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Autonomous stores: How levels of in-store automation affect store patronage

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ABSTRACT

Autonomous stores operate without needing on-site staff present to support and monitor customers. This study seeks to determine which autonomous stores are most likely to succeed. By adapting convenience theory and drawing on secondary and qualitative data, the authors identify unique features of autonomous stores that constitute convenience dimensions: options for check-in (access convenience), staff support (assistance convenience), check-out (transaction convenience), and to allow customers to check their itemized baskets (verification convenience). Perceptions of convenience, autonomy, and safety explain the influences of unique store features. A conjoint experiment provides a test of the direct effects of each dimension on store patronage and indirect effects through convenience, autonomy, and safety perceptions. The results indicate that, with the exception of check-out, consumers prefer staffed stores; having to check in (e.g., with a credit card), limited access to (remote) staff, and an inability to verify the basket before payment represent significant barriers. In turn, some trade-offs arise: Store features that increase convenience and autonomy undermine safety perceptions. Finally, community-based and rural locations are better suited for autonomous stores than anonymous traffic hubs. Retail managers can leverage these findings to decide whether to establish autonomous stores and, if so, with which design.

Technology continues to reshape retailing (Grewal, Levy, & Kumar, 2020; Shankar et al., 2020), and technology-enabled, autonomous, unattended, or unstaffed stores represent one of the latest retail innovations (Pickard, 2017) that arguably can address customers' demands for shopping convenience (Gauri et al., 2021). Some of the world's largest retailers (e.g., Amazon, 7-Eleven, Carrefour, Aldi; see Web Appendix A) are experimenting with autonomous versions of their stores (Palmer & Repko, 2020). As of 2018, around 350 stores globally were autonomous; this number is expected to exceed 10,000 in 2024 (Sunil, 2023). The associated market, estimated to be worth US$67.48 million in 2019, could grow to US$1640.32 million by 2027 (Research & Markets, 2020).

Alongside such growth predictions though, real-world implementations have suffered disappointing trials, ongoing revisions, and slow rollouts. The widely publicized introduction of Amazon Go autonomous stores has been slower than pre-

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dicted: After the first store opening in 2016 (Faithfull, 2021) 3000 stores were predicted by 2021 (Convenience Store News, 2019). However, just about 40 autonomous Amazon Go stores currently exist, operating only in the United States and United Kingdom (Eley, 2021). In 2019, the Dutch retailer Albert Heijn tested its first autonomous store at Amsterdam Schipol Airport; two years later, it switched technology partners and revised the concept, location, and target market to focus on office sites across the Netherlands rather than travel hubs (ESM Magazine, 2021; van Rompaey, 2022). The Swiss retailer Valora similarly placed its first autonomous store in a large train station but then moved it to a university campus. In a further revision, its four latest stores are located near large commuter roads (Valora, 2023).

These outcomes might reflect the tendency of retailers to get excited about technology, without a clear assessment of its purpose, whether it enhances customer convenience, or if its adoption makes business sense (Grewal et al., 2023; Roggeveen & Sethuraman, 2020). Conducting trials and revisions of store concepts, in attempts to achieve customer acceptance, are costly though. For example, scan–pay–go capabilities that rely on consumers' smartphones are more economical for retailers than just-walk-out options (e.g., video cameras maintained by the retailer capture consumer movements and shopping baskets); granting store access through a proprietary app requires more investments than access attained when the customer swipes a credit card. Such considerations in turn emphasize the need to understand whether, why, and when customers embrace the various features of autonomous stores.

Prior research, as summarized in Table 1, has generated insights into customers' perceptions of in-store technologies, including their usefulness and convenience, which in turn inform consumers sense of autonomy, task completion, and store patronage. Key considerations in these studies involve customer traits, such as their experiential desire, technology readiness, or confidence, but not the unique features of autonomous stores. Rather, existing research tends to treat this emerging format as a holistic concept (e.g., Lin, 2022; Park & Zhang, 2022; Wang et al., 2021). Extant research has not outlined the unique features of autonomous stores or differentiated them from other retail formats. Those studies that note its unique features focus exclusively on check-out processes (Cui, van Ecsh, & Jain, 2022; Cui & van Esch, 2022; van Esch, Cui, & Jain, 2021). With this study, we explicitly seek to address the entire shopping journey and thereby identify multiple unique store features, which we categorize into four convenience dimensions. In addition, we test the suitability of various types of locations and compare autonomous stores with staffed stores, which has not been done by prior research. By specifying suitable features of autonomous stores, this study can help retail managers decide to design effective retail locations, powered completely by technology. In line with these research objectives, we pose three main research questions: (1) What unique store features mark autonomous (as opposed to staffed) stores, and how do they affect patronage behavior? (2) How can consumer perceptions of convenience, autonomy, or safety explain the impact of unique store features on patronage behavior? (3) Which store locations are likely to be successful, such that they yield the highest store patronage?

Our study makes three main contributions to emerging research on autonomous stores. Our first contribution is conceptual: Even following multiple global trials of variations of autonomous stores that feature different technologies, no clear definition of autonomous stores and their unique features has been established. Additionally, we apply and extend convenience theory (Berry, Seider, & Grewal, 2002) by introducing two new convenience dimensions relevant to autonomous stores: assistance and verification convenience. We also assign different autonomous store features to four convenience dimensions: access convenience (i.e., options for store access and customer identification), assistance convenience (i.e., options for providing [remote] in-store support), transaction convenience (i.e., options for [automated] basket capture and checkout), and verification convenience (i.e., options for reviewing itemized baskets and receipts for verification). Furthermore, with a conjoint study, we estimate which store features and convenience dimensions have the strongest positive impacts on store patronage. We also reveal the mechanisms underlying these impacts, noting that some technology features incur trade-offs, such as a exerting positive impacts on convenience but a negative impact on safety, leading to null effects for patronage. Finally, with these insights, retailers can make more informed store location choices to attract patronage from a large enough customer base.

Our results can help retailers choose whether to offer autonomous stores and which features and locations to prioritize. For three of the four convenience dimensions, traditional, staffed stores are preferable to autonomous stores—a finding that resonates with the poor trial performance many retailers have experienced. If consumers must use technology to check in, lack access to on-site staff support, and cannot verify the accuracy of the basket before payment, their store patronage intentions decline. Only for the check-out process (transaction convenience) do both staffed and technology-enabled options (e.g., self-checkout terminals or fully automated checkout) have similar impacts on store patronage. As noted, the technology underlying autonomous stores incurs trade-offs for customers, such that their features might be more convenient (e.g., fully automated check-out), while also threatening perceptions of autonomy and safety. Finally, we determine that communities, and rural locations are better suited as locations for autonomous stores compared to traffic hubs. Noting customers' preferences for staffed stores, retailers should seek out a stand-alone location for their autonomous stores, to avoid direct competition.

In the next section, we introduce the concept and definition of autonomous stores, which we differentiate from alternative formats. We also review prior literature, which informs our conceptual background and hypothesis deduction, grounded in theory, and triangulated with data (Web Appendix B). To test the hypotheses, we conduct a conjoint study. In presenting the results, we offer some managerial and theoretical implications, as well as limitations and ideas for further research.

Table 1
Empirical literature on autonomous stores.

Source	Autonomous Store Features	Store Location	Comparison with Staffed Stores	Consumer Perceptions of Store Features	Consumer Characteristics	Consumer Intentions & Behavior	Type of Study and Analysis
Cui et al., 2022	Check-out type (self-service vs. AI-enabled)	Not included	Not included	Arousal and store atmosphere	Innovativeness importance	Purchase intentions	Two field experiments (self-selection into manipulations) with U.S. shoppers, three pilot studies, and one online experiment (MTurk)
Cui and van Esch, 2022	Check-out type (self-service vs. grab-and-go)	Not included	Not included	Autonomy, control, and store atmosphere	Political identity salience	Not included	Field experiment (self-selection into manipulations) with U.S. shoppers, three online experiments (MTurk)
Lin, 2022	Autonomous stores treated as a holistic concept	Not included	Not included	Performance and effort expectancy, social influence, convenience novelty value, and risk	Experience	Patronage intentions	Online survey with experienced and non-experienced consumers from Taiwan, multigroup structural equation modeling with partial least squares
Park and Zhang, 2022	Autonomous stores treated as a holistic concept	Not included	Not included	User attitude	Technology readiness, privacy, control efficiency, chaos	Continuous usage intentions	Online survey with consumers who had visited an unstaffed store (Bingo Box or Tao Café) in China
Pillai, Sivathanu, and Dwivedi, 2020	Autonomous stores treated as a holistic concept	Not included	Not included	Usefulness, ease of use, customization, enjoyment, and interactivity	Technology readiness	Intention to shop	Online survey with Indian customers from cities considered modern retail hubs; a video of an unstaffed store was shown prior to the survey
Sohn, 2024	Autonomous stores treated as a holistic concept	Not included	Not included	Various risk perceptions	Innovativeness, trust in retailer, self-efficacy	Use intentions	Two field experiments (self-selection into manipulations) with U.S. shoppers, one online experiment (MTurk)
van Esch, Cui, and Jain, 2021	Check-out type (self-service vs. AI-enabled)	Not included	Not included	Shopping convenience, attitudes	Self-efficacy and consumers' callousness	Purchase intentions	Two field experiments (self-selection into manipulations) with U.S. shoppers, one online experiment (MTurk)
Wang et al., 2021	Autonomous stores treated as a holistic concept	Not included	Not included	Usefulness, ease of use, attitudes, and risk	Not included	Usage intention	Online survey with Taiwanese customers who were experienced with convenience stores; distribution through private groups
Wu, Aib, and Cheng, 2019	Autonomous stores treated as a holistic concept	Not included	Not included	Experiential quality and satisfaction,	Experiential desire, motivation, and confidence	Loyalty, switching intentions	Survey with Chinese customers who had shopped at an autonomous store before
Xu et al., 2022	Autonomous stores treated as a holistic concept	Not included	Not included	Ease of interaction, task completion, speed of shopping, and attraction	Technology readiness	Not included	Field study with retail customers in China
This study	Check-in options (access), in-store staff support (assistance), basket capturing & check-out (transaction), and basket and receipt verification (verification)	Community, traffic hub, and rural	Included	Convenience, autonomy, safety	Technology readiness, grocery shopping frequency, responsibility	Store patronage intentions	Online conjoint experiment with video manipulations, European sample (Prolific), secondary data, expert interviews, and consumer qualitative data

Background: Autonomous stores

Autonomous stores are accessible retail outlets that can be operated by the retailer without human presence available to monitor or support shoppers. They usually require customers to identify themselves and check in and out, using technology. Fully staffed stores might allow autonomous customer journeys through self-checkout, but they are not equipped to be operated without staff monitoring customers. Some practitioners differentiate autonomous from unstaffed stores, such that the latter do not feature staff on the shop floor (Weinswig, 2020). We deliberately do not base our definition on actual human presence though, because retailers often deploy staff during trial periods to monitor the technology, support customers, or encourage onboarding during the decisive first few visits (Wood & Moreau, 2006). Other retailers (e.g., Bingo Box) offer virtual support; customers can video call remote staff from the otherwise unstaffed store. Even autonomous stores still require some human interventions in back-end operations (e.g., restocking). Thus, our definition of autonomous stores encompasses staffed, remotely staffed, and unstaffed stores, but the store itself must be operational without requiring staff to support shoppers.

Introducing new retail formats represents a common retail growth strategy (Bell, Davies, & Howard, 1997). They offer the potential to reduce shopping friction (Gauri et al., 2021), increase diversification, meet the demands of different consumer markets and shopping situations (González-Benito, Muñoz-Gallego, & Kopalle, 2005) and they also can signal retail modernization (Goldman, Ramaswami, & Krider, 2002). Each retail format represents “a particular set or bundle of benefits” (Kamran-Disfani et al., 2017, p. 17), such that retail managers select various elements of the retail mix to create distinct bundles (Blut et al., 2018). On the basis of these criteria, the retail mix of autonomous stores tends to be similar to that of convenience stores: small, very accessible, with relatively small assortments and often higher prices (Benoit, Evanschitzky, & Teller, 2019). To establish autonomous stores as a new format, distinct from convenience stores, we consider other criteria as well, such as the type of check-in or access to the store and the technology used to capture the basket (e.g., self-scanning at retailers’ terminals, self-scanning using customers’ devices, or automatically captured with cameras).

Relatively little research has explicitly addressed whether autonomous stores exhibit distinctive features or are worth attempting. This existing research is conceptual, technical, or empirical. Conceptual research on autonomous stores introduces the concept and the opportunities they promise for retailers (e.g., Dekimpe, Geyskens, & Gielens, 2020; see also Denuwara, Maijala, & Hakovirta, 2021). Technical literature, often conducted in computer science domains (e.g., Ahmed, Ahmed, Talukdar, Sharif et al., 2023; Guo et al., 2019; Hamidi et al., 2020), explains the technical background of the options available for operating autonomous stores. Finally, empirical research (Table 1) has focused on the characteristics of consumers likely to shop in autonomous stores and their perceptions of autonomous stores as a holistic concept. For example, prior research proposes the influence of people’s openness to innovation, technology, or experiences (Cui et al., 2022; Park & Zhang, 2022; Wu, Aib, & Cheng, 2019; Xu et al., 2022), as well as how they perceive technology in terms of self-efficacy, value, or risk (Lin, 2022, van Esch, Cui, & Jain, 2021). Other studies investigate perceptions of the shopping experience, such as usefulness and ease of use (Pillai, Sivathanu, & Dwivedi, 2020; Wang et al., 2021), risk and novelty value (Wang et al., 2021), and shopping convenience (Lin, 2022). Three studies (Cui et al., 2022; Cui & van Esch, 2022; van Esch, Cui, & Jain, 2021) depart from this holistic view to test one autonomous store feature (type of check-out) and reveal preferences for automated rather than self-checkout. However, the participants in all these studies self-selected into experimental groups, which might bias the results. We know of no studies that investigate multiple, unique store features of autonomous stores across the entire customer journey.

