Journal of Retailing xxx (xxxx) xxx

Contents lists available at ScienceDirect

Journal of Retailing

journal homepage: www.elsevier.com/locate/jretai

Digital signage for promoting price discounts: First insights into customer spending on distant and nearby discounted products

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ARTICLE INFO

Article history:
Available online xxx

Keywords:
Digital signage
Price discounts
Field experiments
Grocery stores
Product location

ABSTRACT

Retailers are increasingly using digital signage to promote price discounts. Our research explores a crucial question: Does displaying price discounts on digital screens, in addition to traditional displays, influence customer spending on discounted products? Through two field experiments in grocery stores involving 7,009 customers, we found that promoting price discounts on digital screens has a significant impact on the sales of discounted products located farther from digital screens (i.e., products outside the department in which the screens are located). However, promoting discounted products near screens (i.e., products in the department) do not have a significant effect on sales. Retailers should consider promoting discounted products on digital screens while considering the product's distance from the screen. For products near screens, traditional printed displays might be sufficient to drive sales. This unique insight can guide retailers and brand manufacturers in optimizing their in-store marketing strategies. Our study offers a valuable starting point for future research on the effects of digital signage on retail sales.

1. Introduction

Retailers are increasingly adopting digital screens in their stores to appeal to customers, improve their experience and communicate with them (Roggeveen et al., 2016). Such screens are known as *digital signage* (Garaus & Wagner, 2019), whose global market size was valued at USD 17.77 billion in 2022 and is projected to reach USD 27.8 billion by 2026 (Markets & Markets, 2022).

While existing research on the content displayed on digital signage has predominantly focused on the impact of affective content, which has a broadly positive influence on consumer perceptions (Garaus et al., 2021) and spending habits (Dennis et al., 2010; Garaus & Wagner, 2019), it is important to note the divergence in its practical application. Retailers are increasingly employing digital signage for an alternate purpose: promoting price discounts (Aydinli et al., 2014; Cenareo, 2020). A recent survey conducted by Future Stores (2021) on a sample of leading retailers shows that a significant majority of them, eighty-six out of one hundred, anticipate digital screens to be effective in promoting price discounts. This

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https://doi.org/10.1016/j.jretai.2024.05.004

strategy is expected to capture customer attention more effectively and, consequently, increase sales of products offered at discounted prices (Cenareo, 2020).

The use of price discounts to improve sales of specific products is a strategy that is well recognized and documented in the marketing literature (Haans & Gijsbrecht, 2011; Sotgiu & Gielens, 2015). Contrary to affective content, price discounts have also been traditionally communicated through printed in-store displays, such as shelf displays and billboards (Han et al., 2022). However, integrating digital signage with these traditional tools and understanding its impact on customer spending on discounted products are important aspects for marketing managers (Future Stores 2021). By adopting an empirics-first approach (Golder et al., 2022), we identified the following research opportunity: the literature on digital signage remains limited with respect to the content displayed on digital screens, primarily focusing on the display of affective content. However, retailers are increasingly investing in digital signage to complement traditional printed displays for price discounts. Therefore, our first research question (RQ1) is as follows: What is the impact of using digital signage to promote price discounts on customer spending for discounted products?

Currently, there is not enough evidence to provide a straightforward answer to this question. While repeated exposure to promotional messages through both digital and traditional printed displays may enhance purchase intentions (Schmidt & Eisend, 2015), the transitory nature of digital screen images (i.e., frequent changes in displayed content, where images disappear quickly and are replaced with new ones) demands more cognitive processing, potentially leading to cognitive overload and difficulty in message retention (Merkt et al., 2011; Wooley et al., 2022). Hence, it is difficult to anticipate the effect of using digital signage for price discounts on customer spending on discounted products.

We address our first research question by conducting two pilot field experiments in collaboration with a supermarket chain that implemented digital signage in two of its stores. We ensured that the supermarket alternated the content on the digital screens for two weeks. In certain time slots, the screens featured product promotions (i.e., price discount conditions), while in others, only service-related information was displayed, such as rewards for loyalty programs (i.e., nonprice discount conditions). Our initial findings suggested that the use of digital signage did not significantly affect customer spending on discounted products. Intrigued by this result, and in line with the empirics-first approach, we further explored our data to gain a deeper understanding of our findings.

According to a recent study on traditional in-store signage, the distance between printed signage and the location of the discounted product significantly affects purchase incidence (Han et al., 2022). It was specifically noted that traditional printed signage, when located far from the product, has little or no effect on the frequency of product purchases, making them approximately 70% smaller than the effects of signage positioned nearby. This finding prompted us to question whether distance could also play a significant role in the context of promotions displayed on digital screens. Hence, our second research question (RQ 2) is as follows: Does the impact of digital signage on customer spending for discounted products vary based on the products' proximity to the screens, i.e., whether they are located nearby or farther away?

Our results show that digital screens promoting price discounts effectively increase customer spending only for discounted products located farther from screens. Interestingly, this effect was negligible for products positioned near the screens.

Thus, our study provides some theoretical and practical insights into the implementation of digital signage. We contribute to extending the knowledge on the effects of digital signage on sales by showing that (i) promoting price discounts on digital screens does not always increase customer spending on discounted products and (ii) contrary to previous findings on traditional printed displays, the use of digital screens increases customer spending only on products located far from the screen.

These results are also valuable for store managers who are investing in digital signage. They should pay close attention to the content displayed on the screens, realizing that, for price promotions, adding digital screens to traditional printed displays to promote nearby products may not be effective in increasing sales of those products. However, using digital signage to promote products located farther from screens can reinforce the message they want to convey to customers and boost the sales of those products.

We acknowledge that examining a phenomenon within a single context could limit our ability to derive broader insights. However, the recent marketing literature has highlighted that single-context studies can offer significant informative value (Stremersch et al., 2023). Furthermore, following the examples of other scholars (Cleeren et al., 2013), we use the evidence presented in our study as a catalyst for future research, aiming to broaden both theoretical and empirical knowledge on the subject. We suggest several research directions to enhance understanding among academics and marketing professionals and enrich the overall base of knowledge on this topic.

