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Bachelor Thesis (IBEB – Marketing Major)

Surfing the Third Wave of Digital Advertising: An Investigation into the Effectiveness of In-App Advertising for Online Grocery Apps

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Abstract

The purpose of this paper is to investigate the impact of in-app banner ads and sponsored product listings on purchase intentions, in the context of online grocery apps. Literature has shown that brand recall has a positive relationship with purchase intentions – thus, this study consists of two experiments that test the effect of exposure of in-app banner ads and sponsored product listings, respectively, on brand recall which is then linked to purchase intentions. This paper also dives deeper into some of the characteristics of in-app banner ads and sponsored product listings. The findings showed that there is a significant positive impact of exposure to in-app banner ads on brand recall and, therefore, purchase intentions. However, there were no significant effects of sponsored product listings. This paper has both academic and managerial relevance. For the former, it aims to bridge certain knowledge gaps in existing literature, while also highlighting new potential areas of research. From a managerial perspective, this paper provides recommendations as to whether marketers should consider in-app advertising as a marketing activity.

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Chapter 1 – Introduction

1.1 Background

According to several industry specialists, retail media is being described as the “third and biggest wave of digital marketing” (Feger, 2023) – the first wave consisting of search advertising, which was followed by the second wave of social media. The retail media market is expected to be worth $45Bn in 2023 and is estimated to grow by a further $10Bn in 2024 (Feger, 2023). Andrew Lipsman (2023), a principal analyst at Insider Intelligence with a focus on retail and ecommerce, has stated that this growth in retail media will be led by retailers that sell consumer packaged goods (CPGs). This statement is in congruence with trends identified in a study by Darrell Bartholomew and Mark Williamson (2022) that show that an increasing number of CPG retailers, including Ahold Delhaize, are branching out and developing their own retail media networks (RMNs) and exchanges. Thus, in this context, retail media consists of promotional channels (e.g., banners, in-store displays, branded content, etc.) that target consumers closer to the point-of-sale (Bartholomew & Williamson, 2022). A RMN therefore, is an ecosystem of online and off-line assets that a retailer would own and offer to third parties (Kryvtsun, 2022). The focus of this study is in-app banner advertising and sponsored products within grocery apps – one of the understudied areas in the RMN space.

One of the advantages of online advertising is that its effects on online purchases are measurable – however, its effects may spill over to in-store purchases, for example. Hence, consolidating a RMN allows firms to better understand the effects of its marketing activities on performance (Lipsman, 2023). Furthermore, in an increasingly privacy-conscious world where cookies are being phased out, retail media offers price personalisation without the need for personal data, as it is based on purchase behaviour (Bartholomew & Williamson, 2022). Hence, it is worth investigating retail media further, especially in the context of grocery and ecommerce grocery retailers.

1.2 Research Problem, Motivation, and Objectives

There exists a significant research gap when it comes to in-app advertising (specifically, banner ads and sponsored product listings) in the context of grocery apps, the focus of this study. There are several studies available that look at the impact of banner ads in other online contexts (e.g., (Li & Bukovac, 1999)) and there are those that investigate the concept of sponsored listings either in the world of e-commerce (e.g., (Joo, Shi, & Abhishek, 2022)) or search engines (e.g., (Ghose & Yang, 2009)). Thus, this study aims to synthesise insights from existing literature surrounding online banner ads and sponsored listings to formulate hypotheses that address the following research question:

RQ: How do in-app banner ads and sponsored products influence consumers' purchase intentions?

Aside from aiming to bridge the aforementioned research gap, this paper will offer managerial insights to allow marketing professionals to allocate resources in a more pragmatic and data-driven manner.

1.3 Overview of Methodology

The effect of in-app advertising and sponsored products on purchase intention will be tested with a between-subjects survey experiment. However, this paper specifically tests consumers' brand/advertising recall – this is because recall is known to have a direct impact on consumers' purchase intentions (Banik & Dhar, 2021), and this will be discussed in greater detail in the literature review. The study will consist of one survey with two experiments (two sets of control and treatment variants – see Chapter 2), out of which each respondent will be presented with one of the parts. The control versions will consist of a series of screenshots of certain product catalogues from (mock) grocery apps, and these screenshots will not contain any in-app banner ads nor sponsored products. These screenshots will be followed by a set of questions that aim to assess the level of brand recall. For example, the respondents will be asked to select a list of brands they remember seeing on the screenshots. The first

treatment variant, on the other hand, will be identical in structure but this time, the screenshots will consist of banner ads for certain brands. The second treatment variant will be identical to the in-app banner ads treatment variant, only this time the screenshots will consist of sponsored products (and no banner ads). However, this, along with the analysis techniques used, will be discussed in greater detail in the methodology section (Chapter 3) of the paper.

1.4 Thesis Outline

Next, provided is a literature review that allows for a strong foundation for what is already known within this field, and what can be extracted and applied to this study to find new relationships. This will lead to the formulation of hypotheses, which will be followed by a more detailed description of the research design. Then, the data analysis and results will be presented which will ultimately allow for the discussion and suggestions for further research.

Chapter 2 – Literature Review

2.1 Aims and Scope

The aim of this review is to find relevant findings in existing literature that can guide the formulation of hypotheses that study the impacts of in-app banner ads and sponsored products on purchase intention within grocery apps. As mentioned earlier, current literature does not directly target the topic at hand, however, research has been done in related fields. For example, the first section will review research done on the effects of online banner ads on purchase intention. Similarly, the second section will look at the impact of sponsored advertising in the context of e-commerce and search engines. The latter is relevant because a grocery app, in many ways, functions similarly to a search engine – users search for products and the app outputs a list of search results, and advertising spaces are auctioned in a comparable manner to that of search engines. It is important to note that the studies do not always use purchase intentions as their dependent variable – in many cases, the variable that is studied can be considered a proxy (e.g., click-through rates). However, in some

cases, this substitution is not feasible and therefore, the final section will look at the mediator, recall, and how that affects purchase behaviour.

2.2 Banner Ads

The first paper (Manchanda, Dubé, Goh, & Chintagunta, 2006) in this section investigates the impact of banner advertising on online purchasing patterns. The study was centred around an online firm that sells health care and beauty products, and over-the-counter drugs to consumers. The dataset spanned from June 11 to September 16 of 2000 and tracked individual cookie information for all purchases. With this data, the researchers were able to isolate the influence of banner advertising (in the form of viewership and click-throughs) and purchases. However, the study does not track the website visits that did not lead to purchases. Thus, the model developed by the researchers focuses on purchase probabilities as their dependent variable, while also accounting for duration dependence (Manchanda, Dubé, Goh, & Chintagunta, 2006). The key relevant finding from this paper is that exposure to banner advertising increases purchase probabilities for current customers – a result that is statistically significant (Manchanda, Dubé, Goh, & Chintagunta, 2006).

The papers in this section that are yet to be discussed in this section also corroborate the first hypothesis – however, they often investigate specific aspects within the scope of banner advertising and, therefore, will be discussed in the context of additional main effects. For now, the first hypothesis can be formulated as follows based on the literature presented:

H1: Advertising a brand through in-app banner ads will increase its recall levels (compared to when a brand is not advertised through an in-app banner ad)**.**

The next paper (Lohtia, Donthu, & Hershberger, 2003) looked at the effects of banner ad content and design elements on click-through rates (CTRs) using data from 8,275 real banner advertisements. Additionally, the paper distinguished between B2B and B2C effects. The elements being investigated ranged included incentives, emotional appeals, interactivity, colour, and animation. However, for the scope of this

study, the relevant elements are animation and colour. Unfortunately, the authors did not provide explicit descriptions of the various colour levels – they only specified "low, medium, and high" levels of colour (Lohtia, Donthu, & Hershberger, 2003). The relevant results showed that the presence of animations increased the CTR for B2C banner ads. Furthermore, it was found that medium colour levels worked better than low and high levels for B2C banner ads (Lohtia, Donthu, & Hershberger, 2003).