In turn, we note research gaps related to the precise role of different store features of autonomous stores (e.g., types of access, assistance, basket verification) including their comparison with conventional staffed versus. Therefore, we include traditional staffed stores in our research, to support format comparisons and accordingly guide retail decision-making more precisely. Should retailers opt to add autonomous stores, our research also offers insights into the most suitable locations.

Conceptual development

In this section, we outline key variables that are pertinent in relation to autonomous stores, then categorize those features into four convenience dimensions. With this foundation, we offer predictions regarding store patronage, the mechanisms on explaining the impact on store features on patronage and most suitable locations of autonomous stores.

Relevant variables for autonomous stores

Store patronage. Existing literature outlines how retail mix variables affect retail patronage (for meta-analyses, see Blut et al., 2018; Pan & Zinkhan, 2006), defined as regular visits to a given store or retailer (Grewal et al., 2003; Pan & Zinkhan, 2006), such that some reciprocity arises between the retailer and customers (Blut et al., 2018). Because we focus on a specific store format, rather than all retail channels, we use “store” rather than “retail patronage” as our focal variable. Patronage is a function of store features over which retailers have direct control (Baker et al., 2002; Grewal et al., 2003), so for many retailers, it represents a strategic aim (Baker et al., 2002; Blut et al., 2018), such that they seek to cultivate positive customer attitudes toward stores to increase patronage (Berry, Seider, & Grewal, 2002; Grewal, Levy, & Kumar, 2009). For autonomous stores, we propose that three perceptions are especially relevant for predicting store patronage: convenience, autonomy, and safety.

Convenience. Customers' increased purchase convenience expectations (Gauri et al., 2021) largely reflect their experiences and interactions with online retailers that deliver products promptly to consumers' homes (Babin et al., 2021; Dekimpe, Geyskens, & Gielens, 2020; Jindal et al., 2021). Convenience in this sense refers to consumers' perceptions of the ease and speed with which they can complete their shopping tasks (Berry, Seider, & Grewal, 2002), which in turn affects their retail patronage (Blut et al., 2018; Seiders et al., 2005). Autonomous stores arguably offer a distinct, appealing form of convenience; for example, technology-enabled basket capture by video cameras might make parts of the check-out process unnecessary (Dekimpe, Geyskens, & Gielens, 2020; Lin & Hsieh, 2011). Yet autonomous stores also might create inconvenience, such as if the technology fails in some way, and no in-store staff is available to provide support, as also has been suggested by self-service literature (e.g., Collier & Kimes, 2013). Therefore, the convenience of different technology options is worth investigating.

Autonomy. Consumers exercise autonomy by freely choosing among different options, without external influences (Wertenbroch et al., 2020), such that they can self-determine and self-govern their behavior and take independent action (Carver & Scheier, 2000). By offering an additional, technology-infused retail channel, retailers seemingly aim to increase consumers' perceived autonomy (Cui & van Esch, 2022); the Swiss retailer Valora (2023) even positions its autonomous stores as appealing because they "meet customers' need for autonomy when shopping." Although autonomy affects shopping behavior (Wang, Raghunathan, & Gauri, 2022), a technology–autonomy paradox can arise (Wertenbroch et al., 2020). That is, autonomous stores increase perceptions of autonomy, because consumers are independent of external influences, such as needing to adhere to set opening hours. But the technology also reduces autonomy, in that requiring fully automated check-out process undermines customers' independent decision-making and ability to self-determine or self-govern their behavior (Wertenbroch et al., 2020). In consumer comments that we gathered in the course of this study, we also find that some respondents believe the technology increases their independence when shopping, but others emphasize their fears of technology failure and the lack of human support (see Web Appendix F-G) making autonomy a relevant variable to investigate. Greater convenience also might undermine autonomy, such as self-determining items in the shopping basket.

Consumer safety perceptions. Finally, safety in relation to retail technology is defined as protection from intrusion, fraud, and loss of personal information (Lin & Hsieh, 2011). Perceptions of safety affect customers' behavior; insufficient safety reduces purchase confidence and makes people feel vulnerable to exploitation, which then affects their loyalty intentions (Rahman et al., 2022). Perceived safety also is a major issue related to the adoption of autonomous systems (Bartneck et al., 2009; Rubagotti et al., 2022). The consumers and experts we interviewed echoed such concerns, citing the risk of theft, misbehavior, or assault by other customers, as well as information security and privacy concerns (Web Appendix C-G) again making safety a relevant variable in the context of autonomous stores.

Convenience dimensions of autonomous stores

Berry, Seider, and Grewal (2002) influential service convenience model refers to traditional brick-and-mortar stores. In line with prior research (Gielens, Gijsbrechts, & Geyskens, 2021), we adapt this model and its dimensions to apply to autonomous stores and thereby identify four relevant convenience dimensions. *Access convenience* refers to consumers' ability to access the store easily and quickly; *transaction convenience* captures the ease and speed of the check-out and payment process (Berry, Seider, & Grewal, 2002). Specific to autonomous stores, *assistance convenience* reflects the ease and speed with which customers can gain access to support during the shopping process. Finally, when shopping baskets are captured by consumers' self-checkout or by technology in autonomous stores, retailers might seek to approve basket accuracy remotely, leading to variations in how and when they transmit itemized receipts to customers that would allow the shoppers to verify their own baskets and whether they have been charged the correct amount. Therefore, we add *verification convenience*, which represents the perceived time and effort needed to confirm the accuracy of the captured and retailer-approved basket and its charges, as well as the perceived effort to rectify any inaccurate charges.

Access convenience. Autonomous stores usually require some form of consumer identification to enter, so access convenience in this retail setting (Berry, Seider, & Grewal, 2002) pertains to the potential friction encountered when entering the store, depending on the available check-in technologies. Some stores offer access after consumers swipe a credit or debit card, others rely on an app, and some offer both (see Web Appendix A). Each of these options could evoke risk perceptions among customers, such as if they worry about system failure or data leakage (Lin, 2022). Among the customers we queried, some dislike the idea of having to check in at all, but others specify their opposition to having to check in with a bank card or having to download an app (see Web Appendix G). Such concerns seem inconsistent, as the experts point out, considering that banks generally require check-in to access ATM self-service areas. Thus, they suggest that retailers potentially can overcome this barrier by achieving customer trust (see Web Appendix G).

Assistance convenience. Even if they are meant to be operational without on-site staff supporting customers, retailers still design autonomous stores to provide customers with some, often remote support. Some offer in-store support staff with restricted hours others offer remote, virtual support through a video terminal or phone or chat helpline, often accessed through the retailer's app (Web Appendix A). If consumers require additional support or the technology creates a barrier, the lack of immediate human in-store support can lead to substantial inconvenience and delay shoppers' task completion. If they cannot find assistance, customers also might sense a restriction to their autonomy. In our interviews, the consumers note such threats to their convenience and autonomy in finding items, answering product queries, issuing complaints, and store cleaning; as solutions, they propose help buttons (see Web Appendix G). They also express concerns about risks created by the lack of in-store staff, such as the potential to attract shoplifters and criminals, challenges to financial safety, or hygiene issues (Sohn, 2024).

Transaction convenience. In autonomous stores, the diverse technology options for basket capturing and check-out processes produce different levels of transaction convenience (Berry, Seider, & Grewal, 2002) and autonomy (Cui & van Esch, 2022). Some fully automated stores, such as Amazon Go, rely on image recognition, and video technologies to capture consumer baskets, allowing consumers to "just walk out," and make the payment process invisible. Both prior literature (van Esch, Cui, & Jain, 2021) and consumers' comments confirm that fully automated check-outs can be convenient and preferable. However, persistent risks from the consumer perspective include potential system failures (Lin, 2022; Sohn, 2024; Wang et al., 2021) or being locked in the store. The consumers also note safety considerations related to the payment process, in line with early research into online shopping, that reflect their perceptions of vulnerability and risk during the payment process (Forsythe & Shi, 2003). We expect similar concerns for autonomous stores.

Verification convenience. Autonomous store concepts capture shopping baskets in various ways, such as self-scanning or automated capturing via image recognition. In turn, many retailers seek to check the accuracy of the basket before sending receipts to customers. Some retailers provide an itemized basket and costs at the moment of check-out; others offer them via email, immediately after the shopping trip. But in some instances Amazon Go provided these details only hours later, suggesting that retailers have chosen different ways to allow customers to view and verify the itemized basket. This feature has relevant consequences for perceived convenience, autonomy, and safety, especially considering the need to contact the retailer long after leaving the store to discuss potential inaccuracies requires substantial effort, which will likely be similar to the effort linked with returning products pointed out by in prior literature (Gielens, Gijsbrechts, & Geyskens, 2021). The retailer's practice of checking and potentially amending the basket might make customers feel vulnerable in terms of financial risk. Because their actions can be overridden by the provider, customers also likely perceive constrained self-determination and autonomy. The consumers we queried clearly stated concerns about not being able to verify their purchases while still in or around the store (Web Appendix G).

Because patronage is a function of store features, which constitute the four convenience dimensions, we expect that the features influence such consumer behavior, and in turn, these relationships likely depend on how customers perceive the store features with regard to convenience (Baker et al., 2002; Grewal et al., 2003), autonomy (Cui & van Esch, 2022), and safety (Lin, 2022). Formally, we hypothesize:

H1. Access convenience (check-in), assistance convenience (staff support), transaction convenience (check-out process), and verification convenience (basket verification) affect consumers' decision to patronize autonomous stores.

H2. The perception of in-store convenience, autonomy, and safety mediate the impact of the features of autonomous stores on store patronage.

Locations of autonomous stores and store patronage

Location is a critical variable in the retail mix (Blut et al., 2018; Bonfrer, Chintagunta, & Dhar, 2022; Grewal, Levy, & Kumar, 2009). In our secondary data, we identify three main types of locations of autonomous stores: traffic hubs, embedded in a community, or rural environments (Web Appendix A). These locations differ in the availability of alternative stores; many alternatives tend to be available at traffic hubs like train stations, whereas there might be none in rural areas. They also vary in terms of anonymity or embeddedness in a community. If autonomous stores are located in high-traffic areas in bigger cities, such as commuter roads, or in travel hubs, such as train stations, consumers tend to be anonymous and have various alternatives available to them, which impacts the ease of their store choice. The type of location can induce diverse reactions in consumers, such that some anticipate that the crowdedness and existing security measures in place in traffic hubs and community locations (cf. rural locations) provides more safety and encourages their decision to patronize an autonomous store. Retailers often open trial stores in existing communities, so potential shoppers already share some form of identity, which may increase acceptance and decision ease. Community-embedded store locations might include apartment buildings, universities, and corporate buildings. Consumers link such locations to their attitude and behavior, such that they might feel more confident patronizing an autonomous store in an environment where they know others. Furthermore, rural areas that also are food deserts suffer from a lack of access to healthy food options (Howlett, Davis, & Burton, 2016). Autonomous stores might help rectify this problem and also might be the only store alternative in an area. To the experts we interviewed, the logic of being embedded in a community also applies to rural stores, where social links with other consumers tend to be important. Consumers in rural areas then might perceive this form of access as useful, with a strong influence on their store patronage. Thus, we hypothesize:

H3. Store location moderates the impact of the store features represented in the convenience dimensions on store patronage.

Methodology

Conjoint analysis is an "analytical technique that is suitable to predict buyers' likely reactions to new offerings with various different features based on which the offering can be optimized" (Rao, 2014, p. 19). With its decompositional approach, it can estimate the contributions of separate attributes (i.e., store features) to an overall judgment (i.e., store patronage)

(Gustafsson, Herrmann, & Huber, 2000). In choice-based conjoint analysis, participants select between (usually) two vignettes; in rating-based conjoint analysis, they rate separate vignettes independently (Rao, 2014). Both approaches yield similar results in terms of predictive ability, so previous research suggests using the version that best fits the intended use (Elrod, Louviere, & Davey, 1992). We deem the ratings-based conjoint approach more suitable for several reasons. First, rating scales can better capture the intensity of preferences and are easier for respondents to use (Gustafsson, Herrmann, & Huber, 2000; Schlereth, Skiera, & Wolk, 2011). Second, to create realistic scenarios, we manipulated the store features in animated videos. Although they are realistic, the videos are not well-suited for pairwise comparisons, because the video and audio of two scenarios cannot be viewed simultaneously, and showing them sequentially can induce profile order effects (Chrzan, 1994). Therefore, with the rating-based conjoint approach, we collected data after showing video vignettes of a store visit, followed by a two-step rating task, as detailed subsequently.

Materials and vignette development. In line with prior marketing studies (e.g., Olsen, 2013; Papies, Eggers, & Wloemert, 2011) and to ensure the relevance of the variables, we derived store features, their levels, and the wording for the vignettes by triangulating data from managerial literature describing existing store concepts, expert interviews, and consumer comments (Krefting, 1991). Autonomous stores are a relatively new retail format that research participants might not have experienced (yet), so we developed realistic experimental scenarios; the animated video vignettes clearly represent the variables and their levels (Aguinis & Bradley, 2014), as the screenshots and vignette wording in Web Appendix H reveal. We started with a full profile design (Gustafsson, Herrmann, & Huber, 2000) with five attributes (location, check-in, assistance, check-out, verification), which is well below the recommended maximum number for conjoint studies (Huber, Herrmann, & Gustafsson, 2000). After an identical introduction, each scenario combined 16 unique video sections that each lasted 4–14 seconds, representing three or four levels for each of the five variables) (for examples see Web Appendix H). In combination, the animated video sections represent different versions of a coherent shopping trip. We excluded a few improbable variable combinations, which could confuse respondents (Hennig-Thurau et al., 2007), leading to a fractional design (Gustafsson, Herrmann, & Huber, 2000). Specifically, we excluded (1) no check-in needed with fully automated check-out, (2) only virtual and phone support available with staffed check-out, (3) staffed check-out with verification only available shortly after or hours after leaving the store, and (4) automated check-out with basket costs being displayed before check-out. We used all 153 remaining valid vignettes to ensure maximum orthogonality; a random orthogonal design was not feasible (Steckel, DeSarbo, & Mahajan, 1991). Each combination of store features was randomized.