2. Background literature

A digital signage system is a private network of screens displaying a range of content from advertisements and local information to entertainment and news (Dennis et al., 2012; Garaus et al., 2021). Research on this topic has consistently shown that the mere presence of a digital screen can enhance the image of malls and stores, evoke positive emotions, increase the intention to approach the store (Burke, 2009; Dennis et al., 2010, 2012; Garaus et al., 2017), and improve overall store satisfaction by positively influencing wait-time perceptions at checkout lines (Garaus & Wagner, 2019). Along this line, Roggeveen et al. (2016) showed that the impact of digital signage varies depending on the size of the store. In larger settings such as hypermarkets, digital screens have been found to boost sales, extend shopping duration, and increase

the variety of products purchased. This is attributed to customers becoming more immersed in the retail environment and more susceptible to impulsive purchases. In contrast, in smaller stores, customers are more task-focused and less receptive to digital signage.

Regarding the specific type of content transmitted on digital screens, the (few) scholars who have addressed the topic have reported the following: (i) evoking a consumption experience, i.e., showing a video of a seaplane landing in a beautiful tropical lagoon next to a golden sand beach instead of written travel details, elicits approach behavior toward the advertisers (Dennis et al., 2014); (ii) affective content, i.e., displaying an image of a child eating an apple rather than just showing the apple, increases impulse purchases and store loyalty (Garaus et al., 2017); and (iii) emotional targeting in digital signage, i.e., aligning content with shoppers' moods, improves purchase intentions and perceptions of product quality and value. Affective content on digital signage (such as ads commemorating a brand's 100th anniversary that depict life events charged with emotion, such as feeding a baby or cuddling with a dog) tends to be more effective in promoting hedonic products. In contrast, informative content (for example, guides on which detergent to use for different stains or videos depicting the production and transport of mineral water) generally works better for promoting utilitarian products (Garaus et al., 2021). (iv) Additionally, a video displaying the price of products increases general sales (Roggeveen et al., 2016).

These insightful findings primarily focus on affective content, suggesting the need for further investigations into other types of content displayed. Along this line, Bauer et al., (2018) stated, "Characteristics of content [of digital signage] that is particularly suited for retail situations […] have to be studied on a fine-grained basis and should cover various design aspects such as information versus promotional content" (p. 505).

Against this backdrop, our research explores the effectiveness of digital signage solutions for promoting price discounts and their impact on customer spending on discounted products. Integrating digital screens with traditional displays to convey price discount messages exposes customers to the promotional message multiple times. On the one hand, the marketing literature suggests that advertisement repetition enhances positive attitudes and strengthens purchase intentions (Schmidt & Eisend, 2015). On the other hand, the transitory nature of images on screens requires continuous processing in working memory, which traditional printed displays do not necessitate (Wooley et al., 2022). As customers' cognitive resources are limited, especially during task-focused shopping, this can lead to cognitive overload (Merkt et al., 2011), making it challenging for customers to retain the message. Therefore, while displaying price discounts on digital screens may reinforce the promoted message, potential information overload could distract them and make it challenging to grasp the message. For this reason, assessing the effectiveness of using digital signage to promote price discounts on customer spending on discounted products is not straightforward.

Moreover, as digital signage screens are positioned in some selected areas of the store, when they display product discounts, another element must be considered: the distance between the display broadcasting the message and the actual location of the product in the store, where consumers find and evaluate it for purchase. Research on traditional printed displays typically suggests that displays located near the focal product category are more effective for purchase incidence due to greater consumer attention and cognitive engagement (Han et al., 2022). Therefore, we might expect that, as with traditional displays, digital displays exert a more substantial influence by focusing greater consumer attention on products located in proximity to a screen.

However, digital screens are more able to activate customers' focal attention than printed displays because of the transitory nature of the images displayed. Indeed, according to Greenwald and Leavitt (1984), focal attention can be elicited by a "colorful, moving, novel" stimulus (p. 585), such as dynamic images on digital screens. Moreover, dynamic attention theory suggests that the dynamic nature of digital images can capture consumers' attention more effectively than printed messages, since human attention focuses on changeable elements in the environment (Wooley et al., 2022). Thus, unlike traditional printed displays, digital screens could also be effective for products located far from the screen: when customers arrive in a department where the distal product is located, they have already paid attention to digital screens, and traditional displays located nearby the product reinforce the message. The spaced exposure (first the screen, then the shelf tag) can help customers better process message information and make purchase decisions (Schmidt & Eisend, 2015).

For nearby products, customers simultaneously acquire the same information from both digital and traditional printed displays. The joint presentation of the same information in dual communication channels (i.e., printed and digital) could further reinforce the message, but it could also be perceived as redundant (Sweller et al., 2011). Previous scholars, primarily in education, have demonstrated that redundancy leads to less message content recall than a single communication channel (only printed or digital) (Albers et al., 2023). In light of the diverse explanations, formulating straightforward hypotheses on the differential effect of digital screens on customer spending on near vs. distant products is complex; hence, in line with the empirics-first approach, we proceed with a set of empirical explorations.

3. Empirical setting

Our research was conducted in collaboration with a European supermarket chain that has been in business for over 40 years. It has 117 stores, approximately 100,000 daily customers, and more than 3,000 employees. As a company that focuses on offering high-quality products at an affordable price, promoting price discounts to customers is crucial. As a means of communication, yellow printed tags with red writing are used to signal in-store offers, which can be found on the shelves next to the promoted products. Billboards are not used to signal price discounts; rather, they are used to provide information

on the product categories found in a particular department or aisle. Pictures of the price discount tags and billboards are shown in Web Appendix A.

The managers of this chain decided to supplement the printed tags with digital signage in some stores, partly to make the store design more innovative but mostly to further promote price discounts. The company has decided to implement digital signage in only two of its stores as a pilot program. The aim of this program was to determine whether to invest in expanding digital signage in all stores.

The collaborating stores are located in a province with approximately 940,000 residents. The stores are 33 km apart and have the same size (approximately 2,000 square meters), layout, assortment, and, of course, the same promotions. Four digital screens of the same size (3 in x 42 in; 279 cm x 53 cm) were installed in each store: one in the fruit and vegetable department, one in the delicatessen section, one in the alcoholic beverages section, and one in the personal hygiene department. The decisions regarding the selection of the discounted products, their prices and the location of the screens were made by the company at the national level, and we had no influence on them.

To assess the effect of displaying price discounts on digital screens, we randomly manipulated the content of the digital screens during different daytime slots in the two stores. We conducted our field experiments a few months after digital signage was first introduced in the stores, which should attenuate both positive (e.g., adopters' excitement for novelty) and negative (e.g., adopters' resistance to change) short-term consumer reactions (Mani & Chouk, 2017; Wells et al., 2010).