Focusing on the animation aspect, the next study (Yoo, Kim, & Stout, 2004) aimed to assess the effects of animated banner ads on, amongst other factors, recall. The authors claimed that by animating banner ads, you effectively increase its "attention-grabbing capabilities", which they found to generate higher levels of recall (Yoo, Kim, & Stout, 2004). Their experiment consisted of a between-subjects 2 (animated vs static) x 2 (involvement: high vs low) design – the latter was included as the authors were also testing the moderating effect of product involvement, however, that feature is not relevant for the purposes of this study.

Contrasting these findings were the results of the study that investigated several creative aspects of banner ads within the gaming industry (Robinson, Wysocka, & Hand, 2007). The sample consisted of 209 ads provided by an advertising agency. In this case, animated banner ads proved to be ineffective in generating click-throughs. However, one of the creative aspects that will also be tested in this study, size, did prove to be effective in positively influencing the CTR (Robinson, Wysocka, & Hand, 2007).

In similar fashion, a study (Bayles, 2002) that used modified versions of eBay and Amazon.com websites to test the impact of animated banner ads on brand recall and recognition showed that there were no significant relationships between animation and a user's ability to recall and recognise banner ads. Thus, animation does not improve "user memory of online banner advertisements" (Bayles, 2002), and therefore, of brands.

Another related experimental (lab) study looked at the cognitive impact of banner ad characteristics (Li & Bukovac, 1999). The findings related to animated banner ads were consistent with those mentioned earlier (Lohtia, Donthu, & Hershberger, 2003) – namely, that animated banner ads resulted in more clicks and better recall as compared to non-animated ads. Furthermore, the results regarding

size were consistent with the previous paper (Robinson, Wysocka, & Hand, 2007) in that larger banner ads also led to more clicks and better recall (Li & Bukovac, 1999).

Although there is some dispute regarding animation, hypotheses surrounding its effectiveness, along with that of size and colour, can now be formulated as follows:

H2: Given that brands are advertised through an in-app banner ad, brands advertised on larger banner ads will have higher recall levels than those advertised on smaller banner ads.

H3: Given that brands are advertised through an in-app banner ad, brands advertised on animated banner ads will have higher recall levels than those advertised on static banner ads.

H4: Given that brands are advertised through an in-app banner ad, brands advertised on banner ads with high levels of colour will have higher recall levels than those advertised banner ads with low levels of colour.

The next three studies in this section depart slightly from the focus purchase-intention-related metrics and look more into factors associated with memory and recall, both relevant in the context of marketing. This will also allow for further discussion of recall in section 2.4.

The first of these two discusses the various factors, including complexity (which can be influenced by the size, colour, and animation, for example) and its impact on processing fluency (Wang, Shih, & Peracchio, 2013). Processing fluency refers to the "ease of stimulus encoding and processing" (Wang, Shih, & Peracchio, 2013). The second study (Drèze & Hussherr, 2003) aimed to discover the reason behind declining CTRs for banner ads at the time. Using a combination of eye-tacking experiments and surveys, they identified that in many cases, web surfers actively avoided banner ads – implying that a large part of the processing of banner ads occurs at the pre-attentive level (Drèze & Hussherr, 2003). Furthermore, the banner ads' messages (influenced by, among other things, size, animation, and colour) aided recall (Drèze & Hussherr, 2003). Thirdly, the final study (Çiçek, Eren-Erdoğmuş, & Daştan, 2017) investigated the factors that aid recall of banner ads in mobile applications. They found that ads are recalled more when they are placed at the top

of the screen in landscape applications (Çiçek, Eren-Erdoğmuş, & Daştan, 2017). Nonetheless, it shows that in-app banner advertising is indeed effective and, therefore, it is evident that presence of banner ads does have an impact on memory/recall of the viewer – this will be revisited in section 2.4

The second part of this overarching relationship will be discussed in section 2.4. Now, we move onto the impacts of sponsored listings on purchase intentions.

2.3 Sponsored Listings

The first paper in this category looks at whether sellers can benefit from sponsored product listings (Joo, Shi, & Abhishek, 2022). The paper also defines sponsored product listings as those "third-party sellers' ads blended in organic product listings" (Joo, Shi, & Abhishek, 2022). Here, the researchers aim to compare the performance of sponsored and organic product listings. The results show that consumers avoid products that are sponsored in the prime positions (i.e., near the top of the screen, for example) – both in terms of clicks and conversions. However, this avoidance is minimised in the lower positions (Joo, Shi, & Abhishek, 2022). Upon further investigation, by modelling ROI of sponsored listings, the researchers find that sellers can "financially benefit from a sponsored listing, if it significantly raises the display position" (Joo, Shi, & Abhishek, 2022). Thus, for it to be financially viable, the marketer must account for the products' current organic positions before deciding to invest in sponsored listings. From this paper, it can be distilled that sponsored listings do impact purchasing behaviour (negatively, on average). Furthermore, positioning also appears to impact consumer behaviour. These are relevant for the formulation of the next set of hypotheses.

Continuing briefly on the topic of positioning, it was found that position effects can lead to an increase of 10%-20% in CTRs (Narayanan & Kalyanam, 2015). This study in particular took a regression discontinuity approach to measure the causal effect of positioning within search advertising – the authors claimed that simply comparing means is likely to be biased due to selection issues, namely that positions are determined by the search engines' auctioning systems. These findings are in

congruence with the findings of a study that used “A Latent Instrumental Variables Approach to Modelling Keyword Conversion in Paid Search Advertising” (2012) – one of the ancillary findings was that sponsored links placed in higher positions increased both CTRs and conversion rates.

The next paper (Reyes, Serafico, Hendrayati, & Ramdhan, 2019) is somewhat contradictory to the first one (Joo, Shi, & Abhishek, 2022) as it claims that their analysis shows promoted (interchangeable with sponsored in this context) listings have a “relatively high level of effectiveness” (Reyes, Serafico, Hendrayati, & Ramdhan, 2019). This study does not directly look at the impacts on purchase behaviour – rather, it makes use of surveys focusing on the EPIC model (Empathy, Persuasion, Impact, and Communication) which is commonly used to assess advertising effectiveness. Hence, indirectly, the paper suggests that sponsored listings do positively impact purchase behaviour (through improved advertising effectiveness).

The following paper that investigates the factors influencing a user’s decision to click on a sponsored link (Jansen, Brown, & Resnick, 2007) goes against the previous paper. The experiment consisted of 56 participants engaging in six e-commerce web searching tasks, and the results show that there is a statistically significant preference for non-sponsored links – in fact, organic links were viewed before sponsored links more than 82% of the time (Jansen, Brown, & Resnick, 2007). The authors claimed that most users took sponsored links as advertisements and only engaged with them if they were relevant to the search and were unconcerned by the links otherwise (Jansen, Brown, & Resnick, 2007).

If a search advertisement (displayed as a sponsored link) is irrelevant to the search task, it may also lead to “irritation” – which one study (Lin & Hung, 2009) found to be negatively related with advertising attitudes. Of course, this does not reflect directly onto brand recall, it does go to show that it affects individuals’ attitudes which may in turn affect one’s ability to recall brands. Contrary to irritation as a result of irrelevant sponsored links, “contextual relevance” (Lu, Chau, & Chau, 2017) was found to be positively related to both attitudinal and behavioural responses in a lab experiment that aimed to simulate real searches on search engines.

Continuing the trend of disagreement in this domain, the next paper investigated whether consumers are averse to sponsored messages – specifically looking at advertising within search engines (Sahni & Zhang, 2022). The large-scaled randomised field experiment with search ads for 3.3. million users in the US revealed that at the margin, users preferred higher levels of advertising within their search engines (Sahni & Zhang, 2022). The authors attribute this to the fact that sponsored links often compensate for the information gaps that may exist in organic listings, and thus leave consumers better off on average (Sahni & Zhang, 2022).

Another empirical study of sponsored links in search engines (Ghose & Yang, 2009) reveals that, as one might expect, sponsored links nearer to the top have a higher monetary value because the conversion rates are highest at the top, and they decrease as you move down the page.