Procedure and measures. When participants agreed to participate, they were exposed to the first part of the study. This initial stage was repeated three times for each participant; they had to rate three different shopping visits with three different vignettes (store types) on the same variables. The first page consisted of a video of a store visit that exposed them to the levels of the five attributes. These levels also were summarized in a table at the end of each video. After viewing the video vignettes, the respondents performed a two-step rating task.

First, they rated store patronage as the main dependent (behavioral) variable, taken from Grewal et al. (2003) but adapted to an 11-point scale, to discriminate more precisely among respondents and carve out small differences in their perceptions of the vignettes. This scaling approach (e.g., versus a 5-point scale) is commonly used in ratings-based conjoint studies for this discriminatory reason (Louviere, 2011). On the following page on the study platform, respondents performed three additional rating tasks that pertained to their perceptions of convenience, autonomy, and safety. Again, to discriminate across factorial combinations (Louviere, 2011), we used 11-point semantic differential scales (see Web Appendix I). By including a measure of convenience, we assess if the different manipulated convenience dimensions actually affect perceptions of convenience. The single item is in line with prior measures of self-service technology convenience that claim to capture the ease and speed of the overall customer experience (e.g., Lin & Hsieh, 2011). The item for autonomy was anchored as being dependent versus independent during the shopping process.[1] We also use common safety terminology, anchored in line with Lin and Hsieh (2011), who capture overall safety in a self-service technology context. Again, because they repeated the first stage of the study three times (with a random vignette), these variables were measured three times per participant.

Second, after participants completed the three simulated store visits and rated them separately, they encountered questions about variables that do not differ across different store visits, such as demographics (age in years, gender, household size, and car access), personality traits (technology readiness [TRI], as a mean collapsed index; Parasuraman, 2000; Parasuraman & Colby, 2015), and general shopping habits, such as if the participant had the main grocery shopping responsibility in the home and their grocery shopping frequency (Blut et al., 2018). These variables were measured once for each participant. All items and the scale end-points are in Web Appendix I, and Fig. 1 provides an overview of the variables and their relationships. Table 2 contains the descriptive statistics for all variables in the model.

Sampling and participants. The self-administered online questionnaire appeared on Prolific, a platform known for its high quality for academic research (Peer et al., 2017). We first conducted a pretest ($n = 25$) to verify the overall design and ensure sufficient variation in the dependent variable. These data confirmed our design, so we used it in the main data set, for which we recruited an additional sample of 675 U.K. participants in spring 2023, to reach a total of 700 usable informants.

We applied several measures to increase the validity of the data. First, all participants received a monetary incentive of £1.84 (US$2.30), equivalent to an hourly rate of £10 (US$12.45) for participating, which is an above-average remuneration.

[1] Item labels should be adapted to respondents' vocabulary and as clear as possible (Bandalos, 2018). The word "independence" has an elementary or middle school familiarity level (ranking 1.431), so we use it instead of "autonomy" (ranking 11.775 in audience familiarity; https://datayze.com/).

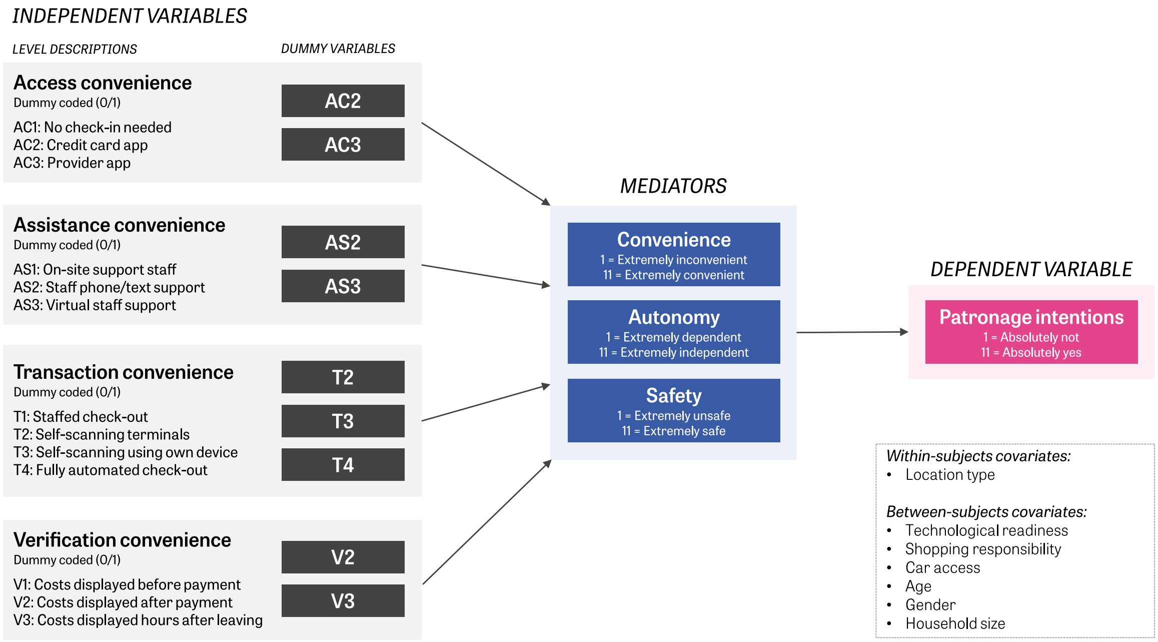

Fig. 1. Conceptual framework: overview of variables and their relationships.

Table 2
Descriptive statistics for key variables.

Variable	Level measured	N	Mean/%	SD	Min/Max
Dependent variable					
Store patronage	Within-subjects	2100	7.11	3.17	1/11
Mediators					
Convenience	Within-subjects	2100	8.20	2.70	1/11
Autonomy	Within-subjects	2100	8.37	2.50	1/11
Safety	Within-subjects	2100	7.66	2.64	1/11
Covariates					
Technological readiness	Between-subjects	700	4.24	.60	1.19/7
Shopping responsibility	Between-subjects	700	2.10	1.43	1/7
Shopping frequency	Between-subjects	700	3.34	.69	1/4
Car access	Between-subjects	700	74.9%	.	0/1
Customer age	Between-subjects	700	40.20	14.62	17/87
Gender (men vs. other)	Between-subjects	700	50.1%	.	0/1
Household size	Between-subjects	700	3.77	1.37	1/10

Second, we clarified in the introduction that we would check respondents' attention (Goodman, Cryder, & Cheema, 2013) and that anyone who failed the attention checks would be removed from further participation. Twice in the course of the survey, we asked participants to select a certain answer (e.g., click "fully agree"), and 15 participants were excluded for failing either attention check. Third, to ensure their full exposure to the video manipulation, we excluded participants using devices with small screens, which removed 9 participants from the sample. Fourth, we planned to exclude respondents who completed the study in less than half of the median response time or took longer than three times this median response time, but all respondents finished within the expected and acceptable range. The panel provider automatically excluded 26 respondents for taking more than 47 minutes. We kept collecting data until we reached 700 usable participants.

Because each respondent saw a randomly drawn subset of three video vignettes, we ultimately obtained a combined sample size of 2100 observations nested within 700 individual respondents. Quota-based sampling implemented by Prolific ensured that the respondents were representative of the U.K. population, as detailed in Table 3.

Data Format and Analysis. Multiple linear regression models are appropriate for analyzing rating-based conjoint data (Gustafsson, Herrmann, & Huber, 2000; Olsen, 2013; Ostrom & Iacobucci, 1995). Because the participants rated three stores with different combinations of convenience and location factors, we carefully acknowledge that the results are nested within individuals. As such, we extend conventional linear models by applying a hierarchical (multilevel) linear modeling approach that allows for this hierarchical structure. This approach thus accounts for variance both within and between specific individuals. In turn, the convenience and location levels were modeled on the within-subjects level, and variables measured solely on the individual level were modeled on a between-individuals level. We also decomposed the dependent variables

Table 3
Demographic details of participants in conjoint study.

Variable	Label	Mean (SD)/%
Age	Age in years	40.20 (14.62)
Gender	Male	50.1%
	Female	49.5%
	Unspecified	0.4%
Location	Urban	36.7%
	Suburban	45.0%
	Rural	18.3%
Education level	Up to secondary school	11.0%
	Higher or secondary education:	17.9%
	College or university	50.6%
	Post-graduate degree	19.9%
	Prefer not to say	0.7%

Notes: The total percentages for the education level do not add up to exactly 100.0% due to rounding.

(including mediators in mediation models) into orthogonal latent, within-group, and between-group components (Preacher, Zyphur, & Zhang, 2010).

Formally, the linear models run as two-level path analyses. For the main effect models (i.e., effects of each level of the convenience factors), we used a maximum likelihood estimator. For models designed to estimate indirect effects, we use a Bayesian Markov chain Monte Carlo (MCMC) estimator; this nonparametric estimation technique does not suffer the limitations of parametric estimation techniques when calculating indirect effects (Yuan & MacKinnon, 2009). We specified 100,000 MCMC iterations to ensure stable chains and approximate convergence (half burn-in; potential scale reduction factors < 1.001).

Our key dependent variable is store patronage; the independent variables are the various levels of the four convenience dimensions: access (AC), assistance (AS), transaction (T), and verification (V) (Fig. 1). For modeling purposes, we used a regular indicator coding scheme and created dummies to represent the levels for each factor, which we compared with a reference group. For each convenience factor, we specified conventional staffed store levels—no check-in needed (AC1), on-site staff support (AS1), staffed check-out (T1), and costs displayed before payment (V1)—as baseline categories in the linear model.[2] These variables were modeled on the within-subjects level, because they varied across the three vignettes that each participant saw. We also created dummies to represent our manipulation of location (L) as a within-subjects covariate, and we used within a community (L1) as a baseline category.

The between-subject covariates were those measured only once, such that they did not vary across the three vignettes. In particular, we included variables related to technology readiness (TRI_j) and both grocery shopping responsibilities ($ShopResp_j$) and grocery shopping frequency ($ShopFreq_j$). These added variables can address potential variance due to variables outside the hypothesized research model and help enrich the estimation results (Papies, Eggers, & Wloemert, 2011). We also control for participants' age (Age_j), gender ($Gender_j$), household size ($HhSize_j$), and access to a car (Car_j). Statistically, the main effect model is defined as follows:

Equation 1. Main effects model:

$$\begin{aligned} \mathrm{Patronage_{ij}} = {} & \gamma_{00} + \gamma_{10}\mathrm{AC_{2ij}} + \gamma_{20}\mathrm{AC_{3ij}} + \gamma_{30}\mathrm{AS_{2ij}} \\ & + \gamma_{40}\mathrm{AS_{3ij}} + \gamma_{50}\mathrm{T_{2ij}} + \gamma_{60}\mathrm{T_{3ij}} + \gamma_{70}\mathrm{T_{4ij}} \\ & + \gamma_{80}\mathrm{V_{2ij}} + \gamma_{90}\mathrm{V_{3ij}} + \gamma_{100}\mathrm{L_{2ij}} + \gamma_{110}\mathrm{L_{3ij}} \\ & + \gamma_{01}\mathrm{TRI_j} + \gamma_{02}\mathrm{ShopResp_j} + \gamma_{03}\mathrm{ShopFreq_j} \\ & + \gamma_{04}\mathrm{Car_j} + \gamma_{05}\mathrm{Age_j} + \gamma_{06}\mathrm{Gender_j} \\ & + \gamma_{07}\mathrm{HhSize_j} + u_j + e_{ij} \end{aligned} \tag{1}$$

In this equation i indicates a within-subject unit, j refers to a subject-level unit, γ_{00} is the average intercept, u_j captures the individual deviance from the average, and e_{ij} is the residual error.

Finally, we explore $Convenience_{ij}$, $Autonomy_{ij}$, and $Safety_{ij}$ as mediating variables. For the first-stage model, we regress each potential mediator *k* (Convenience, Autonomy, Safety) on the same independent variables and covariates as in the main model, but we define each of the three mediators as the dependent variable instead (labeled k).

Equation 2. Estimation of first-stage model:

$$\begin{aligned} \mathrm{Mediator_{k_{ij}}} = {} & \gamma_{\mathrm{Mk\_00}} + \gamma_{\mathrm{Mk\_10}}\mathrm{AC_{2ij}} + \gamma_{\mathrm{Mk\_20}}\mathrm{AC_{3ij}} \\ & + \gamma_{\mathrm{Mk\_30}}\mathrm{AS_{2ij}} + \gamma_{\mathrm{Mk\_40}}\mathrm{AS_{3ij}} + \gamma_{\mathrm{Mk\_50}}\mathrm{T_{2ij}} \\ & + \gamma_{\mathrm{Mk\_60}}\mathrm{T_{3ij}} + \gamma_{\mathrm{Mk\_70}}\mathrm{T_{4ij}} + \gamma_{\mathrm{Mk\_80}}\mathrm{V_{2ij}} \end{aligned}$$

[2] We estimated all pairwise differences for each level of each factor by directly comparing the effect sizes between dummy variables.

$$+\gamma_{Mk\_90}V_{3ij}+\gamma_{Mk\_100}L_{ij}+\gamma_{Mk\_110}L_{3ij} +\gamma_{Mk\_01}TRI_j+\gamma_{Mk\_02}ShopResp_j +\gamma_{Mk\_03}ShopFreq_j+\gamma_{Mk\_04}Car_j +\gamma_{Mk\_05}Age_j+\gamma_{Mk\_06}Gender_j +\gamma_{Mk\_07}HhSize_j+u_{Y\_j}+e_{Y\_ij} \quad (2)$$

We then regress $Patronage_{ij}$ on all three mediators and the same independent variables and control variables to estimate the second-stage model as following per Equation 3.