4. Study 1

4.1. Procedure and design

We manipulated the content displayed on the digital screens for two weeks, which is the duration for which the same products remained on sale. Specifically, we randomly assigned some time slots during which the digital screens displayed the products on promotion, i.e., *the price discount condition*. Conversely, in other time slots, the screens displayed service information only, such as home delivery service availability or weekly rewards for point collection, i.e., *the nonprice discount condition.* Fig. 1 shows examples of the content of digital screens under price discount and nonprice discount conditions. Rather than using one of the two stores as a control, we manipulated the screens during time slots in both stores to have a clearer design. This approach helps minimize the influence of environmental factors and potential hidden differences between the two stores. We set three time slots, from 8 am to 12 pm, from 12 pm to 5 pm, and from 5 pm to 8 pm, during which we implemented our manipulation. During these time slots, the digital screens displayed either price discounts *or* service information. We rotated the time slots to avoid confounds related to the time of day (see Web Appendix B for details). Each image was displayed on the screens for approximately 35 seconds before transitioning to the next image. The extended duration of the time slots, along with the programming change during hours with lower store traffic (before the lunch break and before office closures), allowed us to minimize the risk of customers experiencing both conditions.

In the price discount condition, the fruit and vegetable department screen showed salad, bananas (only during the first week) and apricots (only during the second week), all located in the same department as the screen. The screen of the delicatessen department instead displayed mozzarella (located in the department) and beef (located outside the department). The alcoholic beverages department screen included beer (located in the department) and mini-ice cream cones (located outside the department). Finally, the personal hygiene department screen displayed shampoo (located in the department) and coffee (located outside the department). All the featured products were from popular national brands. Fig. 2 presents a simplified blueprint of the stores, highlighting the locations of the digital screens and the discounted products (both in and outside the respective departments) displayed on each screen.

As a dependent variable, we obtained the amount each customer spent on the discounted products during the period of our manipulation from the company. Therefore, our unit of analysis is at the consumer-receipt level. Given the nature of some products, such as fruits and vegetables, which are sold by weight, we were unable to obtain the quantity of products purchased for use as the dependent variable. Moreover, the different product types make it challenging to establish meaningful comparisons. For instance, it is unclear whether purchasing 500 grams of bananas can be compared to buying one or two packs of shampoo or whether the same principle applies to meat and coffee. Nonetheless, evaluating the total amount that consumers spend on discounted products can offer valuable insights into the connection between spending and quantity (i.e., higher spending is likely correlated with a greater quantity purchased).

During the study, we obtained cash receipt data from 4,565 customers (2,036 in the nonprice discount condition; 2,529 in the price discount condition) who bought the discounted products. As previously mentioned, the observations in our dataset are at the customer-receipt level. The average amount spent on the discounted products was 4.09€ (SD 6.08). We also obtained data on total customer spending for each customer. Using a two-sample t test, we verified that the customers in the price discount condition and those in the nonprice discount condition did not differ in terms of general grocery spending ($t_{4563} = .32$; $p = .75$; $M_{(\text{price discount})} = €76.13$; $M_{(\text{nonprice discount})} = €76.66$).

4.2. Results

We started by testing the effect of promoting price discounts on digital screens on customer spending on discounted products using an OLS regression. We found that displaying the discounted products on the screens does not have

Digital Screens in the price discount condition.

Digital Screens in the nonprice discount condition.

Fig. 1. Examples of the content of digital screens under price discount and nonprice discount conditions.

tangible effects on the sales of the discounted products (b = .10; p = .59; $M_{(price\ discount)}$ = €4.14; $M_{(nonprice\ discount)}$ = €4.04). Such a negligible effect remained even when controlling for the store, date, and hour fixed effects (b = .13; p = .53; $M_{(price\ discount)}$ = €4.15; $M_{(nonprice\ discount)}$ = €4.02). Our treatment also does not impact customer spending for nondiscounted products, i.e., total spending minus spending for discounted products (b = .998; p = .60).

Although reflecting a null effect, these initial results are interesting because, according to the literature on advertisement repetition, seeing the same message twice (both on the printed tag and the screen) should enhance positive attitudes and strengthen purchase intentions (Schmidt & Eisend, 2015). Thus, following the empirics-first approach and leveraging the possible role played by screen location, we explored our data in greater depth, investigating whether our manipulation affected customer spending on products located in the department where the screens were installed vs. those located outside differently.

4.3. The heterogeneous effect of product location

We thus examined the potential contingent effect of product location on our initial results. We used a dummy variable taking the value of 1 when the discounted products purchased by customers were located in the department where the screen was placed and 0 when the products were located outside the department. It is important to note that the digital screens were not visible from other departments.

The results show a significant interaction effect between our manipulation and product location in predicting customer spending on discounted products (b = -.95, p = .035) (Table 1, Model 1). We found consistent results when controlling for the day, hour, and store fixed effects (b = -.91, p = .044) (Table 1, Model 2) and for the product category fixed effect (fruits and vegetables, main dishes, dessert, nonfood and other) (b = -.93, p = .032) (Table 1, Model 3).

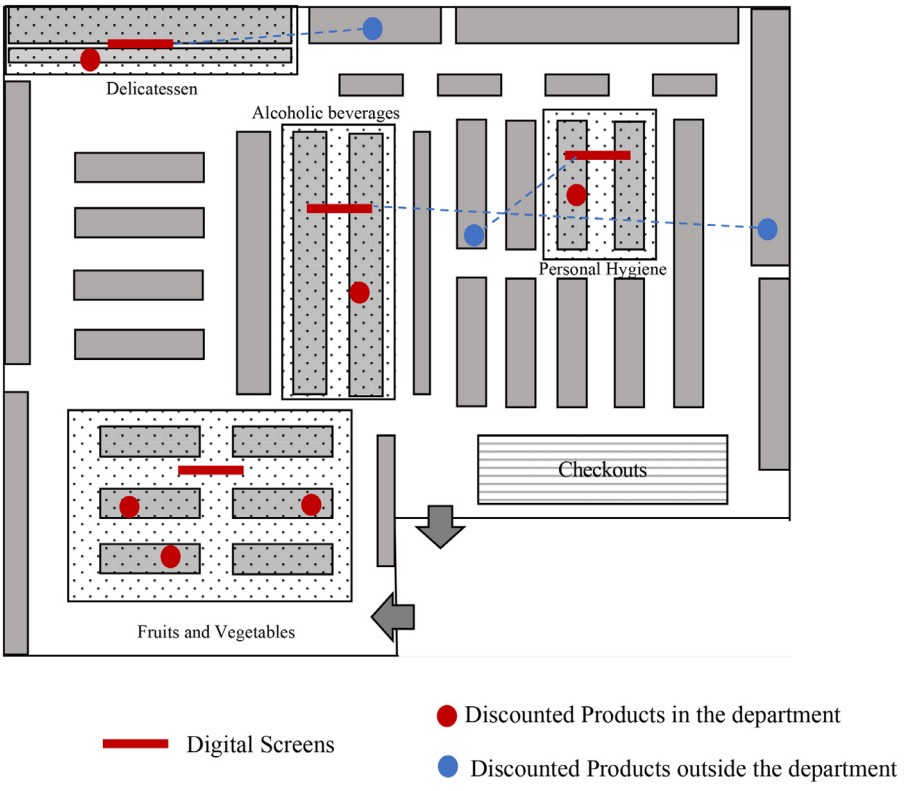

Fig. 2. Blueprint of the stores and the location of digital screens and discounted products (Study 1).

