informed choice" rather than being influenced. When post-adoption doubts arise, these consumers can readily access the pre-adoption advertising as cognitive support, thinking, "I carefully evaluated the information before deciding." The advertising becomes integrated into their decision narrative as evidence of thoroughness, providing justifications that reduce dissonance about their choice. This internal validation process strengthens commitment to the app and motivates continued usage to affirm their decision-making competence. Consequently, advertising exposure provides stronger justifications for high need-for-control consumers, reducing dissonance more effectively and translating into sustained app usage.

H4. The positive effect of pre-adoption advertising exposure on post-adoption app usage (via decreased dissonance) is stronger for consumers with a higher need for control.

3.3. The role of competitive intensity at the market level

Finally, the market context determines the baseline magnitude of dissonance. Festinger (1957) noted that dissonance increases relative to the number and quality of rejected alternatives. In highly competitive markets, the "attractive cognitions" associated with rejected brands are more salient, creating a higher initial state of dissonance. When consumers face numerous alternatives in competitive markets, they experience choice overload, which can lead to decision paralysis, reduced satisfaction, and the potential for increased regret (Iyengar & Lepper, 2000). In more competitive categories, consumers typically consider more (and more attractive) alternatives, increasing the ratio of attractive rejected options and thus baseline post-adoption dissonance (Festinger, 1957). Competitive intensity thus amplifies the number of positive but dissonant cognitions consumers must suppress.

Furthermore, consumers in competitive markets face greater advertising clutter from multiple competitors, which diminishes the efficacy and memorability of any single brand's pre-adoption advertising. Extant advertising research suggests that exposure to competing same-category messages produces competitive interference, lowering memory and effectiveness of focal ads (e.g., Burke & Srull, 1988; Danaher et al., 2008). Perceived clutter is also known to depress ad processing and evaluations across media (Elliott & Speck, 1998). Because the ad-based bolstering of one's choice depends on encoding and later retrieval of the focal message, heavier category advertising can weaken the exposure/dissonance link through competitive interference and perceived clutter. Accordingly, as competitive intensity increases, the indirect effect of pre-adoption exposure on post-adoption app usage via reduced dissonance should attenuate. Formally:

H5. The positive effect of pre-adoption advertising exposure on post-adoption app usage (via reduced dissonance) is stronger in less competitive markets.

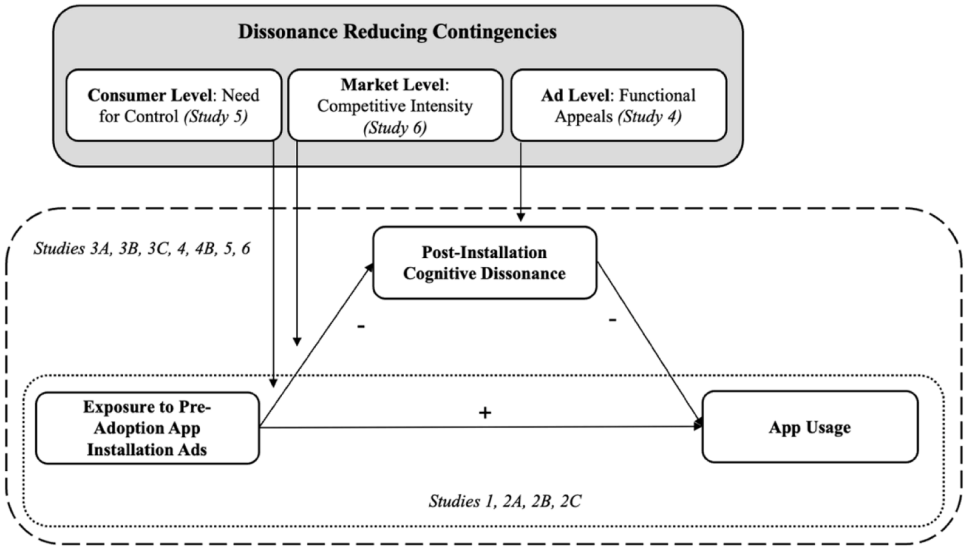


Fig. 1. Investigated relationships at a glance.

We test our proposed hypotheses across eleven studies comprising a field study, a critical incident study, and controlled experiments. Fig. 1 depicts our overall framework.

Studies 1–2C aim to establish our focal main effect across different operationalizations of usage and generalize the effect in various contexts. Studies 3A and 3B provide process evidence through mediation (3A) and moderation (3B). Finally, Studies 4–6 introduce important boundary conditions of our identified framework on the ad, consumer, and market levels. Table 2 provides an overview of our studies.

4. Study 1: Pre-adoption advertising and app usage in a field setting

4.1. Field data

We use data from a video ad campaign run by a Dutch digital service provider (DSP) for a major Dutch online marketplace, designed to drive app installations. The featured app serves a broad user base, enabling individuals to both buy and sell goods and services. The ad campaign featured an auto-playing video ad embedded within a network of third-party host apps. The ad showcased a rotating carousel of items representing categories available to buy on the platform (e.g., electronics, cars, books, fashion, toys) and a call to action, "Go for it. It all starts on [App Name]" with the link opening the app installation page.

Our data comes from a *six-week campaign (weeks 21–26)* run by the DSP in May-June 2017. The DSP randomly selected 562,033 users who had been active on its network of 10 third-party apps in the past year to receive the ad.[1] An additional 137,463 users were randomly assigned to a no-ad control group, in which they were exposed to an unrelated ad instead of the target ad. The DSP recorded every instance of the marketplace app being opened as the primary measure of usage. To our knowledge, no other major marketing campaigns were active for the marketplace app during the study period. Users were unaware of ad assignment, and the random assignment of active users to either an ad-exposure or a no-exposure control group helped ensure balance in unobservable factors. We also confirmed that no major seasonal, political, or entertainment events occurred during the campaign that could confound the results.

To examine usage behavior, we focus on the 7811 users who opened the app for the first time during the campaign: 5246 had ad exposure, and 2565 did not. Since all users adopted simultaneously, external influences and novelty effects were constant across conditions. To minimize daily noise and temporal variation, we aggregate ad exposure and usage data at the weekly level. Fig. 2 compares average weekly usage between ad-exposed and non-exposed users during the campaign.[2] Tables 3a and 3b summarize the app usage across the exposed and unexposed user groups.

Our data show that users who were exposed to the ad campaign before installing the app had greater subsequent usage than those

[1] These users were active on other 10 apps as the treatment users, but none were active in the focal app.

[2] To check that the ad-exposure and no-exposure groups were behaviorally comparable, we examined a random subsample of 151 users (84 in the exposure group, 67 in the control group) and tracked their activity on other apps within the DSP network during weeks 44–49. On average, control users opened non-focal apps 206.55 times per week, whereas exposed users did so 233.12 times. This difference (–26.56) was statistically nonsignificant ($p > .50$), indicating that the two groups did not differ systematically in their overall app-usage intensity. We acknowledge that pre-ad exposure usage metrics would have been more insightful. However, this data was not shared with us by the DSP

who installed the app without ad exposure. To quantify this, we modeled the number of times a user opened the app, controlling for user-level variables and time trends. We estimated the impact of this pre-adoption exposure on app usage events for users who installed the app during the campaign (weeks 21–26), measuring their activity through week 35.

We estimate the following specification:

$$\begin{aligned}\text{Usage}_{it} = {} & \beta_0 + \beta_1(\text{Pre} - \text{adoption Exposure})_i + \beta_2(\text{Cumulative Ad Exposure})_{it} + \beta_3(\text{Ad Interaction})_{it} + \beta_4(\text{Android})_i \\ & + \beta_5(\text{Dutch})_i + \beta_6(\text{Time Trend})_t + \varepsilon_{it} \end{aligned} \quad (1)$$

4.2. Dependent variable

The dependent variable, $Usage_{it}$, is the weekly count of app open events for each user i in week t ($i = 1,\ldots, N$ and $t = 21,\ldots, 35$). This usage data is highly skewed, with many zero values from users who do not open the app, leading to overdispersion (Mean = 5.24, Variance = 288.66). To account for these characteristics, we use a zero-inflated negative binomial (ZINB) model, which is well-suited for analyzing data with a high number of zero values and overdispersion (see Greene, 1994).

4.3. Variable definition

Pre-adoption Exposure User is an indicator variable that takes the value of 1 for users exposed to the ad campaign prior to installation and 0 for no-exposure users who install during the campaign.

We further include observable controls, such as *Cumulative Exposure,* which counts the cumulative number of campaign ads seen by the user by week *t* to control for the effects of ad wear-in or wear-out (Pechmann & Stewart, 1988). *Cumulative Exposure* also accounts for differences in usage behavior, as more active users may have more exposure to ads. We also control for user engagement by including the *Ad Interaction* variable, which counts the number of times a user clicks on an ad in a week. We assume that active interaction demonstrates a higher level of interest and potential receptiveness to the ad.[3] Industry statistics on app usage and operating software suggest that Apple users are more likely to use apps as they spend nine more hours per month using their phones than Android users (Comscore, 2014). To mitigate this potential confound, we introduce a control for the operating system in our model by including *OS* as a dummy variable for the operating system (1 for Android, 0 for iOS).[4] We include a language indicator (1 = Dutch, 0 = English) to account for differences in users' familiarity with the app. A linear time trend (weeks 21–35) accounts for potential usage declines due to novelty or external factors. Table 4 presents summary statistics for all model variables.

The results in Table 5 examine the effect of pre-adoption ad exposure on users' actual app usage. We estimate our proposed model using users who installed the app without ad exposure as the baseline comparison group, i.e., we compare the usage of pre-adoption ad-exposure users with that of no-exposure users in Table 5.[5] The coefficient of the indicator of pre-adoption exposure users is somewhat sensitive depending on the specification, but always statistically significant, suggesting that pre-adoption exposure results in higher usage compared to users with no ad exposure. In line with H1, pre-adoption exposure to the ad increases the number of weekly app usage events by 6% (100 * exp(0.06) −1) compared to the no-exposure comparison group.