Equation 3. Estimation of second-stage model:

$$Patronage_{ij}=\gamma_{Y\_00}+\gamma_{Y\_10}AC_{2ij}+\gamma_{Y\_20}AC_{3ij} +\gamma_{Y\_30}AS_{2ij}+\gamma_{Y\_40}AS_{3ij}+\gamma_{Y\_50}T_{2ij} +\gamma_{Y\_60}T_{3ij}+\gamma_{Y\_70}T_{4ij}+\gamma_{Y\_80}V_{2ij} +\gamma_{Y\_90}V_{3ij}+\gamma_{Y\_100}L_{2ij}+\gamma_{Y\_110}L_{3ij} \gamma_{Y\_120}Convenience_{ij}+\gamma_{Y\_130}Autonomy_{ij} +\gamma_{Y\_140}Safety_{ij}+\gamma_{Y\_01}TRI_j +\gamma_{Y\_02}ShopResp_j+\gamma_{Y\_03}ShopFreq_j +\gamma_{Y\_04}Car_j+\gamma_{Y\_05}Age_j+\gamma_{Y\_06}Gender_j +\gamma_{Y\_07}HhSize_j+u_{Y\_j}+e_{Y\_ij} \quad (3)$$

Multiplying the effect of each independent variable *t* on each mediator *k* and the effect of that specific mediator *k* on $Patronage_{ij}$ allows us to estimate the indirect effects through each mediator, relative to the reference group in each factor as per Equation 4.

Equation 4. Estimation of indirect effect:

$$\text{Relative Indirect Effect}_{IV_t\rightarrow Mediator_k\rightarrow patronage}=\gamma_{M_{k\_t}}\times\gamma_{Y_k} \quad (4)$$

Results

Main effects

We find important differences in the impacts of the convenience dimensions on store patronage (H1). For clarity, we report these results while controlling for relevant covariates (Equation 1), but all significant parameters remain significant whether we include the covariates or not (Table 4). Among the covariates, shopping responsibility, shopping frequency, age, gender, and household size had no significant effects on store patronage, whereas technology readiness ($\gamma_{01}=0.81$, $p<.001$) and car access ($\gamma_{04}=0.66$, $p=.004$) both indicated positive impacts. Traffic hub locations (L2) indicate lower store patronage than community stores (L1) and rural locations (L3) (L2 vs. L1 $\gamma_{100}=-0.32$, $p=.012$; L3 vs. L2 $\gamma_{110}-\gamma_{100}=0.50$, $p<.001$), but we find no difference in patronage intentions between community and rural store locations (L3 vs. L1 $p=.154$).

Turning to the independent variables, for access convenience, we find a significant negative effect on store patronage when shoppers had to use their credit card (AC2) to gain access to the store, relative to both a traditional staffed store with no access restrictions (AC2 vs. AC1 $\gamma_{10}=-0.60$, $p<.001$) and access granted through a retailer app (AC2 vs. AC3 $\gamma_{10}-\gamma_{20}=-0.48$, $p<.001$). No significant difference appears between a traditionally staffed store and access to the store using an app (AC3 vs. AC1 $\gamma_{20}=-0.12$, $p=.350$). Among the assistance convenience features, both staff phone/text support (AS2) and virtual staff support (AS3) result in diminished store patronage compared with on-site support staff (AS1), with no difference between these two remote support options (AS2 vs. AS1 $\gamma_{30}=-1.00$, $p<.001$; AS3 vs. AS1 $\gamma_{40}=-0.88$, $p<.001$; AS2 vs. AC3 $p=.344$). That is, traditional, on-site support staff outperforms both types of remote support. For transaction convenience, we find no differences when we compare traditional staffing with any autonomous alternatives, including self-scanning terminals (T2 vs. T1 $p=.50$), self-scanning using the customer's device (T3 vs. T1 $p=.896$), or fully automated check-outs (T4 vs. T1 $p=.293$). However, the fully automated check-out experience (T4) appears worse than both self-scanning terminals (T4 vs. T2 $\gamma_{70}-\gamma_{50}=-0.55$, $p=.018$) and self-scanning using their own devices (T4 vs. T3 $\gamma_{70}-\gamma_{60}=-0.31$, $p=.031$). Finally, participants care about being able to verify their shopping basket. A traditional verification process, which allows shoppers to observe staff capturing the basket and know the cost before payment (V1), outperforms two autonomous methods, namely, showing the cost immediately after payment (V2, marginally) or several hours later (V3) (V2 vs. V1 $\gamma_{80}=-0.32$, $p=.054$; V3 vs. V1 $\gamma_{90}=-1.35$, $p<.001$). The significant difference between the two autonomous levels indicates that delaying the basket and cost information leads to lower store patronage (V3 vs. V2 $\gamma_{90}-\gamma_{80}=1.03$, $p<.001$).

We also assessed the relative importance of the different convenience dimensions, by determining the utility range for each convenience dimension on the within-individual level (i.e., range of effects on store patronage for each participant

Table 4
Main effect results with store patronage as dependent variable.

Fixed effects	Not.	Main Model			Main Model with Covariates		
		Estimate	SE	p	Estimate	SE	p
Intercept	γ_{00}	8.502	0.287	.000	3.920	1.019	.000
Level-1 (within-subjects)							
Access convenience							
Credit card (AC2)	γ_{10}	−0.600	0.134	.000	−0.598	0.133	.000
Provider app (AC3)	γ_{20}	−0.127	0.133	.340	−0.123	0.132	.350
Assistance convenience							
Staff phone/text support (AS2)	γ_{30}	−0.978	0.131	.000	−0.996	0.131	.000
Virtual staff support (AS3)	γ_{40}	−0.861	0.131	.000	−0.877	0.130	.000
Transaction convenience							
Self-scanning terminals (T2)	γ_{50}	0.255	0.303	.400	0.201	0.301	.504
Self-scanning own device (T3)	γ_{60}	0.048	0.307	.876	−0.040	0.304	.896
Fully automated check-out (T4)	γ_{70}	−0.262	0.338	.438	−0.353	0.335	.293
Verification convenience							
Costs after payment (V2)	γ_{80}	−0.321	0.170	.058	−0.324	0.168	.054
Costs after leaving store (V3)	γ_{90}	−1.367	0.168	.000	−1.351	0.167	.000
Location							
Traffic hub (L2)	γ_{100}				−0.316	0.126	.012
Rural (L3)	γ_{110}				0.180	0.126	.154
Level-2 (between-subjects)							
Technological readiness	γ_{01}				0.812	0.161	.000
Shopping responsibility	γ_{02}				−0.111	0.074	.132
Shopping frequency	γ_{03}				0.117	0.144	.419
Car access	γ_{04}				0.660	0.227	.004
Age	γ_{05}				−0.013	0.007	.067
Gender	γ_{06}				0.328	0.202	.106
Household size	γ_{07}				0.086	0.074	.247
Random effects							
Within-subjects residual	e_{ij}	4.095	0.155	.000	4.048	0.153	.000
Between-subject residual	u_j	5.357	0.364	.000	4.914	0.339	.000
Contrasts							
AC3 vs. AC2	$\gamma_{20}-\gamma_{10}$	0.473	0.127	.000	0.475	0.126	.000
AS3 vs. AS2	$\gamma_{40}-\gamma_{30}$	0.118	0.127	.354	0.119	0.126	.344
T3 vs. T2	$\gamma_{60}-\gamma_{50}$	−0.207	0.186	.266	−0.241	0.185	.193
T4 vs. T2	$\gamma_{70}-\gamma_{50}$	−0.517	0.236	.029	−0.554	0.235	.018
T4 vs. T3	$\gamma_{70}--\gamma_{60}$	−0.310	0.146	.034	−0.313	0.145	.031
V3 vs. V2	$\gamma_{90}-\gamma_{80}$	−1.046	0.128	.000	−1.027	0.127	.000

Notes: Reference levels are as follows: access convenience, no check-in needed (AC1); assistance convenience, on-site support staff (AS1); transaction convenience, staffed check-out (T1) verification convenience, costs displayed before payment (V1); and location, embedded in community (L1). Gender is coded as men (1) versus women and others (0).

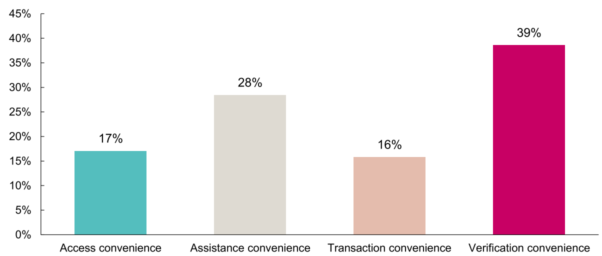

Fig. 2. Relative importance per convenience factor.

and convenience dimension). For each dimension, we divide this range by the sum of the utility ranges across all convenience attributes. These results indicate that verification convenience is the most important factor, followed by assistance convenience, access convenience, and then transaction convenience, as depicted in Fig. 2.

Role of location

To test H3, we assessed the main effects in a separate model in which location type is a moderator of each main effect we tested. However, none of these interactions was significant for any of the store convenience predictors, nor were the contrasts of any pairwise conditional effects between different locations significant. Thus, it appears that the convenience effects in the main model do not differ across types of locations, and we must reject H3. We specify the detailed results of this analysis in Appendix 1.

Process mechanisms

To identify the underlying mechanisms that get activated when shoppers experience different types of convenience (H2), we examine a series of process mechanisms, in the form of participants' perception of convenience (M1), autonomy (M2), and safety (M3). Specifically, we estimate the relative indirect effect of each store feature (i.e., the level of each convenience factor) on store patronage through the mediators, using the multilevel approach that we applied in the main effects analyses. All possible indirect effects and the 95% credible intervals (CI) are in Table 5; Appendix 1 reports on the individual pathways, including the direct effects on each mediator. If the 95% CIs do not include 0, we deem them significant. With this mediation analysis, we thus can determine if convenience, autonomy, and safety perceptions mediate the relationships of our convenience factors (e.g., access, assistance, transaction, and verification) with patronage intentions. Significant indirect effects indicate that changes in the mediators can help explain the effect of the independent variable on the key outcome variable.

For access convenience, relative to a traditional store (AC1), a credit card check-in (AC2) reveals a significantly negative relative indirect effect [ind] through convenience and safety (AC2 vs. AC1 $ind_{conv} = -0.11$, $ind_{safety} = -0.13$) but not through the sense of autonomy. The provider app check-in condition (AC3) yields no significant indirect effects relative to the traditional store (AC3 vs AC1). Using a provider app instead suggests a positive indirect effect, relative to the credit card check-in, through the senses of autonomy and safety (AC3 vs. AC2 $ind_{auton} = 0.06$, $ind_{safety} = 0.11$).

For assistance convenience, compared with traditional on-site support (AS1), we uncover significant negative indirect effects, through perceived convenience and safety, for both staff phone/text support (AS2 vs. AS1 $ind_{conv} = -0.39$, $ind_{safety} = -0.44$) and virtual support (AS3 vs. AS1 $ind_{conv} = -0.21$, $ind_{safety} = -0.42$). Compared with on-site staff, virtual staff support also yields a positive indirect effect through autonomy (AS3 vs. AS1 $ind_{auton} = 0.03$). The two remote options (AS3 vs. AS2) do not evoke different perceptions.

For transaction convenience, compared with regular staffed check-outs (T1), all three autonomous alternatives reveal a significant positive effect, through both convenience and autonomy (self-scanning terminals T2 vs T1 $ind_{conv} = 0.32$, $ind_{auton} = 0.27$; self-scanning using own device T3 vs. T1 $ind_{conv} = 0.29$, $ind_{auton} = 0.28$; fully automated check-out T4 vs. T1 $ind_{conv} = 0.34$, $ind_{auton} = 0.27$). We also note significantly negative effects through safety (T2 vs. T1 $ind_{safety} = -0.24$; T3 vs. T1 $ind_{safety} = -0.29$; T4 vs. T1 $ind_{safety} = -0.41$). Comparing the three autonomous check-out options, no differences arise in perceived convenience or autonomy, but the fully automated option appears less safe (T4 vs. T2 $ind_{safety} = -0.18$; T4 vs. T3 $ind_{safety} = -0.12$).

Finally, for verification convenience, compared with traditional displays of basket items and total costs before payment, we find no indirect effect through either mediator when the costs are available only after payment. However, a negative effect through all the mediators on store patronage occurs if customers see the cost only several hours after leaving the store (V3), relative to both the conventional condition (V3 vs. V1 $ind_{conv} = -0.34$, $ind_{auton} = -0.07$, $ind_{safety} = -0.36$) and exhibits of the cost directly after leaving the store (V3 vs. V2 $ind_{conv} = -0.32$, $ind_{auton} = -0.06$, $ind_{safety} = -0.27$).

Thus, the technology-based options generally increase perceptions of autonomy but decrease perceptions of safety compared with traditional, staffed approaches. For convenience perceptions, the mixed effects indicate some interesting trade-offs. Traditional access methods seem more convenient than autonomous options, like app check-ins, but for transaction convenience, autonomous options like self-checkout appear more convenient than staffed versions. The mediation analysis thus provides insights into how convenience, autonomy, and safety perceptions differ between autonomous and traditional options, yet these perceptual differences do not always translate into significant differences in the main effect, that is overall store patronage. This finding suggests factors other than convenience, autonomy, and safety influence customer preferences for autonomous versus traditional retail options. Still, these mediation results are useful for revealing the mechanisms that drive customer reactions to retail innovations; they also emphasize the need to enhance customers' perceptions of the safety of autonomous options to increase their patronage.