Table 1
Results of the heterogeneous effect of product location (Study 1).

Model Dependent Variable	Model 1 OLS Customer spending on discounted products	Model 2 OLS Customer spending on discounted products	Model 3 OLS Customer spending on discounted products
Condition (price discount)	0.912**	0.931**	0.915**
	(0.416)	(0.429)	(0.401)
Product location (within)	-5.417***	-5.343***	-5.304***
	(0.335)	(0.335)	(0.356)
Condition#Product location	**-0.951****	**-0.911****	**-0.931****
	(0.451)	(0.451)	(0.434)
Constant	8.518***	8.344***	7.624***
	(0.309)	(0.765)	(0.397)
Observations	4,731	4,731	4,731
R-squared	0.130	0.141	0.196
FE	None	Day, Hour, Store	Product Category

Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

A marginal analysis[1] conducted on Model 3 reveals that our manipulation had a negligible effect on customer spending on products located in the department where the screen was placed (b = -.016, p = .923) but had a sizable positive effect on customer spending on products located away from the department where the digital screen was located (b = .915; p = .023). This means that our manipulation increased the average customer spending on products outside the department by approximately 0.92€ (22.5% of the average customer spending on discounted products) (Fig. 3).

[1] Marginal analysis calculates statistics based on predictions of a model (in this specific case, Model 3 in Table 1). The analysis decomposes the impact of price promotion on customer spending for discounted products across products located within the department in which the screens are placed and those placed outside the department. The same procedure is used in Study 2.

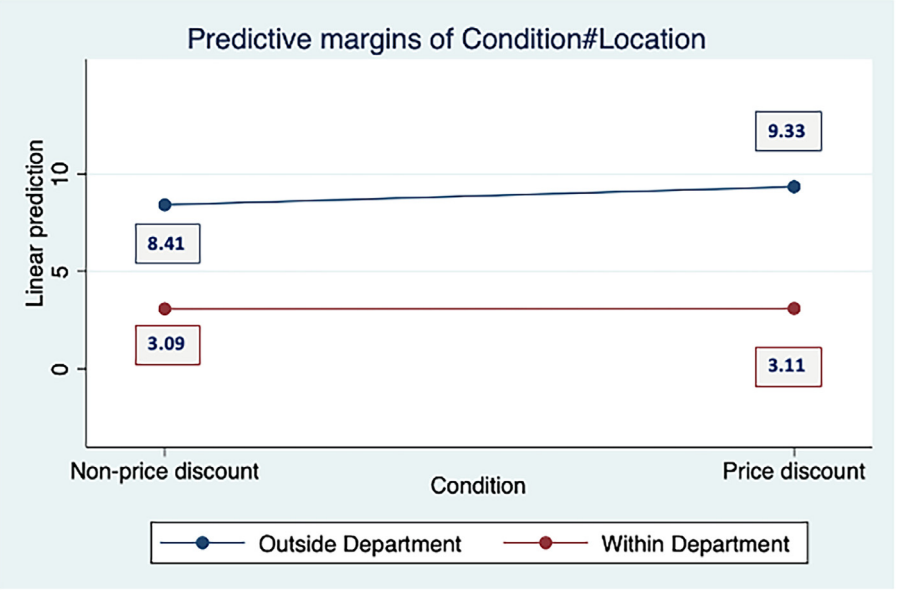

Fig. 3. Predictive margins of Condition#Location on customer spending on discounted products (Study 1).

Table 2
Regular price, discounted price and discount percentage for discounted products (Study 1).

Product	Regular Price (nondisplayed)	Discounted Price (displayed)	Discount Percentage (nondisplayed)	Position
Mini-Ice Cream Cones	€2.95	€2.49	15.59%	Outside Department
Beef (per 100 g)	€1.79	€1.39	22.35%	Outside Department
Coffee (per 500 g)	€4.60	€3.20	30,43%	Outside Department
Average	**€3.11**	**€2.36**	**22,8%**	
Beer	€4.99	€3.29	34.07%	In Department
Salad (200 g)	€1.50	€0.98	34.67%	In Department
Bananas (per 1 kg) (first week)	€2.75	€1.95	29.09%	In Department
Apricots (per 1 kg) (second week)	€3.50	€2.55	27.14%	In Department
Mozzarella	€2.60	€1.59	38.85%	In Department
Shampoo	€2.99	€1.99	33.44%	In Department
Average	**€3.06**	**€2.06**	**32,9%**	

Since customers can buy discounted products both in and outside the department, we also estimated our effect using a mixed regression model to account for the repeated measure of customer spending. The results are consistent with those reported above (see Web Appendix C).[2]

Interestingly, the results from Table 1 also show that the simple effect of product location (near vs. distant discounted products) when the condition is zero (i.e., no price discount shown on the screen) is negative. As the company positioned screens in highly frequented and crowded areas, a substitution effect generated by the availability of a larger number of alternative products in these zones might be the reason for the reduced effectiveness of price discounts on these items. Recent studies, including our own, suggest that increased store crowding tends to decrease the purchase of nonhedonic products (Aydinli et al., 2021).

We also checked whether the products outside the department might have had larger discounts than those in the department, making them more appealing to customers (Aydinli et al., 2014). As shown in Table 2, the average discount percentage for products outside the department was lower than that for products located in the department (22.8% vs. 32.9%). According to absolute number heuristic theory, consumers tend to focus on the information displayed about a discount without making additional calculations (Guha et al., 2018). Since the discount percentage was not shown on either digital screens or printed tags, we checked the average discounted prices presented on both screens and tags. The average discounted price of the two groups was essentially the same (€2.36 vs. €2.06), which also applied to the average regular price (€3.11 vs. €3.06).