4.4. Usage in the post-campaign period

We further examine the long-term impact of ad exposure by estimating the models for the post-campaign weeks (weeks 27–35). We observe that during this period, the coefficient for the pre-adoption user dummy increases, indicating an 8% rise in usage among users exposed to advertising in the post-campaign weeks. As a robustness check, we also estimate the following difference-in-differences (DID) specification.

$$\begin{aligned}\text{Usage}_{it} = {} & \beta_0 + \beta_1(\text{Pre} - \text{adoption Exposure})_i + \beta_2(\text{Post Campaign Weeks})_t \\ & + \beta_3(\text{Pre} - \text{adoption Exposure} \times \text{Post Campaign Weeks})_{it} + \beta_4(\text{Cumulative Ad Exposure})_{it} \\ & + \beta_5(\text{Ad Interactions})_{it} + \beta_6(\text{Android})_i + \beta_7(\text{Dutch})_i + \beta_8(\text{Time Trend})_t + \varepsilon_{it} \end{aligned} \quad (2)$$

This approach builds on the quasi-experimental structure of our data, where some users are exposed to advertising before adoption, while others are not. We define the campaign week as the pre-treatment period and compare usage changes before and after the campaign weeks between the pre-adoption exposure and no-ad exposure groups. The interaction between pre-adoption exposure and the post-campaign period is positive and statistically significant (b = 0.19, p < .001), suggesting that usage among the exposed group

[3] Unfortunately, we do not have dwell time in our dataset. Users who do not interact will most likely skip the ad. Skipping here means that they would just scroll further in the app (not deliberately interrupting the ad).

[4] We re-estimate the models using a randomly selected balanced sample of Android and Apple users to equalize the distribution of operating system between the pre-adoption users and the no-ad exposure users. We also use propensity score matching on operating system and find significant treatment effects (results available upon request). These robustness checks allow us to be confident that the difference in usage can be attributed to pre-adoption ad exposure and not the operating system.

[5] We report the results for the app usage component of the model (which correspond to the negative binomial model for individuals who used the app)

Table 2
Overview of studies.[#]

Study	Design	Context	Sample	Dependent Variable	Purpose	Key Finding
Main Effect Studies						
Study 1	Field study (DSP campaign)	Marketplace app	N = 7811 (Dutch app adopters)	App open count (weekly)	*External Validity:* Test effect in a real-world marketplace.	Ad exposure increases weekly app usage; effect persists post-campaign
Study 2A	Critical Incident Study	26 app categories	N = 450 (UK, iOS users)	App screen time (minutes)	*Generalizability*: Verify effect across 26 app categories.	Ad exposure leads to higher app screen time; effect stronger over time and for lower engagement users.
Study 2B	2 (Ad Exposure: Target vs. Unrelated) between-subjects: Main effect	Audiobook subscription app	N = 338 (North American students)	Usage time commitment	*Causality:* Confirm ads *cause* increased commitment.	Ad exposure increases willingness to commit to longer subscription periods (i.e., more anticipated usage).
Study 2C	2 (Ad Exposure: Target vs. Unrelated) between-subjects: Main effect	Audiobook subscription app	N = 397 (UK)	Voucher choice (incentive compatible)	*Consequential Choice*: Test effect with real monetary stakes.	Ad exposure increases spending relative to no exposure. More spending on voucher = longer subscription commitment
Process Studies						
Study 3A	2 (Ad Exposure: Target vs. Unrelated) between-subjects (Process mediation design)	Marketplace app	N = 197 (UK)	Users' anticipated app-use frequency	*Mediation:* Test cognitive dissonance as the mechanism.	Ad exposure reduces post-adoption dissonance which in turn increases usage intent.
Study 3B	2 (Ad Exposure: Target vs. Unrelated) × 2 (Post-Installation Dissonance) between-subjects (Process by moderation)	Marketplace app	N = 286 (US)	Users' anticipated app-use frequency	*Process Verification:* Confirm mechanism via moderation.	Process by moderation: Dissonance moderates ad effect and, thus, confirms causal chain.
Study 3C (Web Appendix)	2 (Ad Exposure: Target vs. No ad) between-subjects (Process mediation design)	Marketplace app	N = 336 (UK)	Users' anticipated app-use frequency	*Robustness Check: Introduce a no-ad condition*	Ad exposure reduces post-adoption dissonance which in turn increases usage intent also when ad exposure is compared to no ad exposure (instead of exposure to an unrelated ad).
Contingency Studies						
Study 4	4 (Ad Type: Control vs. No Slogan vs. Functional vs. Experiential) between-subjects	Marketplace app	N = 289 (UK)	Users' anticipated app-use frequency	*Ad Level*: Test how ad content (functional) reduces dissonance.	Relative to the Experiential ad, the Functional ad reduces dissonance and in turn increases usage intent.
Study 4B (Web Appendix)	3 (Ad Type: Control vs. Functional vs. Promotional) between subjects	Grocery app	N = 300 (US)	Users' anticipated app-use frequency	Investigate the role of price promotions (vs functional promotions)	Relative to the Promotional ad, the Functional ad reduces dissonance and in turn increases usage.
Study 5	2 (Ad Exposure: Target vs. Unrelated)	Audiobook subscription app	N = 182 (UK)	Voucher choice (incentive compatible)	*Individual Level:* Test how user traits (need for control) reduce dissonance level.	The dissonance-reducing effect of ad exposure is stronger for consumers with a higher need for control, translating into greater voucher allocation
Study 6	2(Ad Exposure: Target vs. Unrelated) x 2(App operates with strong competition vs. no competition)	Perfume Subscription app	N = 686 (UK)	Voucher choice (incentive compatible)	*Market Level:* Test how competition increases dissonance.	Ad exposure generates greater dissonance in highly competitive markets, attenuating the positive effect on usage.

[#] Detailed scales used in the studies can be found in Web Appendix J.

increases more notably following the campaign (approximately 21%) (see Table 5). The magnitude of this coefficient is notably larger than the original coefficient (b = 0.06) that captures average usage differences between groups pooled across all weeks, while the DID interaction isolates the additional divergence in usage that emerges specifically after the campaign ends, over and above any pre-existing differences and common time trends. During the campaign period both groups are still relatively new users, and usage patterns are still forming. After the campaign ends, the habits established through pre-adoption exposure continue to strengthen among the exposed group while the non-exposed group follows a flatter trajectory, causing the gap between groups to widen over time. This is consistent with our theoretical framework: users who have internalized the app's value increase usage to maintain a less dissonant state, creating a self-reinforcing cycle of long-term engagement.

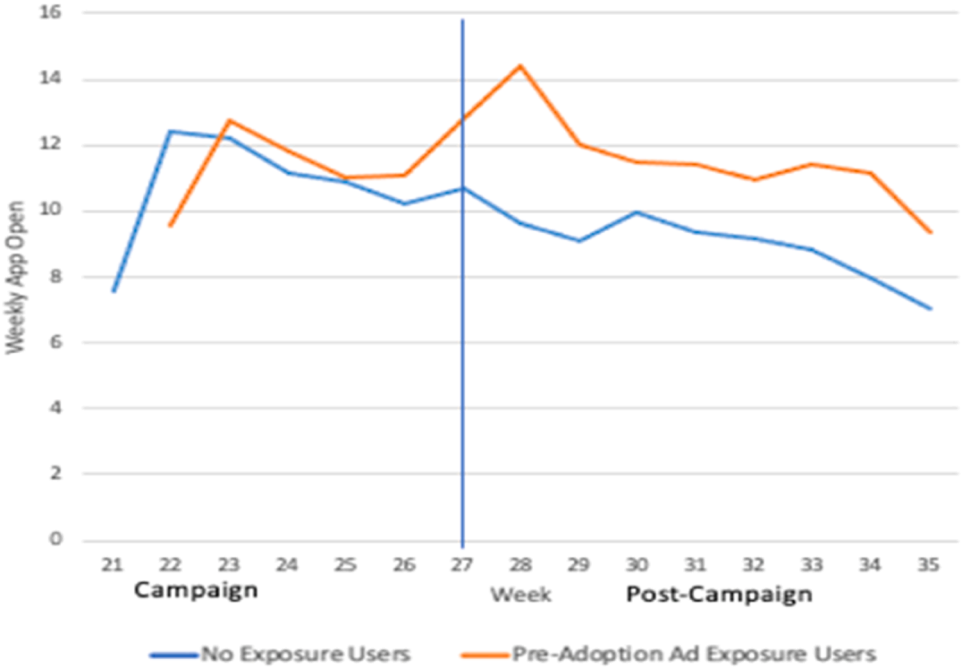


Fig. 2. Average app usage by ad exposure for users who install during the campaign.

Table 3a
App usage summary statistics.

	Number of Users	Average Weekly Usage	S.D.	Med.	Min	Max
All users	7811	4.95	13.13	0	0	482
No exposure users	2565	4.36	12.91	0	0	482
Pre-adoption exposure users	5246	5.24	16.99	0	0	445

Note: We record zero usage for weeks when users do not open the app.

Table 3b
Distribution of pre-adoption exposure users by exposure timing, exposure frequency, and engagement.

App Adoption Week	Observations	Unique Users	App Usage	Ad Exposures	Ad Interaction
Week 21	15,875	1340	4.65	0.02	0.05
			(15.34)	(0.43)	(0.40)
Week 22	19,557	1711	5.22	0.03	0.05
			(16.90)	(1.53)	(0.99)
Week 23	7337	673	4.85	0.04	0.08
			(16.33)	(0.94)	(0.92)
Week 24	12,329	1188	6.21	0.14	0.31
			(18.43)	(3.01)	(3.19)
Week 25	3340	334	5.51	0.05	0.10
			(20.38)	(0.55)	(0.50)

Note: Statistics are reported for respondents based on the week in which they were first exposed to the campaign. "Observations" refer to user-level records used in estimation, while "Unique Users" counts distinct individuals whose first exposure occurred in the indicated week. Ad exposure and engagement variables are count measures; missing values were recoded as zeros to indicate no observed exposure or activity.

4.5. Selection bias

We further apply a two-step Heckman selection model to address selection bias, in which ad-exposed users may systematically differ from unexposed users. In the first stage, we use a probit model to predict adoption, with ad interactions and cumulative exposure serving as instrumental variables to isolate the impact of advertising. We then compute the Inverse Mills Ratio (IMR) from this stage to correct for selection into the usage sample. The second stage estimates a ZINB model of post-adoption app usage, including the IMR to adjust for the selection bias. These results support our previous findings, indicating that pre-adoption ad exposure is significantly associated with an 8% increase in app usage (calculated as $100 \times [\exp(0.08) - 1]$), even after accounting for differences in adoption

Table 4
Summary statistics of variables used in the model.