Signalling is of course a very important concept in this realm, and the next study looked at evidence from a field experiment using mobile search (Sahni & Nair, 2020) to investigate the role of signalling in search advertising. The mobile search was for a website that provided listings and reviews for restaurants in a given area. The treatment was randomly assigned, and these users were made aware that certain listings were paid-ads, and the control group did not receive this disclosure – effectively isolating the "effect on outcomes of a user knowing that a listing is sponsored – a pure signalling effect" (Sahni & Nair, 2020). The findings showed that disclosure increased calls to the restaurant by 77%, ceteris paribus (Sahni & Nair, 2020).

Before moving on to the formulation of hypotheses, it is important to be reminded that in this section a lot of the papers did not look at purchase behaviour. However, as mentioned in an earlier section, a grocery app can be considered analogous to a search engine and therefore, for this paper, it is to be assumed that a click or conversion is equivalent to purchase intention because users of grocery apps are very near the point of sale anyway, and it is a relatively low-involvement process. With that in mind, it is evident that sponsored listings do affect consumer behaviour – but the direction of this effect is not very clear. Therefore, the hypothesis relating to the sponsored listings will be as follows:

H5: Advertising a brand by listing it as being sponsored will increase its recall levels (compared to when it is not listed as being sponsored).

Within the presented literature, it is apparent that position (Ghose & Yang, 2009) and relevance of advertising to the search task (Jansen, Brown, & Resnick, 2007) also have an impact on the efficacy of sponsored listings. Thus, the effects of these characteristics can be hypothesised as follows:

H6: Given that brands are listed as being sponsored, brands that are listed in the top half of the screen will have higher recall levels than those brands listed in the bottom half of the screen.

H7: Given that brands are listed as being sponsored, brands that are relevant to the search task will have higher recall levels than those brands that are irrelevant to the search task.

The explanation of relevance in H7 will be provided in the research design section.

Finally, recall will be revisited and discussed in greater detail in the next and final section of the literature review.

2.4 Recall

The first paper deviates slightly from the potential target group for this paper as it focuses on the impact of advertising on children's purchase intention, while focusing on the mediation role of advertisement recall (Banik & Dhar, 2021). The authors found advertisement recall to fully mediate the relationship between, for example, information in advertisements and purchase intentions. Similarly, a study (Gesmundo, et al., 2022) that targeted millennial users of the social media app TikTok, found that brand recall positively affects purchase intentions. The study that focused on Pakistani brands (Khurram, Qadeer, & Sheeraz, 2018) also corroborates this relationship, as the researchers found that brand recall is positively associated with actual purchases. In other contexts, a Malaysian study (Adis & Kim, 2013) that

investigated the “mediating role of brand recall” on purchase intentions in advergames also found a positive relationship between brand recall and consumer purchase intentions, through a descriptive study which made use of surveys sent to online gamers. In the context of packaged milk brands in Karachi, Pakistan, one study (Memon, Arif, & Farrukh, 2016) identified brand association and recognition as elements of brand recall – their results showed that both association and recognition, and therefore brand recall, were positively related with purchase intentions. Finally, to solidify the assumption that brand recall positively influences purchase intentions, a study (Tharmi & Senthilnathan, 2012) based around branded baby soaps looked at the relationship between brand equity and purchase intentions. The authors identified brand awareness (made up of brand recall and recognition) as a pillar of brand equity, and they found a positive relationship between brand equity and purchase intentions.

The papers here focus on the effects of banner ads on recall. Although a banner ad differs in many ways to a sponsored product, its core purpose is identical to that of a banner ad – that is, to attract a consumer’s attention towards a specific product (Amazon Ads, n.d.). Hence, for the purposes of this study, the effects of and on recall will also be applied to sponsored listings.

Therefore, it is justified for this paper to investigate the impact of in-app advertising on purchase intention through the recall variable. The research model is further explained through a visualisation in the next section.

2.5 Visual Representation of Research Model

The figures below offer a visualisation of the research model for in-app banner ads and sponsored products.

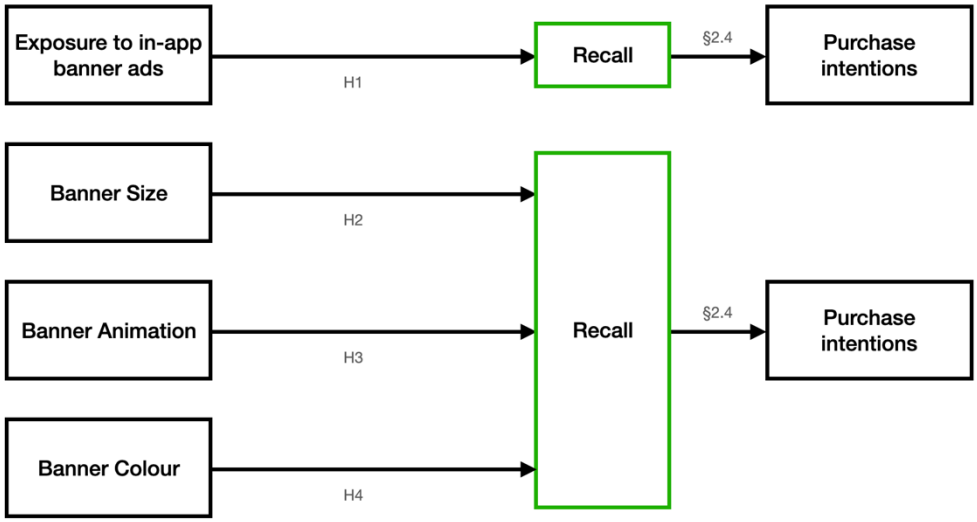

Figure 1. Research model for the investigation of in-app banner ads

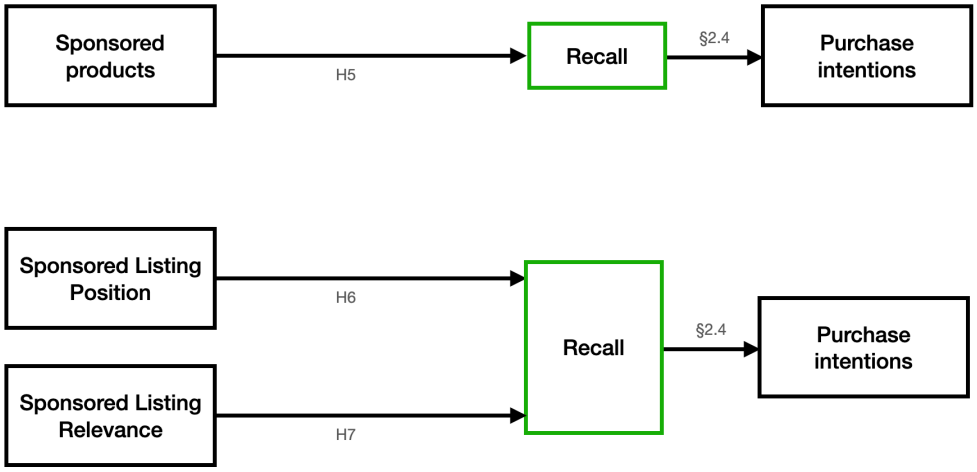

Figure 2. Research model for the investigation of sponsored products

2.6 Summary of Hypotheses

Table 1. Summary of hypotheses

H	Hypothesis
1	Advertising a brand through in-app banner ads will increase its recall levels (compared to when a brand is not advertised through an in-app banner ad)**.**
2	Given that brands are advertised through an in-app banner ad, brands advertised on larger banner ads will have higher recall levels than those advertised on smaller banner ads.
3	Given that brands are advertised through an in-app banner ad, brands advertised on animated banner ads will have higher recall levels than those advertised on static banner ads.
4	Given that brands are advertised through an in-app banner ad, brands advertised on banner ads with high levels of colour will have higher recall levels than those advertised banner ads with low levels of colour.
5	Advertising a brand by listing it as being sponsored will increase its recall levels (compared to when it is not listed as being sponsored).
6	Given that brands are listed as being sponsored, brands that are listed in the top half of the screen will have higher recall levels than those brands listed in the bottom half of the screen.
7	Given that brands are listed as being sponsored, brands that are relevant to the search task will have higher recall levels than those brands that are irrelevant to the search task.