[2] In an attempt to replicate our estimation not conditional on purchases, we also used a Tobit Mixed Model. This approach considers the customer spending of those who did not buy near or far products as zero and allows us to have a measure of spending for distant products and another for nearby products for each consumer. Unfortunately, this method results in approximately 50% of the values being zeros, leading to a substantial censoring effect. Nevertheless, the results indicate a directional but not significant effect ($b = -0.20$; $p = .582$). See Web Appendix D for details.

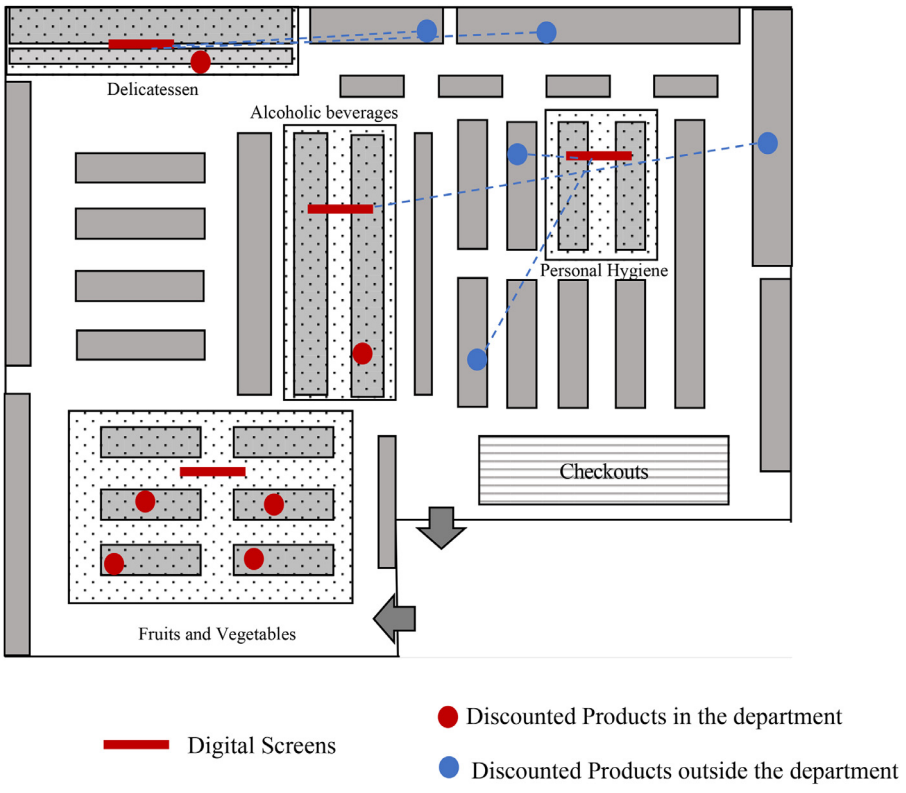

Fig. 4. Blueprint of the store and location of digital screens and discounted products (Study 2).

4.4. Discussion

In Study 1, we found that displaying price discounts on digital screens did not affect customer spending on discounted products. We explored our data in greater depth and discovered that our manipulation had a positive effect on the customer spending of products located outside the department in which the screen was located. These results suggest that for products in the department where the screen is located, displaying price discounts on digital screens in addition to printed tags does not affect customer spending. However, for products outside the department, it appears that the printed tag might serve as a reminder of the information already seen on the screen and reinforce the promotional message, influencing customer spending on those products. To strengthen the validity of these findings, we conducted a replication of our manipulation in Study 2 in one of the two stores after a two-week interval when the set of discounted products was replaced.

5. Study 2

5.1. Procedure and design

In Study 2, we had the opportunity to replicate the manipulation from Study 1 in one of the two stores of the chain to see whether the identified effect holds when changing the discounted products. As in the previous study, we set and rotated the three daytime slots, during which the digital screens displayed either price discounts or service information. Additionally, in this study, each image was displayed on the screens for approximately 35 seconds before transitioning to the next image.

This time, the fruit and vegetable department screen displayed price information about salad, tomatoes, pineapple, and zucchini, all located in the same department as the screen. The delicatessen department screen displayed burrata (located in the department), salmon (located outside the department), and sliced meat (located outside the department). The alcoholic beverages department screen featured lager beer (located in the department) and dessert (located outside the department). Finally, the personal hygiene department screen included canned tuna and rice, both located outside the department. In this case, all the products were from popular national brands. The proportion of discounted products located outside the department in Study 2 (45%) was greater than that in Study 1 (33%). Fig. 4 shows the location of the discounted products displayed on each screen.

Table 3
Results of the heterogeneous effect of product location (Study 2).

Model Dependent Variable	Model 1 OLS Customer spending on discounted products	Model 2 OLS Customer spending on discounted products	Model 3 OLS Customer spending on discounted products
Condition (price discount)	1.197***	1.188***	0.847***
	(0.221)	(0.234)	(0.201)
Product location (within)	-2.538***	-2.578***	-0.755***
	(0.185)	(0.185)	(0.213)
Condition#Product location	**-1.106***	**-1.065***	**-0.855***
	(0.252)	(0.253)	(0.228)
Constant	4.476***	4.853***	3.072***
	(0.162)	(0.542)	(0.206)
R-squared	0.202	0.213	0.351
FE	None	Day, Hour	Product Category
Observations	2,579	2,579	2,579

Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

During the two-week period of our manipulation, 2,444 customers (1,152 in the nonprice discount condition; 1,292 in the price discount condition) purchased the discounted products. The average spending on the discounted products was 2.86€ (SD 3.27). Customers did not differ in terms of general grocery spending ($t_{2442} = .49$; $p = .63$; $M_{(\text{price discount})} = €61.80$; $M_{(\text{nonprice discount})} = €62.72$).

5.2. Results

We first tested the effect of promoting price discounts on digital screens on discounted product sales. This time, we found that displaying the discounted products on screens increased the sales of the discounted products (b = .42; $p<.01$; $M_{(\text{price discount})} = €3.06$; $M_{(\text{nonprice discount})} = €2.64$). The effect holds when controlling for day and hour fixed effects (b = .57; p<.01; $M_{(\text{price discount})} = €3.13$; $M_{(\text{nonprice discount})} = €2.56$). However, this result seems to contrast with the findings from Study 1, and, thus, requires further investigation to examine whether it was driven by the greater proportion of products located far from the screen. Moreover, as in Study 1, we note that our treatment does not affect customer spending on nondiscounted products (b = .023; $p = .99$).