	Pre-adoption Exposure Users	No Ad Exposure Users
App Usage	5.24	4.36
	(16.99)	(12.91)
Week 21 Cohort Dummy	0.27	—-
	(0.44)	
Week 22 Cohort Dummy	0.33	—-
	(0.47)	
Week 23 Cohort Dummy	0.13	—-
	(0.33)	
Week 24 Cohort Dummy	0.21	—-
	(0.41)	
Week 25 Cohort Dummy	0.06	—-
	(0.23)	
Cumulative ad exposure	2.19	—-
	(9.90)	
Ad interaction	0.29	—-
	(2.62)	
Android	0.33	0.58
	(0.47)	(0.49)
Dutch	0.79	—-
	(0.41)	
Excess zeros	37,298	17,961
N	58,438	32,196

Note: Standard deviation in parentheses ().

Table 5
Comparison of usage of pre-adoption Ad exposure users with no exposure users.

Variables	Pre & Post Campaign Weeks		Post Campaign Weeks		DID Specification		Heckman Selection	
	Coeff. (SE)	*p*	Coeff. (SE)	*p*	Coeff. (SE)	*p*	Coeff. (SE)	*p*
Pre-adoption Exposure	0.06 (0.03)	0.02	0.08 (0.03)	0.01	0.02 (0.03)	0.42	0.08 (0.03)	0.008
Post-Campaign Weeks					0.11 (0.04)	0.001		
Pre-adoption Exposure × Post Campaign Weeks					0.19 (0.04)	<0.001		
Cumulative Ad Exposure	–0.02 (0.01)	<0.001	–0.02 (0.01)	0.02	–0.02 (0.01)	0.001	−0.02 (0.00)	<0.001
Ad Interaction	0.07 (0.02)	<0.001	0.10 (0.02)	<0.001	0.08 (0.02)	<0.001	0.02 (0.01)	0.05
Android	–0.71 (0.02)	<0.001	–0.66 (0.02)	<0.001	–0.68 (0.02)	<0.001	–0.42 (0.02)	<0.001
Dutch	0.00 (0.02)	0.97	0.00 (0.03)	0.97	–0.00 (0.02)	0.91	0.06 (0.03)	0.05
Time Trend	–0.03 (0.00)	<0.001	–0.05 (0.00)	<0.001	–0.04 (0.00)	<0.001	–0.04 (0.00)	0.18
Inverse Mills Ratio							–0.01 (0.01)	0.32
Intercept	2.64 (0.03)	<0.001	2.74 (0.06)	<0.001	2.67 (0.03)	<0.001	2.46 (0.04)	<0.001
Model Summary	Log Likelihood = −184,652.7 N = 90,634		Log Likelihood = −129,084.1 N = 70,296		Log Likelihood = −184,333.2 N = 90,634		Log Likelihood = −186,834.1 N = 90,634	

behavior (see Table 5).

4.6. Heterogeneity in ad exposure timing

Because users vary in their usage patterns and ads were shown only when users were active in apps, different users in the ad-exposure group were exposed to the ads at different times. This variation in exposure timing implies that each user's post-ad exposure period differs. We account for this heterogeneity in exposure timing by categorizing users into cohorts based on the week in which each user is first exposed to the ad. For each week of the campaign period, we create a separate cohort dummy variable, Ad Exposure Week, which takes the value 1 for all users exposed to the ad in week g and 0 otherwise. We interact Ad Exposure Week with the Preadoption Exposure User variable to estimate the cohort-specific pre-adoption ad exposure effect (see Table 6).

We find that users exposed to ads before adopting the app exhibit a 13% increase in usage compared to those without any exposure (calculated as $100 \times [\exp(0.12) - 1]$). Importantly, this positive effect persists even after the campaign ends. In the post-campaign period, users with pre-adoption ad exposure exhibit 8% higher usage than those who adopt without ad exposure. This difference grows to 14% when we account for variation in exposure timing. Taken together, these findings suggest that users with pre-adoption ad exposure not only exhibit higher immediate engagement but also have a more sustained increase in usage over time.

4.7. Discussion

Our field data indicate that pre-adoption ad exposure is associated with a 6% increase in weekly app usage, and this effect persists post-campaign, with exposed users maintaining 8% higher usage in subsequent weeks. DID analysis reveals a 21% relative increase among ad-exposed users after the campaign period. After correcting for differences in adoption likelihood, we observe 8% higher usage among users exposed to advertising. Accounting for heterogeneity in ad exposure timing shows the effect increases to 13% for users exposed prior to adoption. These results support H1 using actual marketplace app usage data, suggesting that pre-adoption advertising meaningfully enhances engagement beyond installation, a key consideration for retailers. Across specifications, repeated ad exposure negatively affects usage, whereas ad interaction positively affects usage (see Figure A.1 in Web Appendix A). We also tested if our results are driven by heavy app users who would use the app frequently regardless of advertising. We find that our results are robust to the removal of heavy app usage users (see Table A.1 in Web Appendix A).

Our field data provides a positive association between pre-adoption ad exposure and post-adoption usage. However, several limitations should be noted. First, while users were randomly assigned to exposure and control groups, we observed some imbalances in characteristics such as operating system and adoption rates, which may suggest imperfect balance. Second, ad exposure within the treatment group was not randomly assigned; the timing and frequency of exposure were partly determined by users' broader activity patterns. Unfortunately, due to a lack of access to pre-campaign usage data, we cannot entirely rule out systematic differences between the treatment and control groups.[6] Third, we rely on app opens as a proxy for usage and cannot observe installation timestamps or richer engagement metrics such as session duration or in-app behavior. While our study focuses on post-adoption usage as a primary driver of long-term engagement, we acknowledge that the absence of transaction and revenue data limits our ability to directly quantify the financial return on advertising spend for retailers. Fourth, our data availability was constrained as we could not access information about the app where the ad was placed, nor were we able to observe user behavior in other apps. Due to these limitations, we cannot fully control for broader mobile usage tendencies or unmeasured preferences for app categories. Finally, the study is based on a single campaign for a Dutch online marketplace app, which may limit generalizability to other contexts or app types. To address these limitations, the next set of studies introduces a critical incident approach and controlled experimental designs. These studies enable alternative specifications of app usage, mitigate concerns about selection bias, and facilitate a cleaner identification of the effects of pre-adoption advertising.

5. Study 2A – critical incident study – usage as duration

In Study 1, we operationalized app usage as the number of times a user opened the app. However, some users may not open the app frequently but still use it for extended periods. To address this, Study 2A observed consumers' actual app screen time and the relative screen time compared to all other apps installed on a user's phone. In addition, Study 2A expands the scope of our investigation to include 26 app categories, whereas Study 1 focused on only one. Furthermore, Study 1 was limited in its ability to measure important user and usage characteristics such as demographics, the number of installed apps, and total phone usage time. We include these in Study 2A, which further underscores the robustness of our effect and allows us to explore novel boundary conditions. We do so by conducting a critical incident study (cf. Eigenraam et al., 2021; Sirianni et al., 2013) in which we measure iOS users' app screen time. This approach enables us to observe a phenomenon with high ecological validity while still allowing us to ask consumers questions.

5.1. Method

Participants. We recruited 500 UK iOS users via Prolific. We excluded 12 for failed attention checks, 23 for screen time not enabled, and 15 for implausible/erroneous data, leaving 450 participants (52% female; Mage = 36.14, SD = 11.51, range = 18–65).

Procedure and measurements. We pre-screened participants as iOS users who had installed a new app within the last two months and asked them to name their most recent install, which became the focal app for all subsequent questions. We also inquired whether the participants had encountered any advertisement for this app before installing it (binary choice: yes/no). Later, we asked the participants to retrieve their phones and access the iOS Screen Time feature, which automatically tracks how much time users spend on different apps and on the screen overall. We provided the participants with a comprehensive guide to obtaining screen time information. Subsequently, we asked participants to provide the *total screen time* for the last week (hours, minutes) and *the screen time for the focal app* during the previous week (hours, minutes), as reported by the screen time app.[7] Participants also reported the app's *cost, days since installation, app category* (from Apple's 26 categories), *number of apps installed* in the last two months, and demographics (*age, gender*)

[6] To account for any systematic differences in the ad-exposure and control users emanating from operating system distribution (e.g., Apple users typically exhibit higher baseline app usage), we employed propensity score matching to equalize the likelihood of ad exposure. The positive causal effect of advertising on post-adoption usage was confirmed to be statistically significant and consistent when the analysis was re-run using both Inverse Probability Weighting Regression (see Web Appendix A).

[7] Screen time always reports full minutes and hours as such, making it a discrete measurement. Hence, each reported value represents a specific point in time and cannot take on an infinite number of possible values within a given range.

Table 6
Accounting for exposure time heterogeneity.

	During & Post Campaign Weeks			Post Campaign Weeks		
	Coeff.	SE	*p*	Coeff.	SE	*p*
Pre-adoption Exposure	0.12	0.05	0.01	0.13	0.06	0.03
Pre-adoption Exposure Week 21	−0.20	0.05	<0.001	−0.19	0.05	<0.001
Pre-adoption Exposure Week 22	−0.05	0.05	0.29	−0.01	0.05	0.84
Pre-adoption Exposure Week 23	−0.08	0.05	0.13	−0.08	0.06	0.18
Pre-adoption Exposure Week 24	0.03	0.05	0.51	0.04	0.06	0.50
Cumulative ad exposure	−0.02	0.01	0.01	−0.02	0.01	0.07
Ad interaction	0.06	0.02	0.003	0.08	0.02	<0.001
Android	−0.69	0.02	<0.001	−0.64	0.02	<0.001
Dutch	0.01	0.02	0.62	0.01	0.03	0.69
Time trend	−0.04	0.00	<0.001	−0.05	0.00	<0.001
Constant	2.64	0.03	<0.001	2.72	0.06	<0.001
Model summary	Log likelihood =−184,578.1 N =90,634			Log likelihood = −129,065.6 N = 70,296		

Note: The coefficient Pre-adoption Exposure Week g is the short form of the interaction term($Preadoption\ Exposure\ User_i \times Ad\ Exposure\ Week g$) for g ∈ {21, …, 24}. Users first exposed in Week 25 (*Ad Exposure Week*25) serve as the baseline exposure cohort.