Discussion and implications

As the rollouts of autonomous stores continues to occur more slowly than was initially planned and predicted, retailers continue experimenting with various store features to appeal better to customers. The novel technology that facilitates these relatively new shopping channels provides several competing options, but research into their market acceptance remains scarce and limited in scope. Therefore, retailers need more evidence and insights into which features are likely to encourage the highest patronage, in which locations, by which types of customers. Drawing on a conjoint study, we address such issues, as reflected in our three main research questions. In turn, retail managers can use these findings to design their ongoing trials of autonomous stores and increase the chances that their efforts succeed. We accordingly outline several recommendations for retailers next, before we elaborate on implications for research.

Table 5
Indirect effects of different convenience factors on store patronage.

Convenience factors (Independent variables)			Indirect effects through specific mediator M_k								
			Convenience (M1)			Autonomy (M2)			Safety (M3)		
				95% CI			95% CI			95% CI	
Indirect effect of test level (I_k)	Relative to reference level (J_k)	I–J	Est.	$CI_{2.5}$	$CI_{97.5}$	Est.	$CI_{2.5}$	$CI_{97.5}$	Est.	$CI_{2.5}$	$CI_{97.5}$
Access convenience											
Credit card	No Check-In Needed	AC2 vs. AC1‡	−.112*	−0.217	−0.010	−0.019	−0.057	0.016	−.127*	−0.210	−0.048
Provider App	No Check-In Needed	AC3 vs. AC1	−0.049	−0.126	0.028	0.017	−0.017	0.053	−0.017	−0.095	0.060
Provider App	Credit card	AC3 vs. AC2‡	0.064	−0.035	0.165	.035*	0.003	0.074	.110*	0.036	0.187
Assistance convenience											
Staff phone/text support	On-site support	AS2 vs. AS1‡	−.386*	−0.506	−0.274	0.015	−0.019	0.052	−.442*	−0.543	−0.351
Virtual staff support	On-site support	AS3 vs. AS1‡	−.205*	−0.317	−0.096	.034*	0.001	0.073	−.417*	−0.516	−0.328
Virtual staff support	Staff phone/text support	AS3 vs. AS2	.181*	0.076	0.291	0.019	−0.013	0.055	0.025	−0.049	0.099
Transaction convenience											
Self-scanning terminals	Staffed check-out	T2 vs. T1	.318*	0.066	0.576	.265*	0.164	0.388	−.236*	−0.421	−0.060
Self-scanning own device	Staffed check-out	T3 vs. T1	.286*	0.029	0.545	.278*	0.175	0.405	−.291*	−0.478	−0.114
Fully automated check-out	Staffed check-out	T4 vs. T1	.343*	0.063	0.630	.272*	0.165	0.406	−.413*	−0.622	−0.215
Self-scanning own device	Self-scanning terminals	T3 vs. T2	−0.033	−0.190	0.123	0.013	−0.035	0.065	−0.055	−0.164	0.053
Fully automated check-out	Self-scanning terminals	T4 vs. T2‡	0.025	−0.169	0.220	0.008	−0.053	0.072	−.176*	−0.319	−0.040
Fully automated check-out	Self-scanning own device	T4 vs. T3‡	0.058	−0.059	0.177	−0.005	−0.045	0.033	−.121*	−0.211	−0.037
Verification convenience											
Cost after payment	Cost displayed before payment	V2 vs. V1	−0.022	−0.165	0.119	−0.012	−0.059	0.032	−0.081	−0.182	0.017
Cost after leaving store	Cost displayed before payment	V3 vs. V1‡	−.339*	−0.487	−0.199	−.067*	−0.122	−0.024	−.355*	−0.468	−0.251
Cost after payment	Cost after leaving store	V3 vs. V2‡	−.317*	−0.431	−0.210	−.056*	−0.097	−0.022	−.273*	−0.360	−0.195

* 95% CI does not overlap 0.
‡ Unmediated main effect was significant (cf. Table 4).
Notes: Each indirect effect is estimated relative to one of the other levels of that convenience factor. All convenience factors were included simultaneously as independent variables, using an indicator dummy coding; all three mediators were simultaneously included as parallel mediators. The full coefficients of the model are in Appendix 2.

Implications for practice and opportunities for retailers

Staffing autonomous stores. Our review of global store concepts involving unstaffed, unmanned, unattended, or autonomous stores (see Web Appendix A) reveals varying levels of automation. We define autonomous stores as any accessible retail outlets that can be operated without human presence to monitor or support shoppers. This definition does not exclude stores that deploy some staff or situations in which consumers engage with staff. Most trials of autonomous stores feature on-site support staff, and retailers likely want to provide at least some on-site support. Such realizations informed our deliberately operational perspective in defining autonomous stores; customers can experience an autonomous customer journey, or stages thereof, in any retail outlet that offers self-checkout terminals. In contrast with autonomous stores, staffed stores that feature self-checkout terminals are not designed to be operated fully without staff presence. In this view, investing in customer-facing technologies that enable more autonomous customer journeys can be regarded as a gradual shift toward potentially operating as autonomous stores in the future.

Preferences for staffed stores. Our results resonate with the real-world evidence of disappointing outcomes for trials of autonomous store concepts, in that they show that customers still prefer conventional, staffed stores in relation to three of the four convenience dimensions (access, assistance, and verification). Having to check in to the store, not having in-store staff support, and being unable to verify the basket before payment are significant barriers to shopping in autonomous stores. Such attitudes might change over time, but at the moment, retailers need reasons other than consumer demand to justify the establishment of autonomous stores (e.g., staff costs, learning curve effects, customer data).

Stand-alone locations. All types of locations (traffic hub, community, rural) are tested for autonomous stores. Regardless of autonomous store elements, the less anonymous locations in rural areas and communities naturally yielded a higher patronage than busy traffic hub locations such as at a train station. Also considering that staffed stores largely outperform autonomous stores, retailers should anticipate more difficult market acceptance of autonomous stores that are located near staffed stores. We recommend stand-alone locations for autonomous stores, to avoid direct proximity to and competition with conventional, staffed stores such as at busy train stations. At stand-alone locations, consumers might shift the focus of their comparison, such that they consider the effort needed to reach an alternative distant, conventional store against the relatively smaller effort needed to access an autonomous store via for instance using an app. This said, such stand-alone locations could appear in community locations (e.g., apartment blocks), or rural locations with no retail presence. Both Lifvs or Tante Enso focus strategically on rural areas in which conventional retailers do not operate, potentially because staffed stores cannot be run profitably. However, traffic hubs with stand-alone locations such as petrol or charging stations or rural train stations without other stores nearby might also be good locations. Important to note the impact of the features on store patronage did not differ depending on the type of location.

Trials in community settings. Location is invariably a crucial determinant of retail success (Blut et al., 2018; Bonfrer, Chintagunta, & Dhar, 2022; Grewal, Levy, & Kumar, 2009). Our conceptualization of location is distinctive though, in that it refers to types of locations for autonomous stores, rather than distance to the store. A common approach tests the performance of autonomous stores in community environments, often among the retailer's own employees (e.g., 7-Eleven, Amazon). Considering our findings that community locations perform similarly to rural locations, we confirm that testing autonomous stores in community settings likely is justified for operational reasons (e.g., theft, troubleshooting), but such locations are not required for consumer acceptance.

Autonomous check-out is not essential. Transaction convenience, as it relates to check-out options, has varied impacts. None of the four levels we test exerts effects on patronage, but the indirect effects reveal some interesting trade-offs. All three autonomous check-out options (self-checkout terminal, self-checkout with customer device, and fully automated check-out) positively affect patronage through convenience and autonomy, but this positive effect is outweighed by a negative effect through safety, leading to a null overall effect on patronage. These findings indicate wide acceptance of self-checkout technologies, so retailers can take other criteria into account when choosing their investments. Technology for fully automated check-out remains expensive and can make customers feel vulnerable, so retailers can benefit from taking cost into consideration, avoiding these expenses, but still achieve similar market acceptance. If retailers can mitigate the safety concerns surrounding autonomous technology options, they even might gain more acceptance than staffed options. This means retailers can look forward to substituting for human employees (Larivière et al., 2017) and mitigating hiring and training expenses (Schneider, 2017), especially those related to resource-intensive check-out processes (McKinsey Global Institute, 2015).

Leeway in technology choices. Some of the unique features of autonomous stores do not significantly affect patronage; for example, self-checkout terminals versus using the customer's own devices and virtual support staff do not have notably different effects on patronage. Retailers thus can make strategic design choices, even if they diverge somewhat from customers' preferences, to balance those preferences against cost considerations. That is self-checkout, virtual staff terminals, and apps are more expensive than using consumers' devices for self-scanning or offering a phone hotline. Because these features do not affect patronage, the retailers can prioritize such operational over market acceptance criteria.

Avoid delaying verification. The new verification convenience dimension that we identify in autonomous stores represents the most important barrier to store patronage (Fig. 2). In some autonomous stores, consumers participate in capturing their own baskets (self-checkout), in others it is fully automated. In either case, retailers likely need to check and approve basket accuracy, which can take time (Albrecht, 2021). But for customers, not being able to verify the basket and receipt before payment is a concern, evoked by decreased feelings of convenience, autonomy, and safety. We thus rather than delaying customers' ability to verify their own receipt we recommend tests in which retailers approve baskets immediately by default, especially for loyal customers with high accuracy levels, and then check and potentially contest incorrect receipts only as necessary.

Address safety concerns. Most technology options available in autonomous stores make customers feel unsafe and insufficiently protected from intrusion, fraud, or loss of personal information. This substantial concern hinders acceptance of autonomous stores. For example, when it comes to autonomous check-out options, the positive convenience and autonomy effects get whipped out by feelings of vulnerability and lack of safety. Thus, retailers that manage to address this challenge will be better able to capitalize on the advantages that autonomous stores offer in terms of convenience and autonomy.

Current concept changes. Current developments in global retail markets indicate the external validity of our findings. For example, Amazon already has removed the requirement for customers to check in to some of their U.K. stores; instead, they only need to check out at the exit, where they also see the automatically captured basket before leaving the store. Juxta, a new U.S. technology provider, has developed a means for customers to either confirm their basket before leaving the store (increasing verification convenience) or just walk out using automated payment (increasing transaction convenience) (Lindeberg, 2023). In their autonomous store in Paris, Carrefour has removed the need to check in, but cameras track customer movements using virtual avatars. Shopping baskets are fully automated and captured by cameras, which increases convenience and autonomy, but the actual check-out and payment take place at terminals, so customers can verify the correctness of their basket before paying. At least one store operator is always available in the store too, increasing assistance convenience (Into the Minds, 2022).

Implications for research

Inspired by global developments, we investigate autonomous stores as an emerging retail format and thereby generate insights about which unique autonomous store features are likely to yield the highest customer acceptance, relative to location and consumer characteristics. With this, we respond to calls for research into how technology is changing retail and patronage (e.g., Blut et al., 2018; Shankar et al., 2020) and contribute to literature on convenience, patronage, and retail technology.

Our research contributes to the retail channel and technology literature by identifying unique features of autonomous stores, which enables us to define this new format and delineate it from existing ones. Grounded in convenience theory (Berry, Seider, & Grewal, 2002) and informed by data we gathered from store concepts, expert interviews, and consumer comments, we group these unique features into key convenience dimensions. We also take inspiration from Gielens, Gijsbrechts, and Geyskens (2021), who adapted convenience framework to click-and-collect formats, and contribute to this research stream by adapting and extending the initial convenience framework to autonomous stores by introducing two new dimensions: assistance and verification convenience (Fig. 1). Our results affirm that these two dimensions are tremendously important for autonomous store patronage (Fig. 2). Lack of on-site staff support and not being able to verify the basket before payment both decrease patronage, as does access convenience, manifested as having to check in to the store.

In their meta-analysis, Blut et al., (2018) call for context-specific studies of how technology affects retail patronage. Accordingly, we contribute to patronage and technology literature by identifying some trade-offs that technology options incur; they can be perceived as positive (more convenience and autonomy) and negative (less safety) at the same time, depending on the variable. The finding that most technology options raise safety concerns also aligns with a broad interpretation of safety, which is not limited to physical safety but also includes financial safety and privacy concerns (Web Appendix G). Customers feel vulnerable and unsafe if they must use a credit card to check in, only have access to remote support, or experience delayed basket verification.

Recent technology frameworks suggest retailers should reflect on the main purpose of their technology investments, such as increasing efficiency versus achieving enhancement, for the main target group of staff versus customers (Grewal et al., 2023). We concur with the importance of such considerations, in the context of autonomous stores. Autonomous stores might claim to increase consumer autonomy, but for consumers, just self-checkout or a fully automated version of it already increases autonomy (and thus patronage). Other technology features, such as apps for store access or delaying receipts, decrease autonomy, as well as safety and convenience, with overall negative impacts on patronage. These ambivalent autonomy outcomes resonate with Wertenbroch et al.'s (2020) description of paradoxical algorithms that are set up to increase autonomy while actually reducing it. With our findings, we contribute to retail technology research by emphasizing the importance of consumer perceptions of convenience, autonomy, and safety, as well as the trade-offs among them.

Finally, Blut et al. (2018) note that most empirical research on retail patronage draws on survey data. For scholars pursuing further research in this area, we present a novel empirical approach to investigate new retail formats. With a conjoint study, we immerse participants in a shopping trip by providing video depictions of different stages of the customer journey, featuring different new technology options. Such video manipulations are particularly relevant to test innovative formats that customers might not have experienced (yet).