5.3. The heterogeneous effect of product location

Hence, we again tested the interaction effect of product location and our manipulation to predict customer spending on discounted products using OLS. We still found a negative sizable effect (b = -1.11; p<.01) (Table 3, Model 1) that also held when controlling for the day and hour fixed effects (b = -1.07; p<.01) (Table 3, Model 2) and for the product category fixed effect (fruits and vegetables, main dishes, fish, dessert and other) (b = -.85; p<.01) (Table 3, Model 3). A marginal analysis conducted on Model 3 reveals that displaying price promotions on screens increased customer spending on products outside the department in which the screen was located by approximately €0.85 ($p<.01$) (30% of the average customer spending on discounted products) but had negligible effects on products in the department (b = -.007; $p = .942$) (Fig. 5). The results are also consistent when using a mixed regression model (Web Appendix E)[3].

We also checked the average discount percentage (26.4% vs. 24.1%), the average discounted price (€2.10 vs. €2.15) and the average regular price (€2.78 vs. €2.82) for products outside and in the department. As shown in Table 4, all these values were similar across the two groups.

5.4. Discussion

In Study 2, we were able to show that the contingent effect found was not due to the type of discounted product. Indeed, even when promoting different types of products (i.e., rice, salmon, canned tuna, coffee, dessert, ice cream), the results support the notion that displaying price discounts on digital screens has a positive effect on customer spending only on products located away from the screen.

[3] Estimating our effect again using a Tobit Mixed Model, the censoring effect, as in Study 1, is still sizable (approximately 50%). Nonetheless, the results support a negative and marginally significant effect (b = -0.48; $p = .073$). See Web Appendix D.

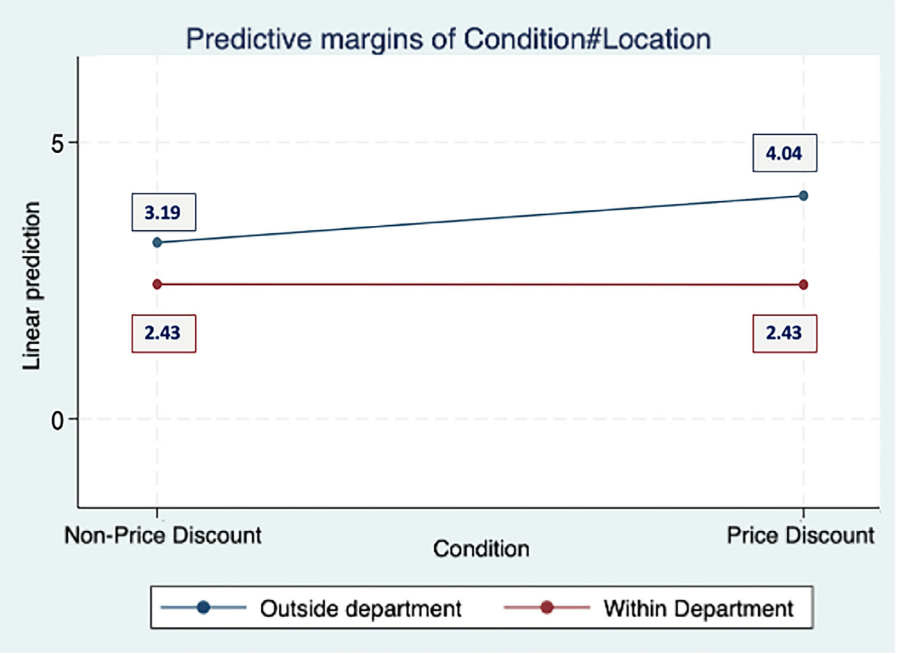

Fig. 5. Predictive margins of Condition#Location on customer spending on discounted products (Study 2).

Table 4
Regular price, discounted price and discount percentage for discounted products (Study 2).

Product	Regular Price (nondisplayed)	Discounted Price (displayed)	Discount Percentage (nondisplayed)	Position
Dessert	€2.99	€2.19	26.7%	Outside Department
Sliced meat (per 100 g)	€1.90	€1.30	31.6%	Outside Department
Salmon (per 100 g)	€2.25	€1.53	32.%	Outside Department
Rice	€1.99	€1.49	25.1%	Outside Department
Canned Tuna	€4.79	€3.99	16.7%	Outside Department
Average	**€2.78**	**€2.10**	**26.4%**	
Lager	€4.20	€3.58	14.8%	In Department
Salad (per 1 kg)	€1.98	€.50	24.2%	In Department
Tomatoes (per 1 kg)	€2.48	€1.98	20.1%	In Department
Zucchini (per 1 kg) (first week)	€1.99	€1.50	24.6%	In Department
Pineapple (per 1 kg) (second week)	€1.98	€1.38	30.3%	In Department
Burrata	€4.30	€2.98	30.7%	In Department
Average	**€2.82**	**€2.15**	**24.1%**	

6. Implications

6.1. …for Scholars

Our findings extend the knowledge on the effects of digital signage on customer spending. We provide initial insights suggesting that, in contrast to what has been found for affective content (e.g., Dennis et al., 2014), promoting price discounts on digital screens does not always increase the sales of discounted products. In particular, we found that adding digital screens to traditional displays has a positive effect on the sales of discounted products located far from the screen. A recent paper on the effect of traditional printed displays on purchasing incidence has shown that displays located far from the discounted product have a 70% lower effect on purchase incidence than displays located near the product (Han et al., 2022). Distant traditional displays only elicit customers' preattention (i.e., seeing but not paying attention to the displays), while traditional displays close to the product manage to elicit focal attention (i.e., paying attention and purchasing the product) (Greenwald & Leavitt, 1984; Han et al., 2022).

The results of our field studies suggest that this effect does not extend to digital displays. One possible explanation is that for products located far from screens, the dynamic content of digital screens may be more effective than the static content of traditional displays in attracting customer focal attention to those products (Han et al., 2022). Conversely, for nearby products, having both traditional and digital screens may create a redundancy effect and ultimately have no impact

on customer spending (Sweller et al., 2011). This explanation aligns with the findings of Roggeveen et al. (2016), who showed that digital signage is ineffective in small stores, where, due to space constraints, all information is acquired by customers simultaneously, potentially creating a redundancy effect. Therefore, displaying price discounts on both digital and traditional printed displays for products located near the screen risks being ineffective.