Table 7
The link between pre-adoption Ad exposure and usage duration.

	Coeff.	SE	*p*
(Intercept)	4.06	0.2	<0.001
Pre-adoption ad exposure	0.38	0.15	0.03
Total screen time	0.00	0.00	0.001
Sex	−0.03	0.13	0.83
Age	−0.01	0.01	0.13
Days since installation	0.01	0.01	0.07
Cost app	0.02	0.02	0.36
Number of installed apps	0.02	0.03	0.48
Category dummies	included		

$R^2 = 0.32$.

5.2. Results

Descriptive statistics and model-free evidence. Among our study participants, 139 (30.89%) saw an advertisement for the focal app before installing it. The participants installed the focal app an average of 17.17 days ago (SD = 15.66). They spent, on average, 1807.80 min (SD = 1271.55) on their phone screens in the last week and 79.54 min (SD = 173.02) on the focal app. Users who saw an ad for the focal app before installing it used it longer (M = 109.04 min; SD = 207.33) than those who did not see an ad before installation (M = 66.36 min; SD = 153.82), $t(448) = 2.43$, $p = .02$. Users who saw an ad did not differ significantly in total screen time (M = 1819.45 min; SD = 1172.06) from those who did not see an advertisement for the focal app (M = 1802.59 min; SD = 1315.37), $t(448) = 0.13$, $p = .90$).

Hypothesis test. To test H1, we used Poisson regression given the discrete nature of usage duration data. Ad-exposed users used the focal app more than non-exposed users, controlling for total screen time and other variables (see Table 7), supporting H1. A linear-regression robustness check (see Web Appendix B, Table WA B.1) confirmed this: ad-exposed users spent 8.7% of total screen time on the focal app vs. 6.0% for non-exposed users. We also estimated a Poisson regression model restricted to apps classified as 'shopping' in the App Store (N = 64; 14% of the sample); results remain robust (Table WA B.2).

We estimate a further Poisson regression model with focal app screen time as the dependent variable to explore the durability of our focal effect (see Table WA B.3). The analysis reveals a positive Ad exposure × Days since installation interaction effect, further demonstrating that the effect of ad exposure on app usage becomes stronger over time. This is consistent with Study 1′s higher post-campaign engagement (Model 2, Tables 5–6).

5.3. Discussion

This study aims to replicate Study 1′s results and address the identified limitations of the field study. The results support H1 and demonstrate the strong, consistent positive impact of pre-adoption ad exposure on post-adoption usage. This effect is robust to different operationalizations of app usage (i.e., screen time in the focal app, screen time in the focal app as a percentage of total screen time, and the number of app opens) while controlling for important usage and user characteristics. Furthermore, we show that the effect of advertising exposure becomes stronger over time. Finally, this study also demonstrates that the observed effects are generalizable

beyond retail apps.

6. Study 2B – usage as subscription time commitment

Our first two studies examined the main effect of pre-adoption ad exposure on app usage, measured as app opens (Study 1) and screen time (Study 2A). Study 2B extends this investigation by testing whether the effect generalizes to another managerially relevant outcome: subscription time commitment. The underlying rationale is that if pre-adoption advertising increases usage, it should also lead consumers to commit to longer subscription plans as they anticipate higher usage. This study tests that assumption.

6.1. Method

Participants and design. We recruited 350 participants from a subject pool at a North American university. After removing duplicate entries, incomplete responses, and three participants who failed the attention check, the final sample consisted of 338 participants (44.1% female; $M_{age} = 20.62$, SDage = 1.22).[8] The participants were randomly assigned to one of the conditions of a single-factor (exposure to mobile advertising: target ad vs. unrelated ad) fully randomized between-subjects online experiment. This approach resembles the one used in our field experiment, in which consumers either saw the target ad or an unrelated one.

Procedure and measurements. Participants in the Pre-Adoption Ad Exposure condition read a scenario in which they encountered an advertisement for the eBook retailer eBooks.com's app and subsequently installed it. The control group read a parallel scenario featuring an unrelated ad (for the music streaming service deezer), followed by the same installation of the eBooks.com app. Participants in both conditions were shown a description of the functionality of the eBooks.com app (see Web Appendix C). We follow this scenario paradigm (ad or unrelated ad exposure, subsequent installation, and all participants being informed about the app's basic functionality) in all experiments presented in this paper. To minimize the differences between the two ads, the ad copy in the unrelated ad condition was based on the same creative as the target ad (see Fig. 3).

Participants in both conditions were then asked to indicate their commitment to the newly installed ebooks.com app by picking a plan. Because our focus is post-adoption engagement, we condition on adoption and measure commitment through plan choice and anticipated use, thereby avoiding a binary adoption outcome that would confound unrelated drivers of uptake. The task mirrors standard onboarding (tier selection, including a free/basic plan), which permits low-commitment responses without forcing engagement.

The dependent variable was participants' choice between two subscription plans. Participants were presented with the following options: The *Short-Term Subscription ("Flex Plan")* was described as a rolling one-month subscription costing $12.99 per month. It included unlimited access to the full eBook catalog, one free premium eBook credit per month, one "skip-the-line" reservation per month, and the possibility to cancel at any time.

The *Long-Term Subscription ("Commit & Save Plan")* was described as a 12-month subscription billed annually at $99 (equivalent to $8.25 per month). It included unlimited access to the full eBook catalog, one free premium eBook credit per month (12 in total), two "skip-the-line" reservations per month, and exclusive seasonal offers such as bonus credits or curated collections. The dependent measure was a binary choice, coded as *0 = Short-Term Subscription (Flex Plan)* and *1 = Long-Term Subscription (Commit & Save Plan)*. These plans follow industry practice, in which longer-term plans are paid in a lump sum, resulting in a lower monthly price and including some benefits (e.g., see audible.com). Following this choice, we assessed intrinsic interest in the ebook app category with 7-point Likert scales (1 = Strongly Disagree, 7 = Strongly Agree): "I'm very interested in eBooks," "I wish to learn more about eBooks," and "Reading eBooks is a pleasurable experience."

6.2. Results

A two-sample test of proportions indicated that participants exposed to pre-adoption advertising were significantly more likely to select the long subscription option than those in the control condition. Specifically, 41.6% of participants in the advertising condition selected the long subscription, compared to 29.7% in the control condition ($z = -2.29$, $p = .022$). We estimated a series of logistic regression models predicting long subscription choice as a function of advertising exposure and proposed covariates (see Table 8). In Model 1, advertising exposure significantly increased the likelihood of selecting the long subscription option (b = 0.523, SE = 0.230, $p = 0.023$). This effect remained significant after controlling for participants' interest in eBook apps (Model 2: b = 0.507, SE = 0.235, $p = .031$).

[8] Following established practice for response-time–based quality control, in all online experiments in this paper, we excluded respondents whose total survey completion time was morethan ±2 SD from the sample mean. SD–based trimming is a widely used method for response-time outlier exclusion and performs well in simulations (low bias; few Type-I errors; Berger and Kiefer, 2021). Completion time is a reliable non-reactive indicator of careless or meaningless responding (Leiner, 2019); very fast completions are associated with satisficing and poorer data quality (Greszki et al., 2015; Malhotra, 2008), while very slow completions often reflect distraction and reduced attentiveness (Read et al., 2022). This is particularly important to ensure the working of experimental manipulations in online experiments. In this study, none of the participants were slower or faster than 2SD. Hence, no response time-based exclusions were applied.



Fig. 3. Stimulus material study 2B. Target Ad (left) and control Ad (right).

6.3. Discussion

Study 2B supports H1, demonstrating that pre-adoption advertising effects extend to subscription commitment decisions. Participants with ad exposure were significantly more likely to select the 12-month subscription plan (41.6%vs. 29.7%; $p = .022$), and this effect was robust to differences in intrinsic interest in the ebook category. This finding suggests that advertising exposure creates higher usage expectations, which translate into a greater willingness to commit to extended subscription periods.

7. Study 2C – incentive compatible voucher allocation

In this study, we examine the impact of pre-adoption advertising on incentive-compatible voucher allocation to mitigate hypothetical bias. By forcing real trade-offs between apps under budget constraints, the design mirrors marketplace choices and strengthens external validity. This consequential choice enables us to test mechanism-driven predictions on a real outcome, rather than relying solely on self-reports.

Participants and design. We recruited 410 UK participants via Prolific. Given the context of this study, participants were pre-screened to ensure they were smartphone users. After removing 13 participants whose survey duration was longer or shorter than two standard deviations from the mean (see Study 2B), the final sample consisted of 397 participants **(**50.13% female**;** $M_{age} = 43.21$, SDage = 13.41). The participants were randomly assigned to one of the conditions in a single-factor, fully randomized between-subjects online experiment (exposure to mobile advertising: target ad vs. unrelated ad), similar to Study 2B.

Procedure and measurements. We followed Study 2B's paradigm with audiobooks.com as the target ad. Participants saw either the target ad or an unrelated ad for Quietude (meditation app). Participants in both conditions were shown a description of the functionality of the audiobooks.com app (see Web Appendix D). To minimize differences, both ads used similar creative (Fig. 4).

The primary dependent variable was an incentive-compatible allocation task framed as a prize draw. Participants allocated a potential £50 win between Audiobooks.com vouchers (monthly audiobook subscription at £7.99/month) and Scentbird vouchers (monthly fragrance subscription at £7.99/month) in any integer proportion totaling £50. We then recorded app interest and demographics. Increased voucher allocation indicates participants purchase more app usage time.

7.1. Results

An independent-samples t-test indicated that participants exposed to pre-adoption advertising were significantly more likely to allocate funds to audiobook vouchers than participants in the control condition. Specifically, participants in the advertising condition on average allocated £33.15, compared to £29.03 in the control condition ($t = -2.29$, $p = .03$). We estimated linear regression models predicting voucher allocation as a function of advertising exposure (see Table 9). In Model 1, advertising exposure significantly increased the amount allocated to the audiobook voucher (b = 4.116, SE = 1.896, $p = .031$). This effect remained significant after controlling for participants' interest in audiobook apps (Model 2: b = 3.609, SE = 1.771, $p = .042$).