Chapter 3 – Methodology

3.1 Research Design

As described in Chapter 1, the research design for this study consists of two between-subjects survey experiments. For H1-H4, the experiment consists of a 2 (banner size: large vs small) x 2 (animation: animated vs static) x 2 (colour level: high vs low) experimental design. Whereas for H5-H7 the experiment is made up of a 2 (position: top half of screen vs bottom half of screen) x 2 (relevance: relevant to search task vs irrelevant to search task) experimental design. In the case of relevance, it is important to note that a strict relevance is being considered. For example, as can be seen in figure 3, the product titled 'Dupa Dups' is considered irrelevant because it is part of the 'Sweets' category whereas the search task shows that the category being searched is 'Chips'. Since the number of factors and levels are relatively manageable, a full factorial design was constructed in IBM SPSS (see Appendix A).

The measure for the dependent variable, recall, was derived from existing literature, specifically the study by Michaela Draganska, Wesley Hartmann, and Gena Stanglein (2014) – the researchers provided a multiple-choice list of brands and respondents were asked to select the ones that they recalled, after being exposed to the ad campaigns. The study tested these with real ad campaigns and made use of statistical techniques to account for pre-existing knowledge of brands in conjunction with a pre-campaign survey, as this prior knowledge can potentially bias the respondents' recall rates. Since these statistical tests and pre-campaign surveys are beyond the scope of this study, fake brands are being tested – effectively eliminating the possible interaction between prior brand knowledge and brand recall. Using this list approach, we can analyse whether respondents are able to identify specific brands that, in the treatment variants, were advertised through banner ads or sponsored listings. Therefore, we will consider a logistic approach to see whether respondents are able to recall a specific brand or not (binary). Using figure 3 as an example, our recall measure would compare whether respondents are more likely to identify 'Dupa Dups' when it is advertised versus when it is not.

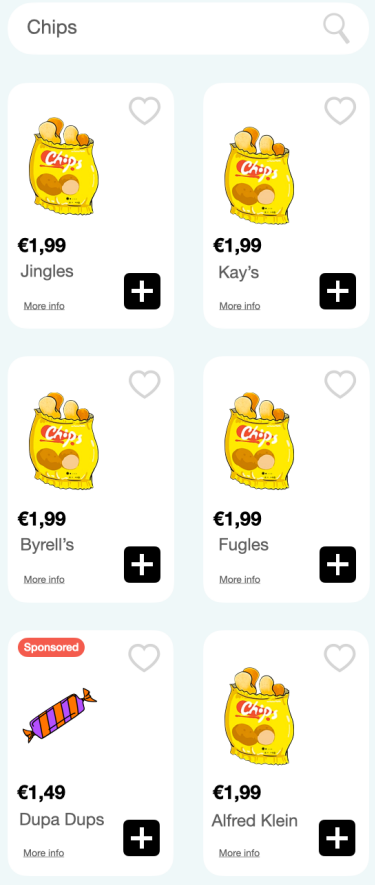

Figure 3. Screenshot from a mock grocery app used in the experiment

As discussed in Chapter 2, by studying the effects of in-app advertising on brand recall, we can effectively understand the influence of said advertising on purchase intentions since the relationship between recall and purchase intention has been established by prior research. Thus, this research design is justified for the purposes of addressing the research question of this paper. Furthermore, this design was chosen as it is the most practically viable, given the scope of a bachelor thesis. For example, an online survey is relatively easy to distribute – this combined with the experimental nature of the survey means that the research question can be addressed given the present limitations.

3.2 Sampling Method

Since the research question generally focuses on the impact of in-app advertising on consumer behaviour, the target population consists of all current and potential users of online grocery apps. Therefore, it is not feasible to obtain a

sampling frame for this target population. Thus, although random sampling is desirable, the method of convenience sampling is also reasonably appropriate for this study. As for the sample size determination, calculations on Minitab software revealed that for a 2-level factorial design with 3 factors, a minimum of 65 runs is required. Participants will be recruited by the distribution of the online survey to various online channels such as WhatsApp groups available at the disposal of the social setting of the researcher. It is also important to note that a monetary incentive is provided to attract honest participation – in the form of a chance for one participant to win a gift card worth €50 (selected at random after data collection is complete).

3.3 Data Collection Methods and Procedures

The specific questions used for data collection can be found in Appendix B which contains an export of the survey being used. There is a notable prompt for the survey targeting H2 such that participants are instructed to pay attention to the search term, as this defines the relevance of the results that are pictured in the screenshots from the mock grocery app. After each of the screenshots in the control variants, participants are required to select the brands that they recall from the screenshot (out of a list of 10 fake brands). Furthermore, respondents are asked to answer questions about their age, gender, and usership of online grocery apps – this is done for the purposes of sample description and to incorporate these measures as control variables. Finally, the order of screenshots in all cases is randomised to account for and eliminate learning effects.

3.4 Data Analysis

To isolate the impact of in-app advertising on brands that were advertised through in-app banner ads and sponsored listings, we can estimate the probability (P_{recall_i}) of respondent i being able to recall a particular brand when it was advertised, as compared to when it was not using a logistic regression as seen in equation 1 (for H1 and H5). On top of the treatment variable, data collected for sample description will also be used as control variables – namely, this included age, gender, and whether the respondent had online grocery apps in the past. In the interest of clarity,

the control variables have not been included in the equation that follow but will be discussed in subsequent chapters.

$$\log\left(\frac{P_{recall_i}}{1-P_{recall_i}}\right) = \beta_9 + \beta_{10}Advertise \quad (1)$$

$$\therefore P_{recall_i} = \frac{e^{\beta_9+\beta_{10}Advertise}}{1+e^{\beta_9+\beta_{10}Advertise}} \quad (2)$$

The effects of the characteristics of in-app banner ads and sponsored product listings will also be tested, and they are modelled as follows for H2, H3, H4, H6, and H7:

$$\log\left(\frac{P_{recall_i}}{1-P_{recall_i}}\right) = \beta_{11} + \beta_{12}Size + \beta_{13}Animation + \beta_{14}Colour \quad (3)$$

$$\therefore P_{recall_i} = \frac{e^{\beta_{11}+\beta_{12}Size+\beta_{13}Animation+\beta_{14}Colour}}{1+e^{\beta_{11}+\beta_{12}Size+\beta_{13}Animation+\beta_{14}Colour}} \quad (4)$$

$$\log\left(\frac{P_{recall_i}}{1-P_{recall_i}}\right) = \beta_{15} + \beta_{16}Relevance + \beta_{17}Position \quad (5)$$

$$\therefore P_{recall_i} = \frac{e^{\beta_{15}+\beta_{16}Relevance+\beta_{17}Position}}{1+e^{\beta_{15}+\beta_{16}Relevance+\beta_{17}Position}} \quad (6)$$

Chapter 4 – Results

4.1 Sample Description

Table 2, figures 4, 5, and 6 provide an overview of the sample description which included age, gender, and whether the respondent has ever used an online grocery app (labelled ‘past user’). The data is coded such that gender takes the value of one if the respondent indicates that they are male, and 0 if they are female (note: one respondent opted for ‘prefer not to say’). Similarly, user takes the value of one if the respondent claims to have had used an online grocery app in the past, and zero otherwise.