6.2. …for Retailers

Considering the actual global market value of digital signage (USD 17.77 billion), it is understandable why this technology is increasingly adopted. Retailers have decided to use digital signage to make the in-store experience more appealing for their customers. However, one of the most persistent challenges related to the adoption of digital signage concerns the content to be displayed (Future Stores 2021). Our findings provide some guidance to retailers who use or plan to use digital screens to promote price discounts.

When designing the content to be promoted on screens, managers should pay attention to the location of the products that they want to promote. Using both available means (traditional and digital displays) to communicate the promotion to the customer at the crucial moment of his or her store visit (i.e., when he or she is in front of the product) may be redundant. Instead, our results suggest that using screens to promote products far from the screens and then employing traditional displays in proximity to the products can increase customer spending on those products. Although we investigated the effect in two grocery stores, our results could provide initial insights for retailers in different sectors to experiment with using digital and traditional signage to promote discounted products located far from screens.

6.3. …for Digital signage content providers

Another challenge associated with the use of digital signage for retailers is the lack of expertise in content creation (Future Stores 2021). As a result, an increasing number of companies that install digital screens provide their clients with subscription services to create the content to be displayed on the screens. Our findings may assist digital signage content providers in better advising their clients on the optimal use of digital signage for price discounts and recommending which screens to promote products, considering their location relative to them.

6.4. …for Future research

Although our study focuses on a single context (i.e., in grocery stores), we believe our findings may be applicable to other retail settings for various reasons. First, price discounts are common across various retailers. Even when price discounts are not applied daily, effectively communicating discounts to customers during specific periods, such as sales events or when clearing excess inventory, is essential for increasing sales of discounted products. Second, the majority of retailers utilize traditional printed displays in stores, and such displays are static. Consider an apparel store, where price discounts are often indicated both on the stand displaying the clothes and on the product label itself. In sum, we believe our findings could also be observed in other contexts where price discounts are displayed on both digital screens and traditional printed media. However, our study provides only initial insights that require further in-depth investigation. Table 5 shows some future research questions that can be explored to extend our understanding of displaying discounted prices on digital screens.

Executive summary

Research opportunity in digital signage and price discounts

Retailers are increasingly employing digital signage within stores to enhance customer experience and promote products. While prior research has largely focused on the impact of emotional-affective content, we recognize a gap in understanding the effectiveness of digital signage in promoting price discounts. This is important given the rapid growth of digital signage for price promotion. This trend is underscored by a recent survey conducted by Future Stores (2021), which revealed that a significant majority (86 out of 100) of leading retailers anticipate the efficacy of digital screens in promoting price discounts.

Our study: assessing the impact of digital signage on discounted products

In our study, we conducted two pilot field experiments in collaboration with a supermarket chain. We explored the influence of digital signage on customer spending for products offered at discounted prices. Our research is novel because it shifts the focus from emotional-affective content to the promotion of price discounts on digital screens.

Key findings

- Effect of Digital Signage: Surprisingly, our initial findings suggested that digital signage did not significantly impact customer spending on discounted products.
- Impact of Screen Proximity: Further analysis revealed that digital screens were more effective in increasing customer spending on discounted products located farther from the screens, compared to those near the screens.

Table 5
Future research avenues.

In-Store Displays	• In our paper, we showed that promoting price discounts is effective for products located far from the digital screens. The initial research will delve into the motivations and mechanisms behind this effect. ◦ What factors influence customer attention and engagement with digital screens in retail environments? ◦ How does distance between the product and digital screens impact customer decision-making process? ◦ Are there specific product categories for which price discounts on distant screens are more/less effective? • What is the effect of using only digital screens to promote price discounts? ◦ Does using only digital in-store displays enhance customers' perception of the store as being more innovative and cutting-edge? ◦ Are customers confused when traditional displays are replaced by digital displays, given their familiarity with traditional displays in stores? ◦ What are retailers' potential cost savings when transitioning from traditional printed materials to digital displays? ◦ How does using digital displays impact the workload of frontline employees and their ability to dedicate more time to customer service? ◦ Can real-time updates and modifications of promotions in digital displays lead to increased customer engagement and sales? • What is the effect of the typology of the digital signage systems? ◦ What are the comparative effects of various digital screen types on the effectiveness of price discount promotions? This inquiry could investigate the specific roles and effectiveness of different digital display formats, such as ceiling-mounted screens versus eye-level, wall-mounted screens, in promoting price discounts.
Discounted Products	• In our study, discounted products were physically located in stores, making it possible to know the distance between the products and the screen locations. However, what happens with goods that are not available or tangible, for example, in a travel agency or a restaurant, where a customer cannot see the food before ordering it but only when it is ready? On the one hand, the moment of ordering can be considered the time when the consumer is closest to the product, the crucial moment when the customer should be reminded of the offer. Using digital signage before the moment of ordering and then using traditional printed displays at the time of ordering could be an effective strategy. On the other hand, the moment of ordering is when the customer chooses among all the available product categories in these types of retailers. Therefore, the customer's attention is dedicated to navigating through the entire set of alternatives (e.g., in a restaurant, beverages, appetizers, main courses, desserts). • How does the effect of digital screens change if the discounted products near or far from the screen are complementary? ◦ How does promoting products on digital screens that are located farther away but that complement items near the screen influence sales? ◦ Can this strategy result in a positive spillover effect, boosting sales for products situated close to the screen as well?
Price Promotions	• What is the effect of promoting different types of price promotions on screens? ◦ Do promotions such as 3-for-2 have the same effect as price discounts? ◦ How does the increased attention that digital screens attract, compared to traditional static displays, influence consumers' effort to process and interpret the format in which the discount is presented (e.g., percentage, showing both the regular price and the discounted price)?
Technology Interactivity	• What is the effect of promoting price discounts on interactive digital screens? ◦ Does interaction with the screen change the customer's perception of the distance to the product's location? ◦ What types of information can be interactive (e.g., different discount formats)?
Content Scheduling	• Is alternating price discounts with institutional content an effective strategy, or does it distract customers from the promotional message?
Customer Perceptions	Investigating consumers' perceptions of using digital signage to promote price discounts is also useful. Different methods such as observations and short interviews can help to better explain the mechanism underlying the effect detected in this paper.

Theoretical Insights: Our study contributes to the literature by challenging the traditional notion that digital signage, like printed displays, is more effective when placed near the promoted products. We show that digital signage can have a different, sometimes opposite, impact.