Table 8
Effect of pre-adoption Ad exposure on long-term subscription.

12-month subscription	Model 1			Model 2		
	Coeff.	S.E.	*p*	Coeff.	S.E.	*p*
Ad Exposure	0.52	0.23	0.02	0.51	0.24	0.03
Interest	—			0.346	0.09	<0.001
Intercept	−0.86	(0.17)	<0.001	−2.271	0.40	<0.001
Model Summary	Pseudo $R^2 = .01$ LR χ^2=5.25			Pseudo $R^2 = .05$ LR χ^2=22.26		



Fig. 4. Stimulus material study 2C. Target Ad (left) and control Ad (right).

7.2. Discussion

Study 2C provides robust support for H1, demonstrating that participants exposed to pre-adoption advertising allocated significantly more money to audiobook vouchers (£33.15 vs. £29.03; $p = .03$), representing a 14% increase in monetary commitment. A monetary commitment implies a greater usage commitment since funds must be allocated to a subscription. This effect remained significant after controlling for category interest, indicating that advertising influences actual spending behavior beyond mere preference attraction. The findings confirm that pre-adoption advertising drives genuine behavioral changes that translate into real resource-allocation decisions with meaningful financial implications.

8. Study 3A – process evidence by mediation

Our previous four studies have consistently demonstrated that pre-adoption exposure to advertising increases post-adoption app usage across various operationalizations and in different contexts. These studies, however, do not allow us to identify a psychological mechanism that drives the higher usage among users who installed the app after being exposed to advertising. Therefore, the central aim of Studies 3A and 3B is to demonstrate that exposure to ads can reduce users' post-adoption dissonance, thereby increasing app usage (H2).

8.1. Method

Participants and design. We recruited 200 UK consumers via Prolific to participate in an online experiment. Three participants did not finish the study, resulting in a sample of 197 consumers (48.7% female; $M_{age} = 41.66$, $SD = 13.84$, range = 19–88 years). All completion times lay within ±2SD, so no further exclusions were applied. Given the context of this study, participants were prescreened to be smartphone users. We randomly assigned participants to one of the two conditions in a single-factor (exposure to mobile advertising: target ad vs. unrelated ad) between-subjects design.

Procedure. We followed the same experimental paradigm introduced in Study 2B Like our field study, the focal app of this study was a marketplace app. We chose the app Wallapop because its penetration in the UK market was relatively low at the time of the study. In the control condition, we changed the brand name from Wallapop to BeSocial (an app for making social connections) and slightly modified the text to align with the app's context (Fig. 5). To ensure that participants in both conditions did not differ in their understanding of the app's purpose, the next step of the study provided all participants with a brief description and a screenshot of the app (see Web Appendix E). We then measured the focal constructs of this study.

8.2. Measurements

Anticipated app-use frequency. We measured anticipated app-use frequency using a 101-point bipolar sliding scale (0 = "never", 100 = "all the time"; cf. Bernritter et al., 2016), asking participants: *"Imagining yourself in this scenario, how often do you think you would use Wallapop going forward?"*

Post-adoption dissonance. We measured post-adoption dissonance using four items on a 101-point Likert scale, adapted from Sweeney et al. (2000), which comprised their "wisdom of purchase" subscale. An example item is "In hindsight, would you wonder if you really needed this app"? (0 = "Definitely not"; 100 = "Definitely yes"). See Appendix D for the complete scale. The scale's internal consistency was very high (Cronbach's $\alpha = .92$).

In this and all subsequent studies that include the cognitive dissonance mediator, we measure the dependent variable prior to the mediator. This ordering was deliberate because measuring cognitive dissonance first could sensitize participants to the discomfort underlying the manipulation, thereby artificially inflating or deflating responses to the dependent variable. By assessing the dependent variable first, we minimize the risk of such demand effects contaminating the key outcome of interest.

Table 9
Effect of pre-adoption Ad exposure on voucher allocation.

Voucher allocation	Model 1			Model 2		
	Coeff.	S.E.		Coeff.	S.E.	*p*
Ad Exposure	4.12	1.90	.031	3.61	1.77	0.04
Interest	—			4.45	0.58	<0.001
Intercept	29.03	1.34	<0.001	10.07	2.77	<0.001
Model Summary	$R^2 = .01$ $F(2,394) = 32.26$, $p < 0.001$			$R^2 = .14$ F (3, 393) 21.47, $p < 0.001$		

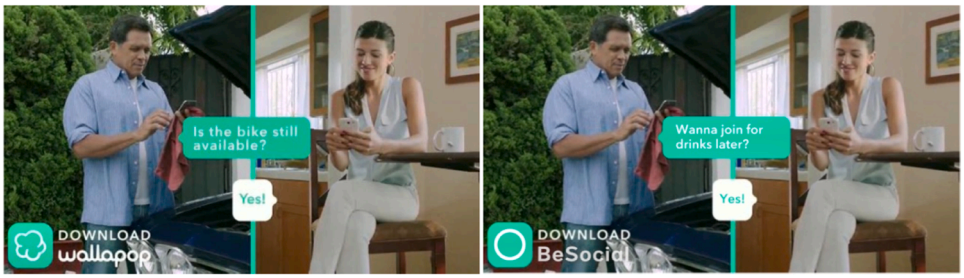


Fig. 5. Stimulus material study 3A. Target Ad (left) and Control Ad (right).

8.3. Results

We first tested our main effect (H1) using ANOVA. Replicating findings from our previous studies, this analysis showed that consumers in the target ad condition indicated a higher anticipated frequency to use the target app ($M = 43.74$; $SD = 26.11$) than users in the non-relevant ad condition ($M = 36.31$; $SD = 24.22$; F (1, 195) $= 4.28$, $p = .040$).

To further test our hypothesis (H2) that exposure to advertising increases usage by decreasing perceived post-adoption dissonance, we conducted a mediation analysis using Hayes's (2013) PROCESS Model 4 (10,000 bootstrapped samples) with exposure to the target ad before installation (0 = exposure to the unrelated ad[9]) as the independent variable, perceived post-adoption dissonance as the mediator, and anticipated app usage frequency as the dependent variable (Table 10). The analysis reveals that exposure to target ads before installation reduced post-adoption dissonance, and that post-adoption dissonance negatively affected anticipated app-use frequency. In support of H2, the analysis showed that exposure to advertising had a positive indirect effect on anticipated app-use frequency (indirect effect = 2.27, Boot SE = 1.20, 95% confidence interval [CI]: [.104; 4.810]).

8.4. Discussion

Study 3A replicates the findings of Studies 1 and 2 (A, B, and C). This replication strengthens the generalizability and robustness of our findings by demonstrating their consistency across different research conditions. Furthermore, this study introduces the reduction of post-adoption dissonance as a psychological process driving the positive effect of pre-adoption advertising exposure on post-adoption usage.

9. Study 3B – process evidence by moderation

To further demonstrate the robustness of our framework, in Study 3B, we employ a moderation-of-process design (Spencer et al., 2005; for applications in marketing, see Aydinli et al., 2017; Schreier et al., 2012). In Study 3B, we manipulate post-adoption dissonance and observe how it moderates the effect of exposure to pre-adoption advertising on usage. The reasoning behind a moderation-of-process approach is that the effect of the independent variable (exposure to advertising) becomes weaker when the process variable (dissonance) is manipulated. Our core argument is that a key driver of the effectiveness of ad exposure in increasing usage is a decrease in experienced dissonance. If we experimentally introduce an increased level of dissonance, our focal main effect should become weaker or disappear.

9.1. Method

Participants and design. We recruited 300 consumers from the general US population via Prolific to participate in an online

[9] Note: Study 3C (Web Appendix F) provides process evidence for the comparison of a target ad vs no ad.

Table 10
Pre-adoption Ad exposure increases anticipated app-use frequency by decreasing perceived dissonance.

	Perceived Dissonance (M)			Anticipated App-Use Frequency (Y)		
Antecedent	Coeff.	SE	*p*	Coeff.	SE	*p*
Pre-adoption ad exposure (X)	−7.49	3.63	0.04	5.16	3.47	0.14
Perceived dissonance (M)	—-	—-		−0.30	.07	<0.001
Constant	49.40	2.60	<0.001	51.28	4.15	<0.001
Model summary	$R^2 = .02$ $F(1, 195) = 4.26$, $p = .040$			$R^2 = .11$ $F(2, 194) = 12.37$, $p < .001$		

experiment. Two did not pass attention checks, and 12 had a completion time of ±2SD from the sample mean and were excluded from the sample. This resulted in a sample of 286 participants (46.85% female; $M_{age} = 36.29$, $SD = 12.77$, range = 19–75 years). Given the context of this study, participants were pre-screened to be smartphone users. We randomly assigned participants to one of four conditions in a 2 (ad: target ad vs. unrelated ad) × 2 (dissonance: yes vs. no) between-subjects design.

Procedure and measurements. The procedure resembled that of Study 3A. We manipulated types of ad copy, similar to Study 3A. Anticipated app-use frequency and perceived dissonance were measured in the same manner as in Study 3A. In the dissonance experimental conditions, dissonance was induced by presenting participants with a specific scenario after they had decided to install the app (cf., Study 3A). "Now imagine that a while after installing the app, you wonder whether you really needed that app and if you should have installed it at all." It is important to note that we are manipulating post-installation dissonance, and therefore, the dissonance manipulation had to occur after the installation decision in the scenario.

Manipulation check. An independent-samples *t*-test revealed that participants in the dissonance conditions experienced significantly greater dissonance (M = 60.99; SD = 28.69) than those in the no dissonance conditions (M = 43.13; SD = 28.53), $t(284) = 5.28$, $p < .001$. This indicates that our dissonance manipulation was successful.

9.2. Results

As expected, a full factorial ANOVA with anticipated app-use frequency as the dependent variable revealed a significant Ad exposure × Dissonance interaction effect, $F(1, 282) = 9.46$, $p = .002$. The analysis also revealed a significant dissonance main effect ($F(1, 282) = 24.69$, $p < .001$) and a non-significant ad exposure main effect ($F(1, 282) = 0.37$, $p = .539$). Planned comparisons showed that consumers in the no dissonance conditions reported anticipating using the app more after exposure to pre-adoption advertising compared to no exposure to advertising (diff = 9.72; SE = 3.73; $t(282) = 2.61$, $p = .010$). This is a replication of our focal main effect.