Table 2. Sample descriptive statistics

Variable	Obs	Mean	Std. dev.	Min.	Max.
Age	134	36.6	16.04	16	60

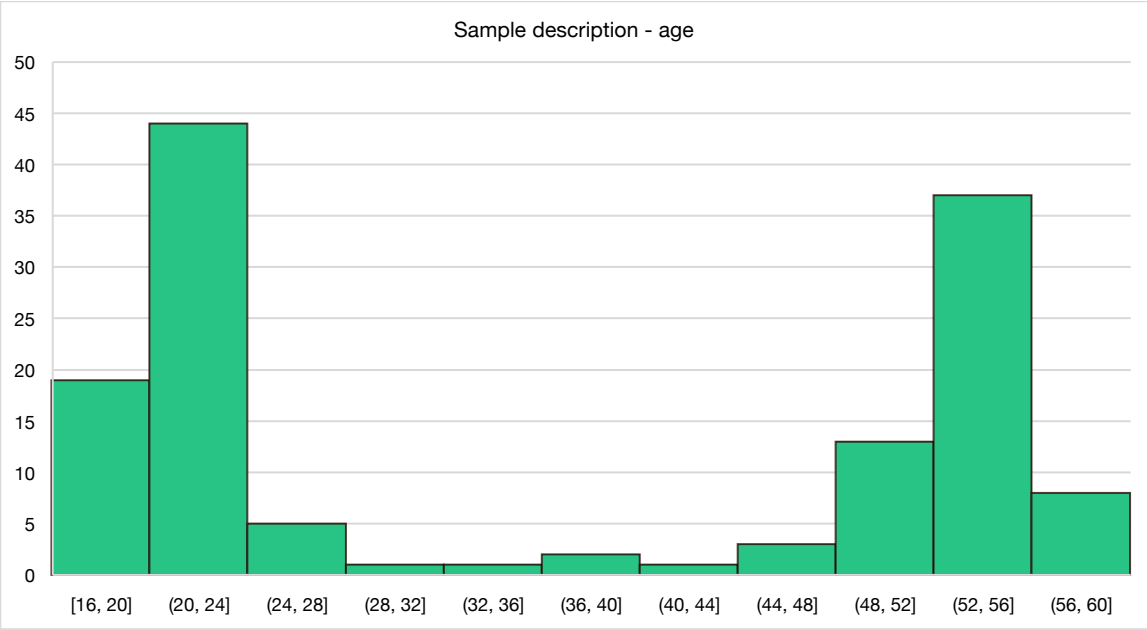

Figure 4. Histogram showing the distribution of participants' ages

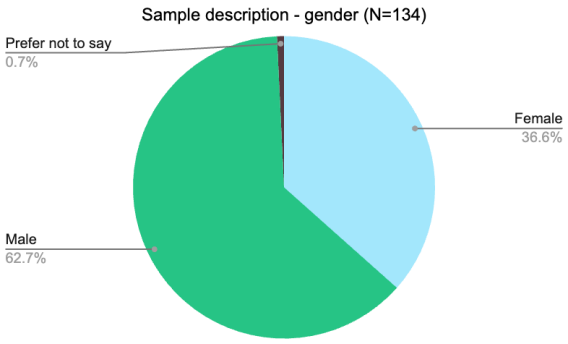

Figure 5. Pie chart showing the distribution of gender within the sample

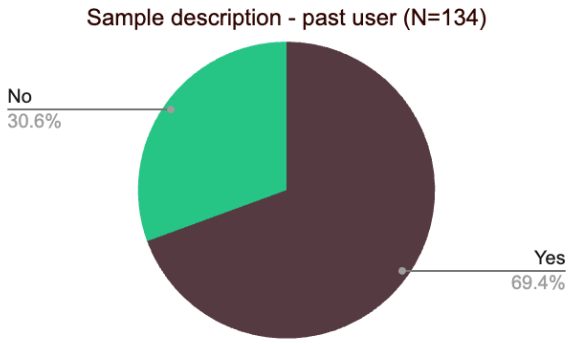

Figure 6. Pie chart showing the proportion of respondents that claim to have used online grocery apps in the past

4.2 Assumptions – Logistic Regression

In the case of logistic regressions, there exist four assumptions (Roback & Legler, 2020) that must be accounted for before any analysis is conducted, and they are as follows:

1. The dependent variable must be binary in nature – this assumption holds because the logistic regression is being used to see if respondents are able to identify a particular brand or not.
2. The observations must be independent of each other – this is indeed the case for this study, as participants were exposed to a randomised set of screenshots to observe, thus eliminating the risk of learning effects, etc.
3. A logistic approach assumes that the variance structure of the outcome is such that the variance is greatest when the probability of desired outcome is 0.5.
4. Finally, a logistic regression assumes that $\log\left(\frac{P_{recall_i}}{1-P_{recall_i}}\right)$ is linearly related to the independent variable. Due to the binary nature of the independent variable, the relationship is indeed linear.

4.3 Hypotheses 1 to 4 – In-App Banner Ads

Now that the assumptions have been discussed, we can proceed with the results of the experiment. This section will look at the relevant findings for H1, H2, H3, and H4. Table 3 provides the descriptive statistics for this experiment.

Table 3. Descriptive statistics for Experiment 1

Variable	Obs.	Mean	Std. dev.
Recall	520	0.777	0.4167
Advertise (Banner)	520	0.523	0.5000

'Recall' is a binary variable that shows whether the respondent was able to identify a specific brand within each screenshot (and these brands were Latja, Mit Mat, Fugles, Brite, Damstel, Alfred Klein, Ka, and Barnier). In this sample, 77.7% of

the respondents were able to identify the aforementioned brands. 'Advertise (Banner)' shows whether a respondent was presented with the control variant or the treatment variant – it appears that 52.3% of respondents were exposed to in-app banner ads, while the remainder did not. Within the treatment group, 'Size', 'Animation', and 'Colour' were distributed equally in accordance with the experimental design as seen in Appendix A – this will also be true for 'Position' and 'Relevance' in the next section.

The results show that a significant logistic regression (logit) was found (LR $\chi^2(4) = 65.15, p = 0.0000$)) with a pseudo-$R^2$ of 0.1189. The same was not found to be true for the model that tested the specific factors of in-app banner ads within the treatment group, as it yielded an insignificant logit regression (LR $\chi^2(6) = 12.09, p = 0.0600$)) with a pseudo-$R^2$ of 0.0614. Still, the coefficients are presented in Table 4.

Table 4. Logit regression results

	H1	**H2, H3, H4**
	(1)	**(2)**
Advertise (Banner)	1.308***	
	(0.243)	
Size		0.148
		(0.386)
Animation		-0.447
		(0.390)
Colour		-0.297
		(0.387)
Age	-0.027**	-0.016
	(0.008)	(0.014)
Gender	-0.175	-0.935**
	(0.258)	(0.468)
Past user	-1.112***	-0.560
	(0.307)	(0.431)
Constant	2.696***	2.329***
	(0.475)	(0.402)
Number of observations	512	272

Notes: Model 1 makes use of a logit regression to estimate the effect of in-app banner ads on $\log\left(\frac{P_{recall_i}}{1-P_{recall_i}}\right)$. Model 2 also uses a logit regression to estimate the effect of the size, animation, and colour levels of in-app banner ads on $\log\left(\frac{P_{recall_i}}{1-P_{recall_i}}\right)$, given that a respondent is exposed to in-app banner ads. Both models use age, gender, and past usership as control variables. Standard errors are reported in parentheses; significance stars correspond to the following significance levels: *p<0.1, **p<0.05, ***p<0.01.

Model 1 considers 512 of the 520 observations (table 3) because one respondent chose not to disclose their gender – since each respondent, in this case, was presented with eight screenshots, this explains the drop in the number of observations. Model 2 has even fewer observations, because as described in the corresponding hypotheses, it only considers the respondents that were exposed to in-app banner ads.

The coefficients from model 1 show that when we zoom in on the impact of in-app banner ads on brand recall by looking at specific brands that were advertised, we observe a positive relationship between in-app banner ads and brand recall. The differences in probabilities can be calculated using equation 2 (for a respondent of a particular age, gender, and past usership). To quantify the effect of in-app banner ads on brand recall levels, the output of model 1 can be used to calculate the predicted probabilities of respondents being able to correctly identify a particular brand. The predicted probabilities can then be compared using a t-test which will allow us to measure the difference in recall levels between the control and treatment group. A Levene's test for equality of variances found that there was a significant difference in variances between the two groups with $F(1,510) = 152.817, p = 0.000$. Thus, a Welch's t-test was used because the null hypothesis of equal variances can be rejected. Accordingly, the test found a significant difference in P_{recall} levels between the control ($M = 0.650, SD = 0.117$) and treatment ($M = 0.882, SD = 0.063$) groups with $t(355.208) = -27.421, p = 0.000$. Therefore, when individuals are exposed to in-app banner ads they are 35.6% more likely to correctly recall the advertised brand, as compared to when that brand is not advertised at all, and this difference is significant at the 1% level.