Limitations and further research

This study has limitations that need to be considered, which open up new questions for future research. Autonomous stores are a relatively new store format, unfamiliar to most consumers (e.g., the first Amazon Go store only opened in March 2021; Kelion, 2021). Our study data come from the United Kingdom, one of the most advanced markets in Europe for autonomous stores, where all major retailers currently are running trials. Although we sought to develop realistic manipulations with animated videos, they still constitute hypothetical situations. As such, our dependent variable captures behavioral intentions, not actual behaviors, and we use intentions as proxies for actual behavior (Straub, Limayem, & Karahanna-Evaristo, 1995). Once autonomous stores are more common, and consumers grow familiar with them, continued research should include field studies with consumers who regularly shop at autonomous stores and capture their actual patronage behavior rather than intentions.

Many consumers perceive substantial barriers to patronizing autonomous stores, which indicates the need for more research on consumers' adoption of variations of this format. Retailers often react rapidly to non-adoption, and technology also is developing rapidly, such that alternative solutions pop up quickly, resulting in novel store features and locations that we did not consider. In line with studies of autonomous virtual shopping assistants (de Bellis & Johar, 2020), research might identify interventions that help retailers to address and overcome those barriers; interventions currently being trialed could be tested systematically. For example, the German cooperative myenso staffs its rural autonomous concept store for very limited opening hours (e.g., one or two hours per day) to reduce barriers for less tech-savvy customers (Wolfram, 2021). Amazon Fresh in the United Kingdom recently removed entry gates and need for customers to check in to the autonomous store (Nott, 2023). A related approach could extend our findings by investigating failed autonomous stores, to determine if consumer acceptance increases or decreases in different shopping contexts, like temporary autonomous stores at music festivals. Such efforts would address the research opportunities identified by Gauri et al. (2021) in relation to seasonal and pop-up stores. Further investigations also might seek more boundary conditions involving other consumer characteristics, locations, or product categories.

Beyond adoption, we encourage research into continued patronage. Consumers grow accustomed to automation overtime. By tracking how shopping behaviors change, further research could determine how quickly such adaptation takes place in relation to autonomous stores. Building on our finding that autonomous check-out alternatives increase patronage through perceived convenience and autonomy, but the effect is attenuated by negative effects due to safety concerns, scholars could advance research on the personalization paradox (i.e., consumers willingly compromise their own privacy in exchange for more convenience or other benefits; Aguirre, Mahr, Grewal, Ruyter et al., 2015). Perhaps over time, safety concerns dissipate, or alternatively, a safety paradox might exist, such that hesitation toward technology can be alleviated or even compensated for by its other benefits. As our findings suggest, mediators other than convenience, autonomy, and safety likely exert influences. Research conducted in the early days of mobile payments also identified some positive impacts on the retailer's image and increased willingness to pay, compared with cash payment (Falk et al., 2016). Perhaps autonomous stores also affect retailers' image, or perhaps check-outs that support frictionless payments might increase willingness to pay or basket sizes.

The specific features of autonomous stores have cost implications, which could be addressed by extending Yao et al.'s (2020) research of Chinese store concepts. Fully automated check-out (e.g., Amazon Go) is very expensive; self-checkout terminals or self-scanning on customers' devices involve smaller investments. But all options have similar effects on patronage. Future research could investigate at what point the potential cost benefits of less expensive but less convenient options (e.g., self-scanning with a customer's device) outweigh the lack of consumer adoption or potential for theft? Another interesting question pertains to the level at which rising staff costs (or shortages), together with decreasing costs of technology, make autonomous stores more economically viable or attractive. Research could extend prior findings showing that staff shortages have negative impacts on not only customer service but also retail sales (Mani, Kesavan, & Swaminathan 2015). Moreover, most autonomous stores are newly built; if retailers can identify a model that induces high consumer adoption, they need research into the potential and challenges associated with retrofitting their existing stores.

Interesting research topics also emerge from a supply chain perspective. The optimal delivery models for autonomous stores might differ: Should they rely on direct (external) delivery by wholesalers/suppliers or (internal) delivery from a larger, nearby store in the same retail chain? In either case, we also need research into delivery fulfillment when the store is unattended. Some wholesalers might accept autonomous supply, as in the case of the Swedish retailer Lifvs, which operates a small warehouse at the back of each unstaffed store in which suppliers autonomously drop off goods without human contact. Noting the tremendous growth but also intense operational challenges of on-demand delivery (e.g., Go Puff, Getir), continued research could investigate alternative income streams for autonomous stores, such that they function as micro-fulfillment centers (Gauri et al., 2021).

From a public policy standpoint, it would be valuable to test whether and to what extent it is sensible for policymakers to support autonomous stores. Research could investigate whether autonomous stores help mitigate the effects of urbanization by preventing food deserts—the justification Norway used when deciding to support such stores (Lunde, 2021). In rural areas, if autonomous stores reduce residents' travel distances, it also would be notable to consider their effects on emissions (Cachon, 2014). Such research efforts could investigate how greater retail availability affects healthy food intake and nutritional inequality (Allcott et al., 2020) and whether they enhance the quality of life in rural areas (Howlett, Davis, & Burton, 2016). Finally, policymakers might support autonomous stores in support of policy interventions designed to shift available labor to sectors in which automation is less suitable but human resources are greatly needed, such as healthcare (Dubois & Singh, 2009).

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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.2023.12.003.

Appendix 1. (Non-)Moderating role of retail location

Equation 5. Model including interactions with type of location

$$\begin{aligned}\text{Patronage}_{ij} = {} & \gamma_{00} + \gamma_{10}AC_{2_{ij}} + \gamma_{20}AC_{3_{ij}} + \gamma_{30}AS_{2_{ij}} \\ & + \gamma_{40}AS_{3_{ij}} + \gamma_{50}T_{2_{ij}} + \gamma_{60}T_{3_{ij}} + \gamma_{70}T_{4_{ij}} \\ & + \gamma_{80}V_{2_{ij}} + \gamma_{90}V_{3_{ij}} + \gamma_{100}L_{2_{ij}} + \gamma_{110}L_{ij} \\ & + \gamma_{111}\left(AC_{2_{ij}} \times L_{2_{ij}}\right) + \gamma_{112}\left(AC_{2_{ij}} \times L_{ij}\right) \\ & + \gamma_{113}\left(AC_{3_{ij}} \times L_{2_{ij}}\right) + \gamma_{114}\left(AC_{3_{ij}} \times L_{3_{ij}}\right) \\ & + \gamma_{115}\left(AS_{2_{ij}} \times L_{2_{ij}}\right) + \gamma_{116}\left(AS_{2_{ij}} \times L_{3_{ij}}\right) \\ & + \gamma_{117}\left(AS_{3_{ij}} \times L_{2_{ij}}\right) + \gamma_{118}\left(AS_{3_{ij}} \times L_{3_{ij}}\right) \\ & + \gamma_{119}\left(T_{2\nu} \times L_{2_{ij}}\right) + \gamma_{120}\left(T_{2_{ij}} \times L_{3_{ij}}\right) \\ & + \gamma_{121}\left(T_{3_{ij}} \times L_{2_{ij}}\right) + \gamma_{122}\left(T_{3_{ij}} \times L_{3_{ij}}\right) \\ & + \gamma_{123}\left(T_{4_{ij}} \times L_{2_{ij}}\right) + \gamma_{124}\left(T_{4_{ij}} \times L_{3_{ij}}\right) \\ & + \gamma_{125}\left(V_{2_{ij}} \times L_{2_{ij}}\right) + \gamma_{126}\left(V_{2_{ij}} \times L_{3_{ij}}\right) \\ & + \gamma_{127}\left(V_{3_{ij}} \times L_{2_{ij}}\right) + \gamma_{128}\left(V_{3_{ij}} \times L_{3_{ij}}\right) \\ & + \gamma_{01}TRI_j + \gamma_{02}ShopResp_j + \gamma_{03}ShopFreq_j \\ & + \gamma_{04}Car_j + \gamma_{05}Age_j + \gamma_{06}Gender_j \\ & + \gamma_{07}HhSize_j + u_j + e_{ij}. \end{aligned} \tag{5}$$

Table A1

Table A1
Path estimates for interaction models.

Fixed effects	Not.	Main Model			Main Model with Covariates		
		Estimate	SE	*p*	Estimate	SE	*p*
Intercept	γ_{00}	8.528	0.483	.000	3.923	1.082	.000
Level-1 (within-subjects)							
Access convenience							
Credit card (AC2)	γ_{10}	−0.770	0.236	.001	−0.790	0.235	.001
Provider app (AC3)	γ_{20}	−0.014	0.232	0.951	−0.016	0.231	.944
Assistance convenience							
Staff phone/text support (AS2)	γ_{30}	−0.975	0.225	.000	−0.981	0.224	.000
Virtual staff support (AS3)	γ_{40}	−0.644	0.227	.005	−0.639	0.227	.005
Transaction convenience							
Self-scanning terminals (T2)	γ_{50}	0.262	0.525	.618	0.141	0.524	..788
Self-scanning own device (T3)	γ_{60}	−0.182	0.526	.729	−0.318	0.525	.545
Fully automated check-out (T4)	γ_{70}	−0.571	0.579	.324	−0.728	0.577	.207
Verification convenience							
Costs after payment (V2)	γ_{80}	−0.109	0.286	.703	−0.107	0.285	.706
Costs after leaving store (V3)	γ_{90}	−1.050	0.287	.000	−1.031	0.286	.000
Location							
Traffic hub (L2)	γ_{100}	0.195	0.651	.765	0.141	0.649	.828
Rural (L3)	γ_{110}	−0.169	0.680	.803	−0.338	0.678	.618
Interactions							
AC2 × L2	γ_{111}	0.158	0.334	.637	0.181	0.333	.586
AC2 × L3	γ_{112}	0.292	0.335	.382	0.327	0.334	.327
AC3 × L2	γ_{113}	−0.185	0.328	.572	−0.204	0.327	.534
AC3 × L3	γ_{114}	−0.118	0.324	.716	−0.105	0.323	.744
AS2 × L2	γ_{115}	−0.353	0.321	.271	−0.317	0.320	.321
AS2 × L3	γ_{116}	0.282	0.323	.383	0.283	0.322	.378
AS2 × L2	γ_{117}	−0.406	0.313	.195	−0.413	0.312	.187
AS2 × L3	γ_{118}	−0.212	0.325	.515	−0.225	0.324	.487
T2 × L2	γ_{119}	−0.285	0.729	.695	−0.222	0.726	.760
T2 × L3	γ_{120}	0.200	0.750	.790	0.378	0.748	.613
T3 × L2	γ_{121}	0.063	0.727	.931	0.137	0.724	.850
T3 × L3	γ_{122}	0.500	0.760	.510	0.659	0.758	.385
T4 × L2	γ_{123}	0.429	0.803	0593	0.513	0.800	.522
T4 × L3	γ_{124}	0.403	0.851	.636	0.582	0.849	.493
V2 × L2	γ_{125}	−0.569	0.412	.167	−0.602	0.411	.143
V2 × L3	γ_{126}	−0.060	0.419	.885	−0.046	0.418	.912
V3 × L2	γ_{127}	−0.495	0.405	.222	−0.535	0.404	.186
V3 × L3	γ_{128}	−0.408	0.414	.325	−0.397	0.413	.337
Level-2 (between-subjects)							
Technological readiness	γ_{01}				0.822	0.161	.000
Shopping responsibility	γ_{02}				−0.110	0.074	.137
Shopping frequency	γ_{03}				0.111	0.144	.441
Car access	γ_{04}				0.669	0.227	.003
Age	γ_{05}				−0.013	0.007	.060
Gender	γ_{06}				0.321	0.202	.113
Household size	γ_{07}				0.084	0.074	.259
Random effects							
Within-subjects residual	e_{ij}	4.009	0.152	.000	4.009	0.152	.000
Between-subject residual	u_j	5.383	0.365	.000	4.911	0.339	.000

Notes: Reference levels: access convenience, no check-in needed (AC1); assistance convenience, on-site support staff (AS1); transaction convenience, staffed check-out (T1) verification convenience, costs displayed before payment (V1); location, embedded in community (L1). Unlike the main effect model in the main manuscript, we include location as a covariate in the covariate-free model so that the interactions can be estimated correctly. We also compared the conditional effects of all convenience store levels for traffic hub locations (L2) and rural locations (L3) and compared them. We find no significant differences.

Appendix 2. Path estimates for mediation model.