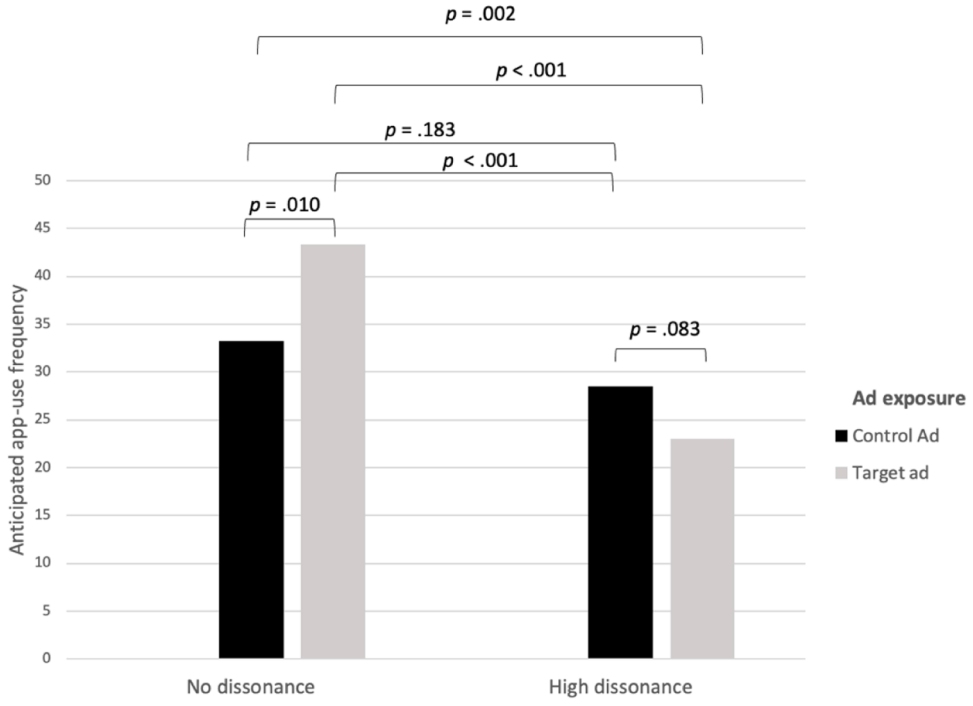


Fig. 6. Anticipated app-use frequency as a function of Ad exposure and dissonance.

Furthermore, in line with what would be expected based on a successful moderation of the process, the results showed that this effect disappears in situations of higher post-installation dissonance: consumers who were or were not exposed to pre-adoption ads in the dissonance conditions did not significantly differ in their anticipated app-use frequency (diff = 6.49; SE = 3.73; $t(282) = 1.74$, $p = .083$.; Fig. 6).

9.3. Discussion

This study provides further evidence for the important role of post-installation dissonance as a mechanism underlying the effects of pre-adoption advertising exposure on usage. This study also confirms the causal negative effect of dissonance on usage. All our studies show that advertising exposure boosts post-adoption app use, confirmed across different measures, contexts, and methods. Studies 3A and 3B highlight perceived cognitive dissonance as a key psychological driver. In the next three studies, we explore three boundary conditions that govern the dissonance-reduction process at different levels: the type of ad copy, which determines the availability of justificatory information (Study 4); the characteristics of the targeted consumer, which shape the individual's drive to maintain psychological consistency (Study 5); and the competitive landscape, which determines the external pressure of attractive rejected alternatives (Study 6).

10. Study 4 – the role of functional appeals in reducing dissonance

Study 4 tests whether an ad framed around functional cues lowers perceived dissonance and, in turn, boosts usage more than an otherwise identical ad framed around experiential cues (H3). Experiential appeals foreground sensory, hedonic, and self-expressive benefits that evoke feelings and lifestyle aspirations (Holbrook & Hirschman, 1982), leaving objective performance expectations vague (Zarantonello et al., 2013). This vagueness hampers consumers' ability to reassure themselves after adoption, as they have no concrete performance yardstick to say, "Yes, the app is doing what it promised."

10.1. Method

Participants and design. We recruited 299 UK consumers via Prolific to participate in an online experiment. Ten took shorter than 2 SDs from the mean to complete the experiment, resulting in a final sample of 289 (49.8% female; $M_{age} = 41.88$, $SD = 13.61$, range = 20–78 years). Given the context of this study, participants were pre-screened to be smartphone users. We randomly assigned participants to one of four conditions in a single-factor (type of ad: unrelated control ad vs. ad with no slogan vs. ad with a functional slogan vs. ad with a non-functional slogan) between-subjects design.

Procedure and measurements. The procedure was similar to that of Study 3A. Again, using the Wallapop app, we manipulated the different types of ad copy, as seen in Fig. 7. The control (i.e., unrelated ad) condition used the same stimulus material as in Study 3A. We measured anticipated app-use frequency and perceived post-adoption dissonance in the same way as in Study 3A. A pre-test (Web Appendix G) confirmed that the functional slogan ad was perceived to communicate significantly more functionality than all other ads. Details on the study procedure can be found in Web Appendix H.

10.2. Results

Main analysis. An ANOVA reveals a significant main effect of the experimental condition $F(3, 285) = 5.05$, $p = .002$. Planned comparisons show that participants in the functional slogan condition report higher anticipated app-use frequency ($M = 30.63$, $SE = 2.28$) than those in the non-functional slogan condition (diff = 8.58, $p = .008$), the no slogan condition (diff = 10.06, $p = .002$), and the control ad condition (diff = 11.36, $p < .001$). The difference in anticipated app-use frequency between these three latter conditions is not statistically significant.

A second ANOVA investigates the ad appeal's effect on perceived post-adoption dissonance. This analysis reveals a significant main effect of the appeal of the ad on perceived post-adoption dissonance $F(3, 285) = 16.88$, $p < .001$. In line with our reasoning, participants in the functional slogan condition perceived significantly less dissonance ($M = 46.85$, $SE = 2.90$) than those in the non-functional slogan condition (diff = −19.73, $p < .001$), the no slogan condition (diff = −16.33, $p < .001$), and the control ad condition (diff = −28.52, $p < .001$). Furthermore, participants in the non-functional slogan (diff = −8.78, $p = .034$) and the no slogan conditions (diff = −12.19, $p = .004$) perceived significantly less dissonance than participants in the control ad condition. The differences between the other conditions were not statistically significant.

Mediation analysis. We conducted a mediation analysis using Hayes' (2013) PROCESS macro to further test our framework. Our theorizing suggests significant indirect effects of the different ad appeals (vs. the control ad) on usage intent via perceived post-adoption dissonance. The mediation analysis supports this, and we present these findings in Table 11. The results show significant and positive indirect effects of all three ads. The functional slogan has the strongest indirect effect on usage intent.

10.3. Discussion

These results further support H3. We demonstrate that an ad's capacity to reduce dissonance by incorporating functional appeal in the ad copy positively influences users' post-adoption anticipated app-use frequency. Marketers and advertisers can leverage this finding by deliberately creating ad copy that informs consumers about the app's usability. Again, we show that a decrease in perceived

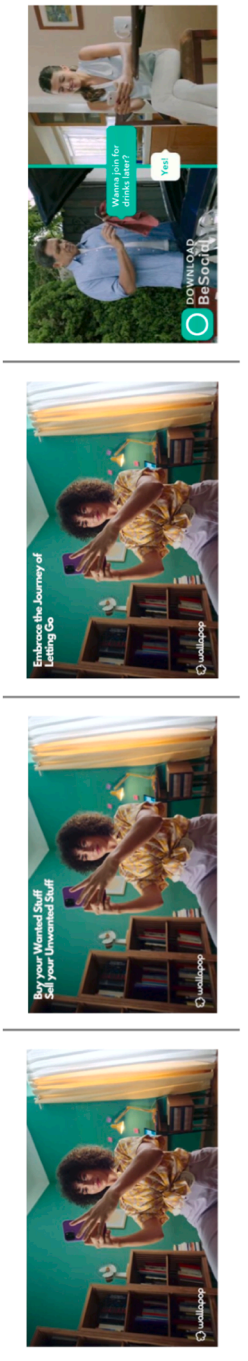


Fig. 7. Stimulus material study 4. No slogan (left), Functional slogan (second from left), Non-functional slogan (third from left), and Unrelated control Ad (right).

post-adoption dissonance mediates this effect. These findings align with Study 1, as the campaign in our field experiment clearly showcased a variety of product categories that consumers could purchase via the app and would, therefore, be categorized as including functional cues.

11. Study 5 – the role of need for control in reducing dissonance

We hypothesize that the positive effect of pre-adoption advertising exposure on post-adoption app usage (via decreased dissonance) is stronger for consumers with a higher need for control (H4). Study 5′s main aim is to test this hypothesis.

11.1. Method

Participants and design. We recruited 200 UK participants via Prolific for an online experiment. After removing participants with incomplete responses and four participants whose response time fell outside two standard deviations from the mean, the final sample consisted of 182 participants (43.4% female; $M_{age} = 41.07$, $SD = 10.82$, range = 20–60 years) who were randomly assigned to one condition of a single-factor (ad exposure: target ad vs. unrelated ad) between-subjects design.

Procedure and measurements. Participants were randomly assigned to view either a focal functional ad for an e-book subscription app or an unrelated Deezer music-service ad—the identical stimuli used in Study 2B. After exposure, participants completed the same incentive-compatible voucher-allocation task as in Study 2B, allocating £50 between the focal app and an alternative retailer (scent bird), and (ii) reported post-purchase cognitive dissonance using the four-item scale from Studies 3A and 3B. We measured need for control with three items adapted from the Desirability of Control Scale (Burger and Cooper, 1979): "I enjoy having control over my own destiny," "I like to be in control of most things that occur in my life," and "I prefer a job where I have a lot of control over what I do and when I do it" (1 = strongly disagree, 7 = strongly agree). This scale was deemed reliable (α = .74), followed by demographics.