In terms of the control variables, there are significant negative associations between age and brand recall, and past usership and brand recall. The implications of these results will be further discussed in the next chapter.

Model 2 shows that within the treatment group, there were no significant differences in respondents' ability to recall the advertised brands when varying the size, animation, and colour levels of the in-app banner ads. However, interestingly, there was a significant difference in brand recall levels between men and women, which was also seen in model 1. For the immediate purposes of this study, it is not worth investigating these differences, but one must acknowledge that within the sample, men had lower levels of brand recall than women, on average (significant at a 5% level).

It is also important to note that in both models, the constant has no interpretation as Age = 0 is not a possible input. The same will hold true for the models presented in the next section.

4.4 Hypotheses 5 to 7 – Sponsored Listings

In similar fashion to section 4.3, this part of the paper will present the descriptive statistics which will be followed by logit regression results for H5, H6, and H7 that aim to investigate the impact of sponsored product listings on brand recall. The analysis technique will be identical to that of section 4.3 – i.e., we will consider a logistic regression approach to assess the impact of advertising brands as being sponsored on brand recall levels.

Table 5. Descriptive statistics for Experiment 2

Variable	Obs.	Mean	Std. dev.
Recall	276	0.692	0.462
Advertise (Sponsored)	276	0.435	0.497

The logit regressions yielded significant models (LR $\chi^2(4) = 20.19, p = 0.0005$)) with a pseudo-$R^2$ of 0.0592 and (LR $\chi^2(5) = 15.93, p = 0.0070$)) with a pseudo-$R^2$ of 0.1075.

Table 6. Logit regression results

	H5	H6, H7
	(3)	(4)
Advertise (Sponsored)	0.045 (0.274)	
Position		-0.624 (0.427)
Relevance		0.624 (0.427)
Age	-0.033*** (0.009)	-0.038*** (0.013)
Gender	-0.199 (0.307)	-0.611 (0.502)
Past user	-0.276 (0.300)	-0.490 (0.473)
Constant	2.312*** (0.421)	3.034*** (0.825)
Number of observations	276	120

Notes: Model 3 makes use of a logit regression to estimate the effect of advertising a brand as being sponsored on $\log\left(\frac{P_{recall_i}}{1-P_{recall_i}}\right)$. Model 4 also uses a logit regression to estimate the effect of the position and relevance of the sponsored listings on $\log\left(\frac{P_{recall_i}}{1-P_{recall_i}}\right)$, given that a respondent is presented with the treatment variant. Both models use age, gender, and past usership as control variables. Standard errors are reported in parentheses; significance stars correspond to the following significance levels: *p<0.1, **p<0.05, ***p<0.01.

The number of observations for experiment 2 differs from that of experiment 1 because in this case, respondents were only presented with four screenshots (compared to eight in experiment 1) – this is because experiment 2 considered two features of sponsored listings whereas experiment 1 looked at 3 characteristics of in-app banner ads. Within experiment 2, model 4 has fewer observations than model 3 because the former focuses only on the treatment group, in line with the corresponding hypotheses.

Model 3 shows that there is no significant difference in brand recall levels between the control and treatment group. Thus, advertising a brand as being

sponsored did not have a significant effect on an individual's ability to recall a particular brand. Moreover, within the treatment group, the position and relevance of the sponsored listing had no significant effects on brand recall levels. The implications of these insignificant results will be discussed further in the next chapter.

Interestingly, in both cases, the variation data seems to be explained by age – this, of course, is not the focus of this research but its implications will be discussed in the next chapter.

4.5 Results Summary

Figures 7 and 8 provides a visual summary of the results, placing them in the context of the hypotheses being supported.

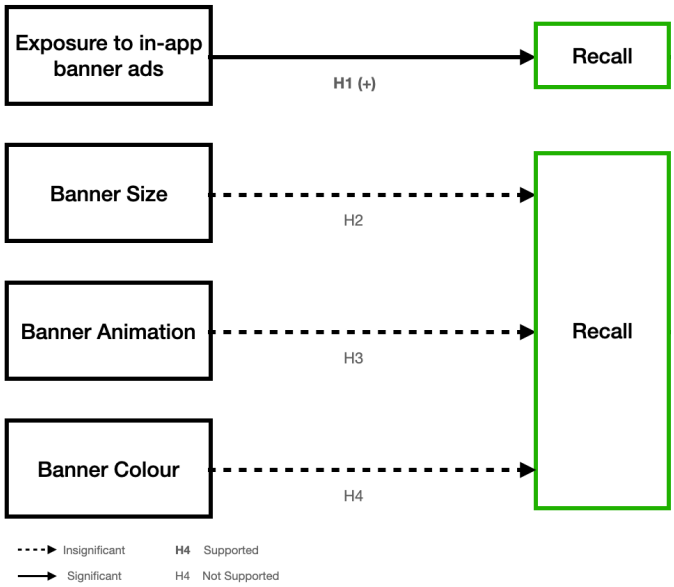

Figure 7. Results summary H1-4

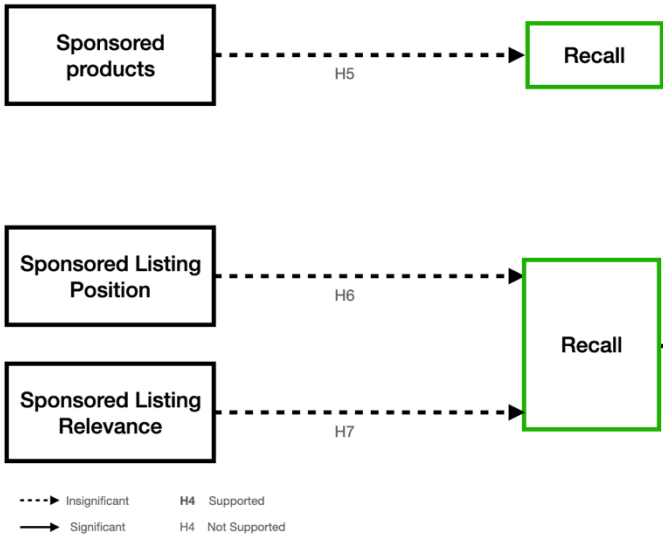

Figure 8. Results summary H5-7

4.6 Additional Findings

Although the focus of this study is to look at individuals' ability to recall particular brands, additional analysis was performed to look at the total number of brands recalled by respondents, per screenshot. The assumptions, setup, and results are presented in appendix D. The noteworthy result from this additional investigation showed that in the presence of banner ads, respondents were, on average, able to recall fewer brands in total (significant at a 5% level). This may seem counterintuitive at first but the potential mechanism for this behaviour will be discussed in more detail in the next chapter.

There were no significant differences in the number of brands recalled when focusing on the characteristics of banner ads, or when looking at sponsored product listings.

Chapter 5 – Conclusion and Discussion

5.1 In-App Banner Ads

As seen previously, a respondent (on average) was 35.6% more likely to recall a particular brand when it was advertised through in-app banner ads, versus in the absence of in-app banner ads. Therefore, it can be concluded from these results that for a particular brand, advertising effectively increases brand recall levels. However, as an additional finding, we did see a decline in the total number of brands recalled by respondents, and it could be the case that the difference can be consolidated by using distraction as a mechanism. Thus, an in-app banner could potentially divert a user's attention away from competing brands, and direct it towards the advertised brand – hence, consolidating the difference in effects of in-app banner ads on brand recall levels and total number of brands recalled.

The managerial implication of this is that from a competitive standpoint, it is worth considering advertising through in-app banner ads as it may aid brand recall for the advertised brand, while diminishing levels of brand recall for competitors. However, it is also important to note that further research surrounding the impact of in-app advertising and distraction on purchase intention is required to make causal claims about the effectiveness of distraction as a mechanism for influencing brand recall.

5.2 Control Variables

In all cases except model 2, age had a significant negative association with brand recall levels. This is an expected result given that recall requires "processing resources" that are "depleted as people grow older" (Craik & McDowd, 1987). Thus, given that the focus of the experiments was to measure recall, age was a suitable control variable to include in the analysis.