Practical Insights: Retail managers should carefully consider the placement of digital signage in relation to the products. Promoting price discounts on digital screens can be more effective for products located farther from these screens. This insight is crucial for retailers investing in digital signage and seeking to optimize its impact on sales.

Conclusion

Our research fills a crucial gap in the understanding of digital signage's role in retail, particularly in the promotion of price discounts. The findings not only extend academic knowledge but also provide practical guidelines for retailers on the strategic use of digital signage to enhance sales of discounted products.

Declaration of competing interest

None.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jretai.2024.05.004.

References

Albers, F., Trypke, M., Stebner, F., Wirth, J., & Plass, J. L. (2023). Different types of redundancy and their effect on learning and cognitive load. *British Journal of Educational Psychology, 93*(S2), 339–352.
Aydinli, A., Bertini, M., & Lambrecht, A. (2014). Price promotion for emotional impact. *Journal of Marketing, 78*(4), 80–96.
Aydinli, A., Lamey, L., Millet, K., ter Braak, A., & Vuegen, M. (2021). How do customers alter their basket composition when they perceive the retail store to be crowded? An empirical study. *Journal of Retailing, 97*(2), 207–216.
Bauer, C., Garaus, M., Strauss, C., & Wagner, U. (2018). Research directions for digital signage systems in retail. *Procedia Computer Science, 141*, 503–506.
Burke, R. R. (2009). Behavioral effects of digital signage. *Journal of Advertising Research, 49*(2), 180–185.
Cenareo (2020). Digital signage trends in 2020: What's now and next for retailers? Retrieved the 21st of April 2023 from: https://blog.cenareo.com/en/digital-signage-trends-in-2020-whats-now-and-next-for-retailers.
Cleeren, K., Van Heerde, H. J., & Dekimpe, M. G. (2013). Rising from the ashes: How brands and categories can overcome product-harm crises. *Journal of Marketing, 77*(2), 58–77.
Dennis, C., Newman, A., Michon, R., Brakus, J. J., & Wright, L. T. (2010). The mediating effects of perception and emotion: Digital signage in mall atmospherics. *Journal of Retailing and Consumer Services, 17*(3), 205–215.
Dennis, C., Michon, R., Brakus, J. J., Newman, A., & Alamanos, E. (2012). New insights into the impact of digital signage as a retail atmospheric tool. *Journal of Consumer Behaviour, 11*(6), 454–466.
Dennis, C., Brakus, J. J., Gupta, S., & Alamanos, E. (2014). The effect of digital signage on shoppers' behavior: The role of the evoked experience. *Journal of Business Research, 67*(11), 2250–2257.
Future Stores (2021). The customer-facing digital signage market in retail through 2021. Retrieved the 21st of April 2023 from: https://futurestores.wbresearch.com/blog/customer-facing-digital-signage-market-in-retail-through-2021.
Garaus, M., & Wagner, U. (2019). Let me entertain you–Increasing overall store satisfaction through digital signage in retail waiting areas. *Journal of Retailing and Consumer Services, 47*, 331–338.
Garaus, M., Wagner, U., & Manzinger, S. (2017). Happy grocery shopper: The creation of positive emotions through affective digital signage content. *Technological Forecasting and Social Change, 124*, 295–305.
Garaus, M., Wagner, U., & Rainer, R. C. (2021). Emotional targeting using digital signage systems and facial recognition at the point-of-sale. *Journal of Business Research, 131*, 747–762.
Golder, P. N., Dekimpe, M. G., An, J. T., van Heerde, H. J., Kim, D. S., & Alba, J. W. (2022). Learning from data: An empirics-first approach to relevant knowledge generation. *Journal of Marketing*.
Greenwald, A. G., & Leavitt, C. (1984). Audience involvement in advertising: Four levels. *Journal of Consumer Research, 11*(1), 581–592.
Guha, A., Biswas, A., Grewal, D., Verma, S., Banerjee, S., & Nordfält, J. (2018). Reframing the discount as a comparison against the sale price: Does it make the discount more attractive? *Journal of Marketing Research, 55*(3), 339–351.
Haans, H., & Gijsbrechts, E. (2011). One-deal-fits-all?" On category sales promotion effectiveness in smaller versus larger supermarkets. *Journal of Retailing, 87*(4), 427–443.
Han, Y., Chandukala, S. R., & Li, S. (2022). Impact of different types of in-store displays on consumer purchase behavior. *Journal of Retailing, 98*(3), 432–452.
Mani, Z., & Chouk, I. (2017). Drivers of consumers' resistance to smart products. *Journal of Marketing Management, 33*(1-2), 76–97.
Markets and Markets (2022). Digital signage market size. Retrieved the 21st of April 2023 from: https://www.marketsandmarkets.com/Market-Reports/digital-signage-market-513.html?gclid=CjwKCAjw6IiBhAOEiwALNqncWruWtpTuCFjXKwesBgjerkHlJLp5FTDv4NZiEMhvV4bGOh8HkOJqBoCxRgQAvD_BwE.
Merkt, M., Weigand, S., Heier, A., & Schwan, S. (2011). Learning with videos vs. learning with print: The role of interactive features. *Learning and Instruction, 21*(6), 687–704.
Roggeveen, A. L., Nordfält, J., & Grewal, D. (2016). Do digital displays enhance sales? Role of retail format and message content. *Journal of Retailing, 92*(1), 122–131.
Schmidt, S., & Eisend, M. (2015). Advertising repetition: A meta-analysis on effective frequency in advertising. *Journal of Advertising, 44*(4), 415–428.
Sotgiu, F., & Gielens, K. (2015). Suppliers caught in supermarket price wars: Victims or victors? Insights from a Dutch price war. *Journal of Marketing Research, 52*(6), 784–800.
Stremersch, S., Gonzalez, J., Valenti, A., & Villanueva, J. (2023). The value of context-specific studies for marketing. *Journal of the Academy of Marketing Science, 51*(1), 50–65.
Sweller, J., Ayres, P., Kalyuga, S., Sweller, J., Ayres, P., & Kalyuga, S. (2011). The redundancy effect. *Cognitive Load Theory*, 141–154.
Wells, J. D., Campbell, D. E., Valacich, J. S., & Featherman, M. (2010). The effect of perceived novelty on the adoption of information technology innovations: A risk/reward perspective. *Decision Sciences, 41*(4), 813–843.
Wooley, B., Bellman, S., Hartnett, N., Rask, A., & Varan, D. (2022). Influence of dynamic content on visual attention during video advertisements. *European Journal of Marketing, 56*(13), 137–166.