	Convenience (M_1)				Autonomy (M_2)				Safety (M_3)				Store Patronage (Y)			
Fixed effects	Not.	Est.	$CI_{2.5}$	$CI_{97.5}$	Not.	Est.	$CI_{2.5}$	$CI_{97.5}$	Not.	Est.	$CI_{2.5}$	$CI_{97.5}$	Not.	Est.	$CI_{2.5}$	$CI_{97.5}$
Intercept	γ_{M1_00}	4.879	3.130	6.627	γ_{M2_00}	5.620	3.954	7.287	γ_{M3_00}	7.128	5.456	8.814	γ_{Y_00}	3.932	1.909	5.948
Level-1 (within-subjects)																
Access convenience																
Credit card (AC2)	γ_{M1_10}	−0.236	−0.447	−0.022	γ_{M2_10}	−0.114	−0.321	0.093	γ_{M3_10}	−0.353	−0.569	−0.136	γ_{Y_10}	−0.293	−0.479	−0.108
Provider app (AC3)	γ_{M1_20}	−0.101	−0.260	0.057	γ_{M2_20}	0.101	−0.105	0.307	γ_{M3_20}	−0.046	−0.260	.169	γ_{Y_20}	0.023	−0.158	0.205
Assistance convenience																
Staff phone/text support (AS2)	γ_{M1_30}	−0.801	−1.026	−0.573	γ_{M2_30}	0.089	−0.114	0.290	γ_{M3_30}	−1.230	−1.442	−1.018	γ_{Y_30}	−0.196	−0.387	−0.006
Virtual staff support (AS3)	γ_{M1_40}	−0.425	−0.649	−0.199	γ_{M2_40}	0.206	0.004	0.407	γ_{M3_40}	−1.161	−1.371	−0.951	γ_{Y_40}	−0.288	−0.478	−0.099
Transaction convenience																
Self-scanning terminals (T2)	γ_{M1_50}	0.651	0.124	1.171	γ_{M2_50}	1.576	1.104	2.049	γ_{M3_50}	−0.651	−1.139	−0.164	γ_{Y_50}	−0.123	−0.550	0.296
Self-scanning own device (T3)	γ_{M1_60}	0.584	0.052	1.108	γ_{M2_60}	1.657	1.179	2.139	γ_{M3_60}	−0.804	−1.299	−0.313	γ_{Y_60}	−0.299	−0.731	0.130
Fully automated check-out (T4)	γ_{M1_70}	0.702	0.121	1.283	γ_{M2_70}	1.627	1.100	2.157	γ_{M3_70}	−1.144	−1.688	−0.603	γ_{Y_70}	−0.575	−1.053	−0.098
Verification convenience																
Costs after payment (V2)	γ_{M1_80}	−0.047	−0.339	0.244	γ_{M2_80}	−0.073	−0.333	0.189	γ_{M3_80}	−0.224	−0.498	0.046	γ_{Y_80}	−0.210	−0.443	0.021
Costs after leaving store (V3)	γ_{M1_90}	−0.704	−0.994	−0.415	γ_{M2_90}	−0.406	−0.668	−0.147	γ_{M3_90}	−0.986	−1.259	−0.713	γ_{Y_90}	−0.563	−0.800	−0.327
Location																
Traffic hub (L2)	γ_{M1_100}	−0.370	−0.572	−0.166	γ_{M2_100}	0.088	−0.109	0.282	γ_{M3_100}	−0.332	−0.536	−0.126	γ_{Y_100}	−0.126	−0.300	0.049
Rural (L3)	γ_{M1_110}	−0.101	−0.260	0.057	γ_{M2_110}	0.012	−0.185	0.208	γ_{M3_110}	0.070	−0.135	0.276	γ_{Y_110}	0.075	−0.099	0.249
Mediators																
Convenience (M1)													γ_{Y_120}	0.483	0.436	0.531
Autonomy (M2)													γ_{Y_130}	0.170	0.118	0.220
Safety (M3)													γ_{Y_140}	0.361	0.312	0.409
Level-2 (between-subjects)																
Technological readiness	γ_{M1_01}	0.508	0.231	0.783	γ_{M2_01}	0.381	0.115	0.644	γ_{M3_01}	0.415	0.150	0.680	γ_{Y_01}	0.814	0.494	1.134
Shopping responsibility	γ_{M1_02}	−0.069	−0.195	0.057	γ_{M2_02}	−0.033	−0.154	0.087	γ_{M3_02}	−0.112	−0.234	0.008	γ_{Y_02}	−0.111	−0.259	0.036
Shopping frequency	γ_{M1_03}	0.080	−0.165	0.329	γ_{M2_03}	−0.151	−0.387	0.086	γ_{M3_03}	−0.110	−0.346	0.126	γ_{Y_03}	0.114	−0.174	0.401
Car access	γ_{M1_04}	0.390	0.004	0.776	γ_{M2_04}	0.140	−0.229	0.511	γ_{M3_04}	0.203	−0.169	0.577	γ_{Y_04}	0.662	0.212	1.114
Age	γ_{M1_05}	0.003	−0.009	0.015	γ_{M2_05}	−0.004	−0.015	0.008	γ_{M3_05}	0.010	−0.002	0.022	γ_{Y_05}	−0.013	−0.027	0.001
Gender	γ_{M1_06}	0.201	−0.144	0.546	γ_{M2_06}	−0.376	−0.709	−0.044	γ_{M3_06}	0.493	0.163	0.826	γ_{Y_06}	0.324	−0.076	0.727
Household size	γ_{M1_07}	0.125	−0.002	0.251	γ_{M2_07}	0.069	−0.053	0.190	γ_{M3_07}	0.156	0.035	0.278	γ_{Y_07}	0.085	−0.061	0.233
Random effects																
Within-subjects residual	e_{M1_ij}	3.533	3.284	3.812	e_{M2_ij}	2.664	2.476	2.873	e_{M3_ij}	2.954	2.744	3.184	e_{Y_ij}	2.104	1.955	2.270
Between-subject residual	u_{M1_j}	3.566	3.081	4.112	u_{M2_j}	3.464	3.031	3.964	u_{M3_j}	3.388	2.948	3.891	u_{Y_j}	5.308	4.663	6.037

Notes: 95% credible intervals are [CI] reported.

References

Aguinis, Herman, & Bradley, Kyle J. (2014). Best Practice Recommendations for Designing and Implementing Experimental Vignette Methodology Studies. *Organizational Research Methods, 17*(4), 351–371.

Aguirre, Elizabeth M., Mahr, Dominik, Grewal, Dhruv, Ruyter, Ko de, & Wetzels, Martin (2015). Unraveling the Personalization Paradox: The Effect of Information Collection and Trust-Building Strategies on Online Advertisement Effectiveness. *Journal of Retailing, 91*(1), 34–49.

Ahmed, Jashim U., Ahmed, Asma, Talukdar, Amreen, Sharif, Raihan, & Zulkarin, Jahangir (2023). Innovation Strategy in Retail: The Unstaffed Digital Supermarkets at LIFVS. *Journal of Information Technology Teaching Cases, 13*(2), 175–181.

Albrecht, Christopher (2021). *Wait, It Takes *Hours* for Amazon Fresh Cashierless Receipts to Arrive?*. OttOmate Available at: https://www.ottomate.news/p/the-need-for-speedy-receipts-at-cashierless (Accessed 4 April 2023).

Allcott, Hunt, Diamond, Rebecca, Dubé, Jean-Pierre, Handbrury, Jessie, Rahkovsky, Ilva, & Schnell, Molly (2020). Food Deserts and the Causes of Nutritional Inequality. *Quarterly Journal of Economics*, 1793–1844.

Babin, Barry J., Feng, Cong, & Borges, Adilson (2021). As the Wheel Turns Toward the Future of Retailing. *Journal of Marketing Theory and Practice, 29*(1), 78–91.

Baker, Julie, Parasuraman, A., Grewal, Dhruv, & Voss, Glenn B. (2002). The Influence of Multiple Store Environment Cues on Perceived Merchandise Value and Patronage Intentions. *Journal of Marketing, 66*(2), 120–141.

Bandalos, Deborah L. (2018). *Measurement Theory and Applications for the Social Science*. New York: The Guildford Press.

Bartneck, Christoph, Kulić, Dana, Croft, Elizabeth, & Zoghbi, Susana (2009). Measurement Instruments for the Anthropomorphism, Animacy, Likeability, Perceived Intelligence, and Perceived Safety of Robots. *International Journal of Social Robotics, 1*, 71–81.

Bell, Richard, Davies, Ross, & Howard, Elizabeth (1997). The Changing Structure of Food Retailing in Europe: The Implications for Strategy. *Long Range Planning, 30*(6), 853–861.

Benoit, Sabine, Evanschitzky, Heiner, & Teller, Christoph (2019). Retail Format Selection in On-the-Go Shopping Situations. *Journal of Business Research, 100*(July), 268–278.

Berry, Leonard L., Seiders, Kathleen, & Grewal, Dhruv (2002). Understanding Service Convenience. *Journal of Marketing, 66*(3), 1–17.

Blut, Markus, Teller, Christoph, & Floh, Arne (2018). Testing Retail Marketing-Mix Effects on Patronage: A Meta-Analysis. *Journal of Retailing, 94*(2), 113–135.

Bonfrer, André, Chintagunta, Pradeep, & Dhar, Sanjay (2022). Retail Store Formats, Competition and Shopper Behavior: A Systematic Review. *Journal of Retailing, 98*, 71–91.

Cachon, Gérard P. (2014). Retail Store Density and the Cost of Greenhouse Gas Emissions. *Management Science, 60*(8), 1907–1925.

Carver, Charles S., & Scheier, Michael F. (2000). Autonomy and Self-Regulation. *Psychological Inquiry, 11*(4), 284–291.

Chrzan, Keith (1994). Three Kinds of Order Effects in Choice-Based Conjoint Analysis. *Marketing Letters, 5*(2), 165–172.

Collier, Joel E., & Kimes, Sheryl E. (2013). Only If It Is Convenient: Understanding How Convenience Influences Self-Service Technology Evaluation. *Journal of Service Research, 16*(1), 39–51.

Convenience Store News (2019), "Seven Predictions About the Future of Convenience Retailing," Available at: https://csnews.com/seven-predictions-about-future-convenience-retailing (Accessed 29 March 2022).

Cui, Yuanyuan, van Esch, Patrick, & Jain, Shailendra P. (2022). Just Walk Out: The Effect of AI-Enabled Checkouts. *European Journal of Marketing, 56*(6), 1650–1683.

Cui, Yuanyuan, & van Esch, Patrick (2022). Autonomy and Control: How Political Ideology Shapes the Use of Artificial Intelligence. *Psychology & Marketing, 39*(6), 1218–1229.

De Bellis, Emanuel, & Johar, Gita Venkataramani (2020). Autonomous Shopping Systems: Identifying and Overcoming Barriers to Consumer Adoption. *Journal of Retailing, 96*(1), 74–87.

Dekimpe, Marnik G., Geyskens, Inge, & Gielens, Katrijn (2020). Using Technology to Bring Online Convenience to Offline Shopping. *Marketing Letters, 31*, 25–29.

Denuwara, Navodya, Maijala, Juha, & Hakovirta, Marko (2021). The Impact of Unmanned Stores' Business Models on Sustainability. *SN Business and Economics, 1*, 143.

Dubois, Carl-Ardy, & Singh, Debbie (2009). From Staff-Mix to Skill-Mix and Beyond: Towards a Systemic Approach to Health Workforce Management. *Human Resources for Health, 7*, 87.

Eley, Jonathan (2021). *Amazon Opens First Physical Store Outside North America*. Financial Times Available at: https://www.ft.com/content/7241895a-c871-46f6-8200-b62182eced3a (Accessed 25 March 2021).

Elrod, Terry, Louviere, Jordan J., & Davey, Krishnakumar S. (1992). An Empirical Comparison of Ratings-Based and Choice-Based Conjoint Models. *Journal of Marketing Research, 29*(3), 368–377.

ESM Magazine. (2021). *Albert Heijn and Selecta to Open Unmanned 'To Go' Stores*. ESM Magazine Available at: https://www.esmmagazine.com/retail/albert-heijn-selecta-124161 (Accessed 9 October 2022).

Faithfull, Mark (2021). *Amazon Bets on Britain as Amazon Go Grocery Stores Set to Launch in London this Week*. Forbes Available at: https://www.forbes.com/sites/markfaithfull/2021/03/01/amazon-bets-on-britain-as-amazon-go-set-to-launch-in-london-this-week/?sh=7c3648f70d3c (Accessed 25 March 2021).

Falk, Tomas, Kunz, Werner H., Schepers, Jeroen J. L., & Mrozek, Alexander J. (2016). How Mobile Payment Influences the Overall Store Price Image. *Journal of Business Research, 69*(7), 2417–2423.

Forsythe, S. M., & Shi, B. (2003). Consumer Patronage and Risk Perceptions in Internet Shopping. *Journal of Business Research, 56*(11), 867–875.

Gauri, Dinesh K., Jindal, Rupinder P., Ratchford, Brian, Fox, Edward, Bhatnagar, Amit, Pandey, Aashish, Navallo, Jonathan R., Fogarty, John, Carr, Stephen, & Howerton, Eric (2021). Evolution of Retail Formats: Past, Present, and Future. *Journal of Retailing, 97*(1), 42–61.

Gielens, Katrjin, Gijsbrechts, Els, & Geyskens, Inge (2021). Navigating the Last Mile: The Demand Effects of Click-and-Collect Order Fulfillment. *Journal of Marketing, 85*(4), 158–178.

Goldman, Arieh, Ramaswami, S., & Krider, Robert E. (2002). Barriers to the Advancement of Modern Food Retail Formats: Theory and Measurement. *Journal of Retailing, 78*(4), 281–295.

González-Benito, Óscar, Muñoz-Gallego, Pablo A., & Kopalle, Praveen K. (2005). Asymmetric Competition in Retail Store Formats: Evaluating Inter- and Intra-Format Spatial Effects. *Journal of Retailing, 81*(1), 59–73.

Goodman, Joseph K., Cryder, Cynthia E., & Cheema, Amar (2013). Data Collection in a Flat World: The Strengths and Weaknesses of Mechanical Turk Samples. *Journal of Behavioral Decision Making, 26*(3), 213–224.

Grewal, Dhruv, Baker, Julie, Levy, Michael, & Voss, Glenn B. (2003). The Effects of Wait Expectations and Store Atmosphere Evaluations on Patronage Intentions in Service-Intensive Retail Stores. *Journal of Retailing, 79*(4), 259–268.

Grewal, Dhruv, Benoit, Sabine, Noble, Stephanie M., Guha, Abhijit, Ahlbom, Carl-Philip, & Nordfält, Jens (2023). Leveraging In-Store Technology and AI: Increasing Customer and Employee Efficiency and Enhancing their Experiences. *Journal of Retailing* online first.

Grewal, Dhruv, Levy, Michael, & Kumar, V. (2009). Customer Experience Management in Retailing: An Organizing Framework. *Journal of Retailing, 85*(1), 1–14.

Grewal, Dhruv, Noble, Stephanie M., Roggeveen, Anne L., & Nordfält, Jens (2020). The Future of In-Store Technology. *Journal of the Academy of Marketing Science, 48*(1), 96–113.

Guo, Bin, Wang, Ziqi, Wang, Pei, Xin, Tong, Zhang, Daqing, & Yu, Zhiwen (2019). DeepStore: Understanding Customer Behaviors in Unmanned Stores. *IT Professional, 22*(3), 55–63.