In model 1, past usership of online grocery apps was negatively associated with brand recall levels – this is interesting as it opens up new avenues for research. It could be the case that past usership indicates tech savviness, which may indicate that users actively avoid giving attention to banner ads – which could potentially

explain this negative association. However, to make causal claims, further research is required.

Finally, model 2 found a significant difference in brand recall levels between men and women, with the former group having lower recall levels than the latter. This finding may be anomalous, but it would require further research to identify an explicit relationship between gender and recall.

5.3 Limitations and Suggestions for Further Research

One of the main limitations of this study was its limited sample size. Perhaps a larger sample size would allow for computation of more robust models – these could help identify relationships between the factors that were being tested in H2-H7.

In addition, it is likely that there was unobserved heterogeneity within the sample that led to omitted variable biases, thus putting into question the internal and external validity of the results.

Experiment 2 looked at the impact of sponsored listings on brand recall. However, as described in the literature review, this is all in the context of search tasks. Therefore, it is possible that experiment 2 yielded mostly insignificant results because the task that was presented to participants was very different from an actual search task. In the experiment, respondents were shown a hypothetical search task, but it did not actually involve the respondent having to perform their own search task, as designing such an experiment would have gone beyond the scope of a bachelor thesis.

Finally, it could also be the case that a lot of the relationships that were potentially insignificant, are indeed insignificant. For example, there were inconsistencies in existing literature regarding users' perceptions of sponsored listings – whether some people actively avoid it (Joo, Shi, & Abhishek, 2022) versus using it as a relevant source of information (Jansen, Brown, & Resnick, 2007). However, to make this statement, one would have to go back to the original suggestion of increasing the sample size to better test the hypotheses.

5.4 Concluding Remarks

Overall, as far as the research question is concerned, this paper goes to show that in-app banner ads are a useful and worthwhile marketing activity for CPG brands that sell their products through online grocery apps – as their appears to be a positive relationship between exposure to in-app banner ads and purchase intentions (mediated by recall). Although not conclusively tested, it still would be interesting to further test sponsored product listings with a larger sample while also accounting for more confounding variables and with a more realistic task. Beyond that, a final note to researchers would be to track developments in the field of retail media to stay on top of trends that allow for further research within in-app advertising specifically.

Bibliography

Adis, A. A., & Kim, H. J. (2013). The Mediating Role of Brand Recall and Brand Attitude in Inflfluencing Purchase Intention in Advergames. *Asia Marketing Journal, 15*(3).

Amazon Ads. (n.d.). *What is banner advertising?* Retrieved May 27, 2023, from Amazon Ads: https://advertising.amazon.com/library/guides/banner-advertising

Banik, S., & Dhar, S. R. (2021). Effect of Advertisement on Children's Purchase Intention: The Mediating Role of Advertisement Recall. *The Journal of Management Theory and Practice, 2*(2), 81-87.

Bartholomew, D. E., & Williamson, M. (2022). Retail Media Networks. *Journal of Retailing and Consumer Services, 69*, Article 103119.

Çiçek, M., Eren-Erdoğmuş, İ., & Daştan, İ. (2017). What Makes Consumers Recall Banner Ads in Mobile Applications. *Emerging Markets Journal, 7*(1), 10-16.

Bayles, M. E. (2002). Designing online banner advertisements: should we animate? . *The Special Interest Group on Computer–Human Interaction* (pp. 363-366). Association for Computing Machinery.

Draganska, M., Hartmann, W. R., & Stanglein, G. (2014). Internet Versus Television Advertising: A Brand-Building Comparison. *Journal of Marketing Research, 51*, 578-590.

Drèze, X., & Hussherr, F.-X. (2003). Internet advertising: Is anybody watching? *Journal of Interactive Marketing, 17*(4), 8-23.

Feger, A. (2023, March 3). *Why retail media will be the third and biggest wave of digital advertising*. Retrieved from Insider Intelligence: https://www.insiderintelligence.com/content/why-retail-media-will-third-biggest-wave-of-digital-advertising

Gesmundo, M. G., Meridor, W. D., Castano, M. N., Jordan, M. S., Muyot, D. V., & Bandojo, A. P. (2022). TikTok as a Platform for Marketing Campaigns: The effect of Brand Awareness and Brand Recall on the Purchase Intentions of Millennials. *Journal of Business and Management Studies, 4*(2), 343-361.

Ghose, A., & Yang, S. (2009). An Empirical Analysis of Search Engine Advertising: Sponsored Search in Electronic Markets. *Management Science, 55*(10), 1605-1622.

Jansen, B. J., Brown, A., & Resnick, M. (2007). Factors relating to the decision to click on a sponsored link. *Decision Support Systems, 44*(1), 46-59.

Joo, M., Shi, J., & Abhishek, V. (2022). Do Sellers Benefit from Sponsored Product Listings? Evidence from an Online Marketplace.

Khurram, M., Qadeer, F., & Sheeraz, M. (2018). The Role of Brand Recall, Brand Recognition and Price Consciousness in Understanding Actual Purchase. *Journal of Research in Social Sciences, 6*(2), 219-241.

Kryvtsun, M. (2022, June 3). *Retail Media Advertising: How E-commerce Is Becoming AdTech's Next Frontier*. Retrieved from Xenoss: https://xenoss.io/blog/retail-media-advertising

Li, H., & Bukovac, J. L. (1999). Cognitive Impact of Banner Ad Characteristics: An Experimental Study. *Journalism & Mass Communication Quarterly, 76*(2), 341-353.

Lin, F.-H., & Hung, Y.-F. (2009). The Value of and Attitude Toward Sponsored Links for Internet Information Searchers. *Journal of Electronic Commerce Research, 10*(4), 235-251.

Lipsman, A. (2023). Attention! Seizing the Retail Media Opportunity. *Insider Intelligence | eMarketer.* Virtual: Insider Intelligence | eMarketer.

Lohtia, R., Donthu, N., & Hershberger, E. K. (2003). The Impact of Content and Design Elements on Banner Advertising Click-through Rates. *Journal of Advertising Research, 43*(4), 410-418.

Lu, Y., Chau, M., & Chau, P. Y. (2017). Are Sponsored Links Effective? Investigating the Impact of Trust in Search Engine Advertising. *ACM Transactions on Management Information Systems, 7*(4), 1-33.

Manchanda, P., Dubé, J.-P., Goh, K. Y., & Chintagunta, P. K. (2006). The Effect of Banner Advertising on Internet Purchasing. *Journal of Marketing Research, 43*(1), 98-108.

Memon, B. A., Arif, H., & Farrukh, M. (2016). Impact of Brand Recall on Customer Purchase Intention. *Journal of Marketing and Consumer Research, 25*(16).

Narayanan, S., & Kalyanam, K. (2015). Position Effects in Search Advertising and their Moderators: A Regression Discontinuity Approach. *Marketing Science, 34*(3), 338-407.

Reyes, W., Serafico, N. M., Hendrayati, H., & Ramdhan, A. (2019). Analysis of the Effectiveness of Promoted Listings Using the Method of EPIC Model. *1st International Conference on Economics, Business, Entrepreneurship, and Finance (ICEBEF 2018).* Atlantis Press.

Roback, P., & Legler, J. (2020). *Beyond Multiple Linear Regression Applied Generalized Linear Models And Multilevel Models in R.* Chapman & Hill.

Robinson, H., Wysocka, A., & Hand, C. (2007). Internet advertising effectiveness: The effect of design on click-through rates for banner ads. *International Journal of Advertising, 26*(4), 527-541.

Rutz, O. J., Bucklin, R. E., & Sonnier, G. P. (2012). A Latent Instrumental Variables Approach to Modeling Keyword Conversion in Paid Search Advertising. *Journal of Marketing Research, 49*(3), 306-319.

Sahni, N. S., & Nair, H. S. (2020). Does Advertising Serve as a Signal? Evidence from a Field Experiment in Mobile Search. *The Review of Economic Studies, 87*(3), 1529-1564.

Sahni, N. S., & Zhang, C. (2022). Are Consumers Averse to Sponsored Messages? The Role of Search Advertising in Information Discovery . *Stanford University Graduate School of Business Research Paper*, No. 3441786.