11.2. Results

ANOVA results for voucher spending showed no significant main effects or interactions (all *ps* > .61). However, for dissonance, there was a significant ad exposure × control interaction ($F(1,177) = 4.40$, $p = .037$), while main effects of ad exposure and control were non-significant (*ps* > .11).

The moderated mediation analysis (PROCESS model 7) further revealed significant support for H4 (Table 12). In the dissonance equation, the interaction between ad exposure and need for control was significant (B = −11.62, SE = 5.48, z = −2.12, $p = .034$), indicating that higher need for control strengthens the dissonance-reducing effect of pre-adoption advertising. Dissonance significantly predicted reduced voucher allocation (B = −0.24, SE = 0.05, z = −4.66, $p < .001$). The index of moderated mediation was significant (IMM = 2.78, 95% BCa CI = [0.32, 6.14]), confirming that the indirect effect of advertising on voucher allocation via dissonance varies as a function of participants' need for control.

11.3. Discussion

These results demonstrate that advertising's indirect effect on usage via dissonance reduction is stronger for consumers with a higher need for control. This finding confirms that the effectiveness of the justification mechanism depends on individual differences in how consumers process advertising exposure. Consumers with a high need for control more effectively convert ad exposure into consonant cognitions that suppress post-adoption doubt.

Table 11
Impact of Ad appeal on usage via perceived dissonance.

	Perceived Dissonance (M)			Anticipated App-Use Frequency (Y)			Indirect effect on Y
Antecedent	Coeff.	SE	*p*	Coeff.	SE	*p*	
No slogan	−12.19	4.14	0.004	−2.10	3.09	0.50	3.40[a]
Non-functional slogan	−8.79	4.11	0.03	0.31	3.04	0.92	2.45[b]
Functional slogan	−28.52	4.10	<0.001	3.40	3.25	0.30	7.96[c]
Perceived dissonance (M)	—-	—-		−0.27	0.04	<0.001	—-
Constant	75.37	2.89		40.32	3.90	0.001	—-
Model summary	$R^2 = .15$ $F(3, 285) = 16.88$, $p < .001$			$R^2 = .17$ $F(4, 284) = 14.64$, $p < .001$			

Reference category = control ad.
[a] sig: 95% CI = [1.08, 6.07]
[b] sig: 95% CI = [.24, 5.16]
[c] sig: 95% CI = [4.47, 12.10]

Table 12
Impact of need for control on usage via perceived dissonance.

Voucher Allocations	Perceived Dissonance (M)			Voucher Allocation (Y)			Index of moderated mediation[†]
	Coeff.	SE	*p*	Coeff.	SE	*p*	
Ad exposure	52.15	32.36	0.107	–1.28	2.92	0.66	
Control	0.75	3.11	0.811	–0.58	1.81	0.75	—
Ad × Control	–11.62	5.48	0.034	—	—		2.78 [0.32, 6.14]
Perceived dissonance (M)	—	—		−0.24	0.05	<0.001	—
Constant	46.37	18.16	0.011	40.50	11.13	<0.001	—
Model diagnostics	var(dissonance)= 711.43			var(voucher)= 351.50			Log L = –1638.53

[†] Index calculated for the Ad × Control interaction (bootstrapped bias-corrected percentile method).

12. Study 6 – the role of competitive intensity in reducing dissonance

Study 6 tests H5 by examining how competitive intensity moderates the effects of pre-adoption advertising. We argue that competitive markets intensify the dissonance-generating potential of pre-adoption advertising by highlighting the abundance of attractive alternatives that consumers must psychologically reject. In competitive contexts, advertising exposure amplifies awareness of foregone options, thereby increasing post-adoption dissonance. We predict that advertising exposure will generate greater dissonance in more competitive market environments.

12.1. Method

Participants and design. We recruited 798 UK participants via Prolific for an online experiment. After removing participants with incomplete responses and those whose completion time fell outside two standard deviations from the mean, the final sample consisted of 686 participants (50% female; $M_{age} = 44.10$, $SD = 13.58$, range = 20–81 years). The study employed a 2 (ad exposure: target ad vs. unrelated ad) × 2 (market competitiveness: high competition vs. low competition) between-subjects design.

Procedure and measurements. Participants were randomly assigned to one of four conditions. The experiment followed our basic scenario paradigm. Participants viewed either a focal ad for a fragrance subscription app (Scentbird) or a control ad (for the Deezer app) and received information indicating the app operated either in a highly competitive market (high competition) or in a market with limited alternatives (low competition; Web Appendix K). Participants in all conditions were shown basic information about the Scentbird app. After exposure, participants completed the same incentive-compatible voucher-allocation task as in Study 2B, allocating a potential £50 win between the focal app and an alternative, unrelated retailer (ebooks.com), and reported post-purchase cognitive dissonance using the four-item scale from Studies 3A and 3B.

For our manipulation check, we assessed perceived market competitiveness with a three-item, 7-point Likert scale (1 = strongly disagree; 7 = strongly agree). The items included: "Scentbird operates in a competitive market," "There are many other services like Scentbird," and "Scentbird has a lot of competition." This scale was highly reliable (Cronbach's α = .95).

12.2. Results

The competitiveness manipulation was successful. Participants in the high competitiveness condition perceived Scentbird to operate in a more competitive market (M = 5.73; SD = 1.19) than those in the lower competitiveness condition (M = 2.73; SD = 1.47), $t(684) = 29.39$, $p < .001$. ANOVA results revealed no significant effects of ad exposure ($F(1682) = 0.71$, $p = .40$), competition ($F(1682) = 0.08$, $p = .78$), or their interaction ($F(1,682) = 0.39$, p = .533) on voucher allocation. For dissonance, there was a significant ad × competition interaction ($F(1,682) = 4.09$, $p = .04$), while the main effect of competition was non-significant ($F(1,682) = 0.32$, $p = .57$); the main effect of ad exposure was marginally significant ($F(1,682) = 3.75$, $p = .05$). This interaction suggests that the effect of advertising on dissonance varies depending on the level of market competition.

A moderated mediation analysis revealed a significant ad × competition interaction predicting dissonance (b = 9.08, SE = 4.48, $p = 0.04$), indicating that advertising exposure generates greater dissonance in highly competitive markets (see Table 13). Dissonance significantly predicted reduced voucher allocation (B = –0.242, SE = 0.025, $p < .001$). The index of moderated mediation was

Table 13
Impact of competitive intensity on usage via perceived dissonance.

	Perceived Dissonance (M)			Voucher Allocation (Y)			Index of moderated mediation
	Coeff	SE	*p*	Coeff.	SE	*p*	
Ad exposure	–6.15	3.17	0.05	0.39	2.99	0.85	—
Competition	–1.80	3.19	0.57	–1.07	2.10	0.61	—
Ad × Competition	9.08	4.48	0.04	0.23	2.97	0.94	–2.20 [–4.39, –0.003]
Perceived dissonance (M)	—	—		–0.242	0.025	<0.001	—
Constant	64.72	2.25	<0.001	45.80	2.21	<0.001	—
Model diagnostics	var(dissonance) = 859.79			var(voucher) = 375.26			Log L = –6297.50

significant (IMM = –2.20, 95% CI = [–4.39, –0.003]), confirming that the indirect effect of advertising on voucher allocation via dissonance varies as a function of market competitiveness.

12.3. Discussion

Study 6 supports H5 by showing that ad exposure is more effective at reducing dissonance and, in turn, increasing post-adoption engagement in less competitive markets compared to highly competitive ones.

13. General discussion

While retail apps are an important channel for driving sales and collecting customer data, their commercial value is only realized if customers continue to engage with them. However, retailers face the critical challenge of converting initial app downloads into active usage, as many users abandon the app shortly after installation. Our research addresses this issue by investigating how pre-adoption advertising can reduce post-adoption dissonance, thereby leading to sustained app usage. We test our proposed framework across eleven studies using a multimethod approach that triangulates evidence across multiple behavioral outcome measures and research designs.

13.1. Theoretical contributions

Our study provides a two-fold contribution to the advertising literature. First, we introduce a novel connection between pre-adoption advertising and post-adoption usage in retail apps. By establishing this link, we extend the digital and mobile advertising literature, which has typically studied the impact of pre-adoption advertising on early behaviors like click-through rates (Chatterjee et al., 2003; Drèze & Hussherr, 2003; Yang & Ghose, 2010) and search behavior (Lewis & Nguyen, 2015; Li & Kannan, 2014). We demonstrate that pre-adoption advertising can influence usage well beyond the initial adoption decision. The finding that pre-adoption advertising can transcend its designed purpose and influence post-adoption use broadens our understanding of how advertising shapes the retail customer journey (Pizzutti et al., 2022).

Second, we propose a dissonance-based framework to explain the theoretical mechanism linking pre-adoption advertising to usage, extending the cognitive dissonance literature (e.g., Brehm & Cohen, 1962; Powers & Jack, 2013; Sweeney et al., 2000) to retail apps. Drawing on Festinger's (1957) propositions that dissonance magnitude depends on the ratio of dissonant to consonant cognitions and the salience of rejected alternatives, we introduce three contingencies that delineate when our proposed effects are likely to strengthen or weaken: ad content at the ad level, need for control at the consumer level, and competitive intensity at the market level. At the ad level, the message's functional content determines whether justificatory cognitions are available to the user. At the consumer level, the user's psychological drive for consistency governs how intensely dissonance is experienced and how much relief pre-adoption advertising can provide. At the market level, competitive intensity determines the visibility of foregone alternatives, thereby amplifying or attenuating the dissonance the user must resolve. Together, these three levels span the message, the consumer, and the market, providing a theoretically grounded account of when pre-adoption advertising will most strongly drive sustained app engagement.

13.2. Managerial implications

Our findings offer valuable insights for retailers managing app acquisition and engagement strategies. While retail app installation rates remain low, averaging 3.9% in the US Apple App Store (Ineza, 2023), the quality of the installer base matters as much as its size. App installation campaigns should be evaluated based on post-adoption shopping engagement rather than download metrics alone, since sustained usage, not installation, drives revenue and loyalty. Our field study shows that a campaign with a lower conversion rate may still deliver a superior ROI if it significantly boosts shopping frequency and sustained engagement among adopters, with usage rates approximately 8% higher for users exposed to pre-adoption advertising. Retailers should therefore calibrate their campaign metrics to their app type. For subscription and digital-catalog apps, the ROI of pre-adoption advertising is best evaluated through renewal rates and long-term commitment decisions, as Studies 2B and 2C demonstrate.