Gustafsson, Anders, Herrmann, Andreas, & Huber, Frank (2000). Conjoint Analysis as an Instrument of Market Research Practice. In *Conjoint Measurement. Methods and Applications* (pp. 5–46). Berlin: Springer. Gustafsson, Anders, Herrmann, Andreas and Frank Huber.

Hamidi, Saidatul Rahah, Yusof, Muhammad Afiq Muhamad, Shuhidan, Shuhaida Mohamed, & Kadir, Shamsiah Abd (2020). IR4.0: Unmanned Store Apps. *Indonesian Journal of Electrical Engineering and Computer Science, 17*(3), 1540–1547.

Hennig-Thurau, Thorsten, Henning, Victor, Sattler, Henrik, Eggers, Felix, & Houston, Mark B. (2007). The Last Picture Show? Timing and Order of Movie Distribution Channels. *Journal of Marketing, 71*(4), 63–83.

Howlett, Elizabeth, Davis, Cassandra, & Burton, Scot (2016). From Food Desert to Food Oasis: The Potential Influence of Food Retailers on Childhood Obesity Rates. *Journal of Business Ethics, 139*, 215–224.

Huber, Frank, Herrmann, Andreas, & Gustafsson, Anders (2000). On the Influence of the Evaluation Methods in Conjoint Design- Some Empirical Results. In Anders Gustafsson, Herrmann Andreas, & Frank Huber (Eds.), *Conjoint Measurement, Methods and Applications* (pp. 183–208). Berlin: Springer.

Into the Minds (2022), “Carrefour Flash: Thoughts on this Autonomous Store and Connected Retail,” Available at: https://www.intotheminds.com/blog/en/carrefour-flash, (Accessed 6 April 2023).

Jindal, Rupinder P., Gauri, Dinesh K., Li, Wanyu, & Ma, Yu (2021). Omnichannel Battle between Amazon and Walmart: Is the Focus on Delivery the Best Strategy? *Journal of Business Research, 122*(1), 270–280.

Kamran-Disfani, Omid, Mantrala, Murali K., Izquierdo-Yusta, Alicia, & Martínez-Ruiz, María Pilar (2017). The Impact of Retail Store Format on the Satisfaction-Loyalty Link: An Empirical Investigation. *Journal of Business Research, 77*(1), 14–22.

Kelion, Leo (2021). *Amazon Fresh Till-Less Grocery Store Opens in London*. BBC Available at: https://www.bbc.co.uk/news/technology-56266494 Accessed: 21 March 2021.

Krefting, L. (1991). Rigor in Qualitative Research: The Assessment of Trustworthiness. *American Journal of Occupational Therapy, 45*(3), 214–222.

Larivière, Bart, Bowen, David, Andreassen, Tor W., Kunz, Werner, Sirianni, Nancy J., Voss, Chris, Wünderlich, Nancy V., & Keyser, Arne De (2017). ‘Service Encounter 2.0’: An Investigation into the Roles of Technology, Employees and Customers. *Journal of Business Research, 79*(October), 238–246.

Lin, Chen-Yu (2022). Understanding Consumer Perceptions and Attitudes toward Smart Retail Services. *Journal of Services Marketing, 36*(8), 1015–1030.

Lin, Jiun-Sheng Chris, & Hsieh, Pei-Ling (2011). Assessing the Self-Service Technology Encounters: Development and Validation of SSTQUAL Scale. *Journal of Retailing, 87*(2), 194–206.

Lindeberg, Greg (2023), “Juxta Launches Autonomous Micro-Convenience Store”, Available at: https://www.cspdailynews.com/technologyservices/juxta-launches-micro-convenience-store, (Accessed 4 December 2023).

Louviere, Jordan J. (2011). Analyzing Decision Making. *SAGE Research Methods*.

Lunde, Ådne (2021). Landets første heildigitale butikk ligg i Eksingedalen. Her går det så det susar I koronatida. *Bergens Tidende* 8th February 2021.

Mani, Vidya, Kesavan, Saravanan, & Swaminathan, Jayashankar M. (2015). Estimating the Impact of Understaffing on Sales and Profitability in Retail Stores. *Production and Operations Management, 24*(2), 201–218.

McKinsey Global Institute. (2015). *The Internet of Things, Mapping the Value Beyond the Hype* Available at https://www.mckinsey.com/~/media/McKinsey/Industries/Technology Media and Telecommunications/High Tech/Our Insights/The Internet of Things The value of digitizing the physical world/Unlocking_the_potential_of_the_Internet_of_Things_Executive_summary.ashx (Accessed: 4 December 2023).

Nott, George (2023). *Will Easier-to-Enter Stores give Amazon Fresh a Boost?*. The Grocer April 19.

Olsen, Erik L. (2013). It’s Not Easy Being Green: The Effects of Attribute Tradeoffs on Green Product Preference and Choice. *Journal of the Academy of Marketing Science, 41*(2), 171–184.

Ostrom, Amy, & Iacobucci, Dawn (1995). Consumer Trade-Offs and the Evaluation of Services. *Journal of Marketing, 59*(1), 17–28.

Palmer, Annie, & Repko, Melissa (2020). *How the Coronavirus Pandemic Helped Convince Grocery Chains to Experiment with New Tech*. CNBC Available at: https://www.cnbc.com/2020/09/06/how-coronavirus-convinced-grocery-chains-to-experiment-with-new-tech-.html (Accessed 8 December 2020).

Pan, Yue, & Zinkhan, George M. (2006). Determinants of Retail Patronage: A Meta-Analytical Perspective. *Journal of Retailing, 82*(3), 229–243.

Papies, Dominik, Eggers, Felix, & Wloemert, Nils (2011). Music for Free? How Free Ad-Funded Downloads Affect Consumer Choice. *Journal of the Academy of Marketing Science, 39*(5), 777–794.

Parasuraman, A. (2000). Technology Readiness Index (TRI): A Multiple-Item Scale to Measure Readiness to Embrace New Technologies. *Journal of Service Research, 2*(4), 307–320.

Parasuraman, A., & Colby, Charles L. (2015). An Updated and Streamlined Technology Readiness Index: TRI 2.0. *Journal of Service Research, 18*(1), 59–74.

Park, Hyun Jung, & Zhang, Yining (2022). Technology Readiness and Technology Paradox of Unmanned Convenience Store Users. *Journal of Retailing and Consumer Services, 65*(March), 1–9.

Peer, Eyal, Brandimarte, Laura, Samat, Sonam, & Acquisti, Alessandro (2017). Beyond the Turk: Alternative Platforms for Crowdsourcing Behavioral Research. *Journal of Experimental Social Psychology, 70*(May), 153–163.

Pickard, Toby (2017). Unstaffed Stores: Continuous Convenience. *IGD Retail Analysis*. Available at: https://retailanalysis.igd.com/presentations/presentation-viewer/t/unstaffed-stores-continuous-convenience/i/7042. (Accessed 8 December 2020).

Pillai, Rajasshrie, Sivathanu, Brijesh, & Dwivedi, Yogesh K. (2020). Shopping Intention at AI-Powered Automated Retail Stores (AIPARS). *Journal of Retailing and Consumer Services, 57*, 102–207.

Preacher, Kristopher J., Zyphur, Michael J., & Zhang, Zhen (2010). A General Multilevel SEM Framework for Assessing Multilevel Mediation. *Psychological Methods, 15*(3), 209–233.

Rahman, Syed Mahmudur, Carlson, Jamie, Gudergan, Siegfried P., Wetzels, Martin, & Grewal, Dhruv (2022). Perceived Omnichannel Customer Experience (OCX): Concept, Measurement, and Impact. *Journal of Retailing, 98*(4), 611–632.

Rao, Vithala R. (2014). *Applied Conjoint Analysis*. Heidelberg: Springer.

Research and Markets. (2020). *Global Unmanned Convenience Store Market (2019 to 2027)- COVID-19 Impact and Analysis*. GlobeNewswire Available at: https://www.globenewswire.com/news-release/2020/05/12/2031697/0/en/Global-Unmanned-Convenience-Store-Market-2019-to-2027-COVID-19-Impact-and-Analysis-by-Offering-Type.html (Accessed: 8 December 2020).

Roggeveen, Anne L., & Sethuraman, Raj (2020). Customer-Interfacing Retail Technologies in 2020 & Beyond: An Integrative Framework and Research Directions. *Journal of Retailing, 96*(3), 299–309.

Rubagotti, Matteo, Tusseyeva, Inara, Baltabayeva, Sara, Summers, Danna, & Sandygulova, Anara (2022). Perceived Safety in Physical Human–Robot Interaction—A Survey. *Robotics and Autonomous Systems, 151*, Article 104047.

Schlereth, Christian, Skiera, Bernd, & Wolk, Agnieszka (2011). Measuring Consumers’ Preferences for Metered Pricing of Services. *Journal of Service Research, 14*(4), 443–459.

Schneider, Christie (2017). *10 Reasons Why AI-Powered, Automated Customer Service Is the Future*. IBM Available at: https://www.ibm.com/blogs/watson/2017/10/10-reasons-ai-powered-automated-customer-service-future/ (Accessed: 8 December 2020).

Seiders, Kathleen, Voss, Glenn B., Grewal, Dhruv, & Godfrey, Andrea L. (2005). Do Satisfied Customers Buy More? Examining Moderating Influences in a Retailing Context. *Journal of Marketing, 69*(October), 26–43.

Shankar, Venkatesh, Kalyanam, Kirthi, Setia, Pankaj, Golmohammadi, Alireza, Tirunillai, Seshadri, Douglas, Tom, Hennessey, John, Bull, J. S., & Waddoups, Rand (2020). How Technology Is Changing Retail. *Journal of Retailing, 97*(1), 13–27.

Sohn, Stefanie (2024). Consumer Perceived Risk of Using Autonomous Retail Technology. *Journal of Business Research, 171*, Article 114389.

Steckel, Joes H., DeSarbo, Wayne S., & Mahajan, Vijay (1991). On the Creation of Acceptable Conjoint Analysis Experimental Designs. *Decision Science, 22*(2), 435–442.

Straub, Detmar, Limayem, Moez, & Karahanna-Evaristo, Elena (1995). Measuring System Usage: Implications for IS Theory Testing. *Management Science, 41*(8), 1328–1342.

Sunil, Aruni (2023). Is the Future of Shopping Still Autonomous? *Sifted*. Available at: https://sifted.eu/articles/future-of-shopping-still-autonomous-brnd#. (Accessed 4 December 2023).

Valora (2023), "Self-Checkout: The New Autonomy when Shopping," Available at: https://stories.valora.com/en/self-checkout-the-new-autonomy-when-shopping/ (Accessed 2 February 2023).

van Esch, Patrick, Cui, Yuanyuan, & Jain, Shailendra P (2021). Self-Efficacy and Callousness in Consumer Judgments of AI-Enabled Checkouts. *Psychology & Marketing, 38*(7), 1081–1100.

van Rompaey, Stefan (2022). Albert Heijn's Belgian Turnover Surpasses One Billion Euro. *Retail Detail* January 19.

Wang, I-Chi, Lias, Chin-Wen, Lin, Kuo-Ping, Ching-Hsin, Wang, & Tsai, Chen-Lin (2021). Evaluate the Consumer Acceptance of AIoT-Based Unmanned Convenience Stores Based on Perceived Risks and Technological Acceptance Models. *Mathematical Problems in Engineering*, 1–12.

Wang, Wangshuai, Raghunathan, Rajagopal, & Gauri, Dinesh K. (2022). Powerlessness, Variety-Seeking, and the Mediating Role of Need for Autonomy. *Journal of Retailing, 98*(4), 706–723.

Weinswig, Deborah (2020). Autonomous Retail Is Booming in Post-Crisis China. *TechNode*. Available at: https://technode.com/2020/09/08/autonomous-retail-is-booming-in-post-crisis-china/. (Accessed 8 December 2020).

Wertenbroch, Klaus, Schrift, Rom Y., Alba, Joseph W., Barasch, Alixandra, Bhattacharjee, Amit, Giesler, Markus, Knobe, Joshua, Lehmann, Donald R., Matz, Sandra, Nave, Gideon, Parker, Jeffrey R., Puntoni, Stefano, Zheng, Yanmei, & Zwebner, Yonat (2020). Autonomy in Consumer Choice. *Marketing Letters, 31*(4), 429–439.

Wolfram, Gerad (2021). 24/7 – Einkaufen rund um die Uhr. *Digitalconnection*. Available at: https://www.digitalconnection.de/connected-customer/24-7-einkaufen-rund-um-die-uhr/. (Accessed 27 April 2023).

Wood, Stacey L., & Moreau, Page C. (2006). From Fear to Loathing? How Emotion Influences the Evaluation and Early Use of Innovations. *Journal of Marketing, 70*(3), 44–57.

Wu, Hung-Che, Aib, Chi-Han, & Cheng, Ching-Chan (2019). Experiential Quality, Experiential Psychological States and Experiential Outcomes in an Unmanned Convenience Store. *Journal of Retailing and Consumer Services, 51*(November), 409–420.

Xu, Ni, Hsu, Ping-Yu, Chang, Yu-Wei, & Kan, Bo-Lun (2022). *Determinants of Unmanned Store Usage Intention Based on Situational Theory and the Technology Readiness Index* Available at SSRN: https://ssrn.com/abstract=3929828.

Yao, Liming, Shuai, Yuhong, Chen, Xudong, & Xiao, Anran (2020). A Two-Stage EBM-Based Approach to Evaluate Operational Performance of Unattended Convenience Store. *International Journal of Retail and Distribution Management, 48*(6), 609–627.

Yuan, Ying, & MacKinnon, David P. (2009). Bayesian Mediation Analysis. *Psychological Methods, 14*(4), 301–322.