Our field data reveal that users who adopt the app organically exhibit significantly lower post-adoption usage than users exposed to advertising. Even after accounting for systematic differences in who chooses to adopt via a Heckman selection correction, pre-adoption ad exposure is associated with an 8% increase in post-adoption usage, confirming this is not a selection artifact. This suggests that pre-adoption advertising functions as a quality filter, attracting a smaller but more engaged user segment that exhibits substantially higher usage and is more likely to sustain that engagement over the long term. Retailers who optimize campaigns solely for installation volume risk acquiring a large but shallow user base with high churn and low lifetime value. Retailers who focus on installation rates as the primary metric for evaluating advertising effectiveness risk undervaluing their campaigns; our evidence suggests that post-adoption engagement, where ad-exposed users demonstrate substantially higher usage, is a more revealing measure of campaign effectiveness.

Our findings indicate that pre-adoption advertising is most effective at increasing post-adoption usage when it uses functional rather than experiential appeals, targets consumers with a high need for control, and runs in less competitive markets. These three conditions highlight when retailers can expect the greatest return from app installation campaigns. Study 4 shows that functional advertising copy reduces post-adoption dissonance by communicating the app's usability, thereby increasing usage relative to non-functional appeals. App installation creative should therefore lead with specific, retrievable functional claims rather than

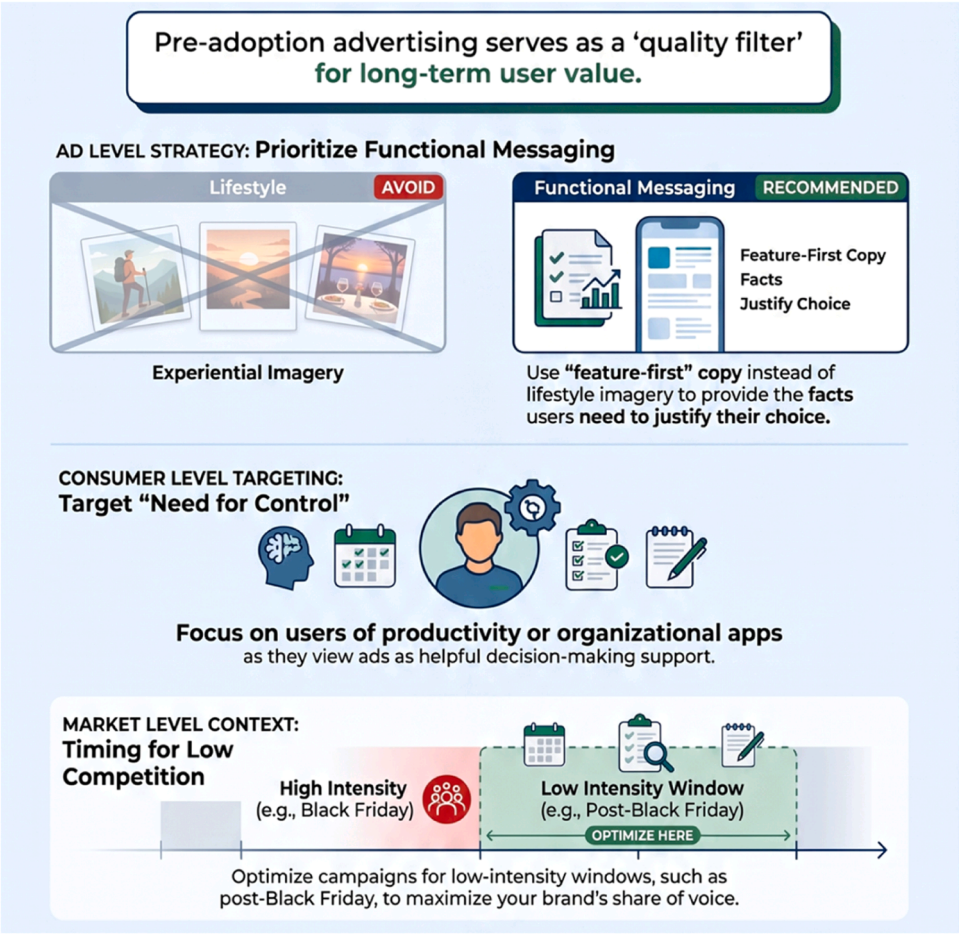


Fig. 8. Managerial recommendations.

emotional or lifestyle imagery. These findings align with emerging industry evidence: user-generated tutorials and app reviews deliver 17% stronger day-7 retention than testimonials (AppsFlyer, 2025), and firms are shifting toward "feature-first" messaging to maintain long-term performance (Motion Creative Cloud Inc., 2025).

Our findings also have implications for effective pre-adoption ad targeting and ad placement. We demonstrate that targeting users who have not yet installed a focal retail app is a high-value strategy, as it not only drives downloads but also increases post-adoption usage. Study 5 indicates that this approach is especially effective for audience segments with a high need for control, as these users more effectively convert pre-adoption advertising into consonant cognitions that suppress post-adoption doubt, and therefore respond more strongly to pre-adoption advertising that sets accurate, transparent expectations about the app.

Importantly, for retailers seeking to target existing customers who have not yet adopted their app, need for control is not directly observable, but may be approximated through behavioral proxies available prior to installation. A tractable approach is to rely on app-category signals already exposed by major advertising platforms (e.g., Google Ads, Apple Search Ads). Sustained use of productivity and organizational applications, such as task managers, planners, calendar tools, and note-taking apps reflects a dispositional preference for structure and self-directed organization and is therefore likely to correlate with higher need for control. Retailers running paid campaigns on these platforms can target audience segments defined by such app usage categories, which are observable and readily available through standard platform targeting tools.

We further highlight in Study 6 that pre-adoption advertising is particularly valuable in less competitive markets, where the dissonance-reducing effect of advertising is strongest because there is less clutter and advertising messages are more salient. This suggests that retailers should strategically time and target their app installation campaigns to take advantage of periods and contexts where competitive intensity is naturally lower. For example, retailers could shift a greater share of their app installation budget to the weeks following major shopping events such as Black Friday or the holiday season, when competitor ad spending drops sharply, but consumer engagement with retail apps remains elevated. Similarly, retailers targeting underserved demographic segments, such as older adults or consumers in mid-sized cities with limited retail options, may find that their pre-adoption advertising generates stronger post-adoption usage gains because competing messages are less prevalent. To implement this approach, retailers could

monitor competitive ad spend data using tools such as Sensor Tower or data.ai to dynamically reallocate their app installation budgets to markets and time windows where share of voice is highest. Our key managerial recommendations for navigating the ad-to-usage funnel are summarized in Fig. 8.

14. Limitations and avenues for future research

Our study has certain limitations that open avenues for future research. First, our field data lack pre-adoption behavioral histories, meaning we cannot directly observe users' app engagement tendencies or broader mobile usage patterns prior to the campaign. Related to this, we were unable to observe user behavior across other apps in the DSP network, which limits our ability to fully account for heterogeneity in general mobile engagement. These data constraints mean that unobserved differences between exposed and non-exposed users cannot be entirely ruled out in a field setting. We address these concerns through a combination of Heckman selection correction, propensity score matching, and controlled experimental designs in subsequent studies, each of which confirms the robustness of our findings. Second, our study relies on app opens as a proxy for engagement and does not include transaction or revenue data, which limits our ability to directly quantify the financial return on pre-adoption advertising investment. Future research with access to post-adoption purchase records could examine whether the observed engagement gains translate into downstream commercial outcomes such as repeat purchase behavior and customer lifetime value.

Third, our primary evidence comes from marketplace and subscription-based retail apps, where the link between post-adoption usage and commercial value is direct and observable. Study 2A provides suggestive evidence that the effect extends more broadly, including to branded retail channel apps where the app primarily functions as a transactional facilitator. The dissonance-reduction mechanism should operate similarly, because consumers who install a branded retailer's app after advertising exposure have the same potential for post-adoption doubt, and the same need for justificatory cognitions to sustain engagement. Examining this context directly, ideally with linked purchase data, is an important future research direction. An additional limitation is that when studying subscription-based retail apps (Study 2B), the two subscription plans differ not only in time commitment but also in price and service features, which limits our ability to isolate the effect of commitment duration per se. We adopted this design to reflect real-world subscription offerings, where long-term plans typically include additional incentives to make an extended commitment attractive to consumers.

Fourth, from Studies 3A onward, we measure the dependent variable prior to the cognitive dissonance mediator. Although this ordering was chosen to guard against demand effects on the primary outcome, it raises the theoretical possibility that prior exposure to the dependent variable measure could itself influence subsequent mediator responses. We note, however, that this concern is mitigated by the mediation-by-moderation evidence reported across studies. The pattern we find whereby the indirect effect emerges specifically under the theoretically predicted conditions would be difficult to reproduce as an artifact of measurement order alone.

Fifth, while we examined functional versus non-functional ad appeals, future research could investigate other ad formats (video, interactive) and their effectiveness in reducing post-adoption dissonance. Studies could also explore how different monetization strategies (in-app purchases, subscriptions) interact with pre-adoption advertising to affect user engagement and revenue.

Sixth, our studies isolate the effect of firm-generated advertising on post-adoption usage, but it remains an open question whether the dissonance-reducing mechanism we identify is specific to advertising or whether other forms of pre-adoption informational exposure, such as word-of-mouth, in-store employee persuasion, or social media content, would produce similar downstream effects. Future research could directly compare the post-adoption consequences of advertising versus other informational sources to establish the boundary conditions of a dissonance-based usage framework more precisely.

Finally, we focused on apps because of their growing importance in retailing and the ease with which usage behavior can be recorded. However, a dissonance-based usage framework could also be applicable in other non-app contexts. Future research could extend our study to these contexts.

AI Usage Statement

During the preparation of this work, the author(s) used ChatGPT to generate experimental stimuli and for copy editing purposes. Fig. 8 has been designed with Google Gemini. After using these tools, the authors reviewed and edited the content as needed and take (full responsibility for the content of the published article).

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jretai.2026.08.007.

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