Tharmi, U., & Senthilnathan, S. (2012). The Relationship of Brand Equity to Purchase Intention. *IUP Journal of Marketing Management*.

Wang, K.-Y., Shih, E., & Peracchio, L. A. (2013). How banner ads can be effective: Investigating the influences of exposure duration and banner ad complexity. *International Journal of Advertising, 32*(1), 121-141.

Yoo, C. Y., Kim, K., & Stout, P. A. (2004). Assessing the Effects of Animation in Online Banner Advertising. *Journal of Interactive Advertising, 4*(2), 49-60.

Appendix A – Full Factorial Designs

Figures 9 and 10 show the SPSS output for the full factorial designs.

Size	Animation	Colour_Lvl	STATUS_	CARD_
Small	Not Animated	Low	Design	1
Small	Not Animated	High	Design	2
Small	Animated	Low	Design	3
Small	Animated	High	Design	4
Large	Animated	Low	Design	5
Large	Not Animated	High	Design	6
Large	Animated	High	Design	7
Large	Not Animated	Low	Design	8

Figure 9. SPSS output for H1 design

Position	Relevance	STATUS_	CARD_
Top	False	Design	1
Bottom	False	Design	2
Bottom	True	Design	3
Top	True	Design	4

Figure 10. SPSS output for H2 design

Appendix B – Survey

In the interest of brevity, provided below is the survey flow (exported from Qualtrics). This will be followed an example of the questions that was used for the recall aspect. Finally, the set of screenshots used will be presented.

Figure 11. Survey flow (1 of 2)

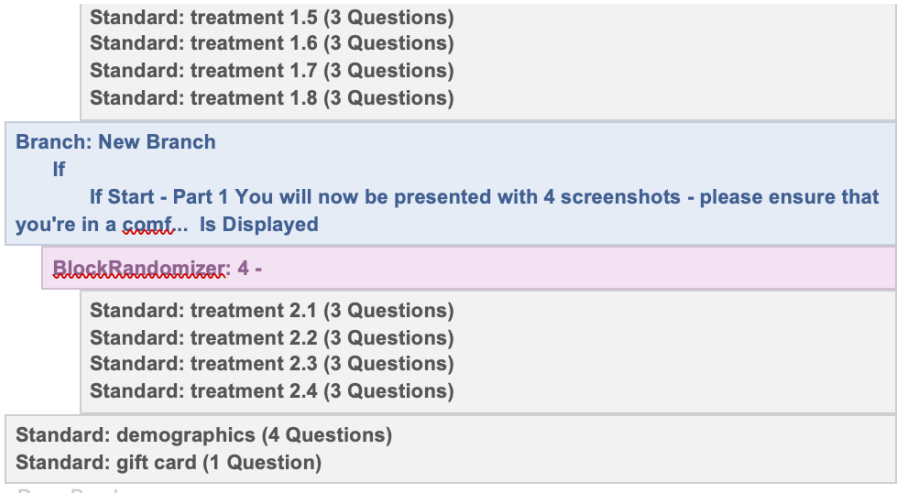

Figure 12. Survey flow (2 of 2)

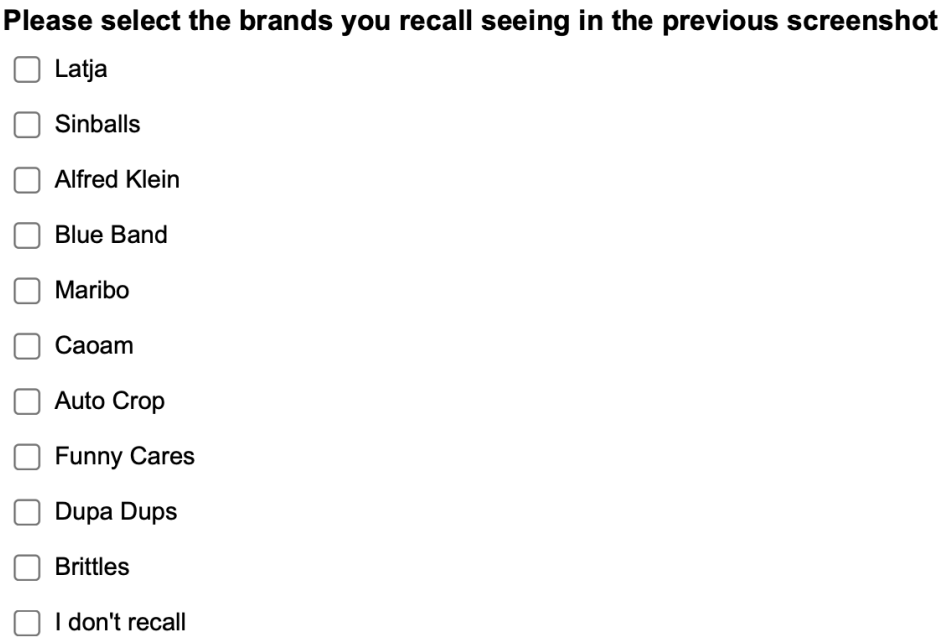

Figure 13. Sample question to check recall

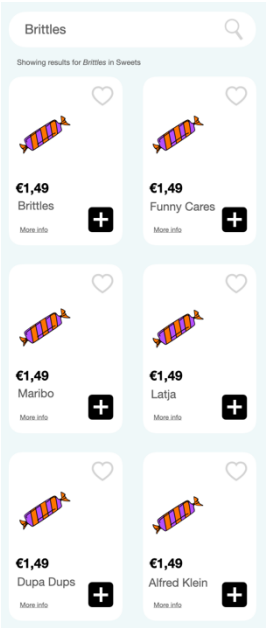

Figure 14. Control 1.1

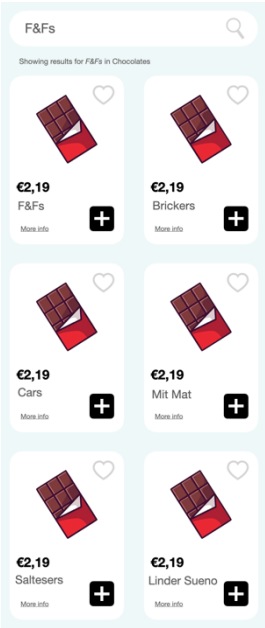

Figure 15. Control 1.2

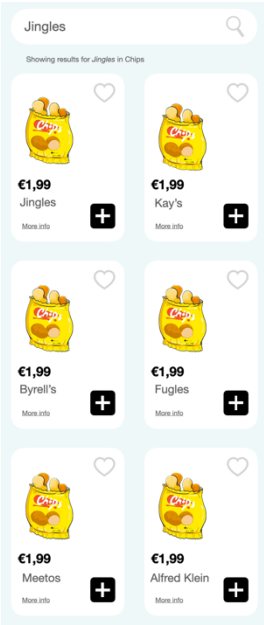

Figure 16. Control 1.3

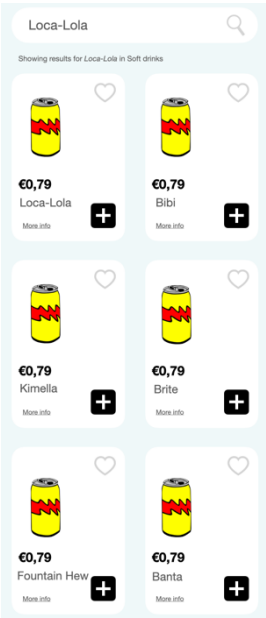

Figure 17. Control 1.4

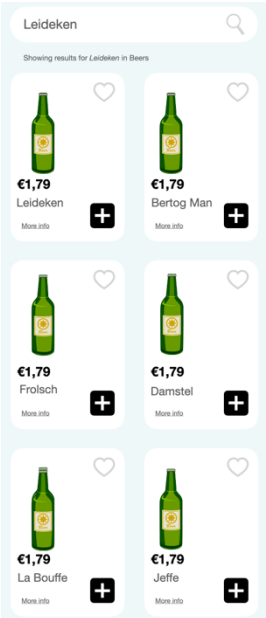

Figure 18. Control 1.5

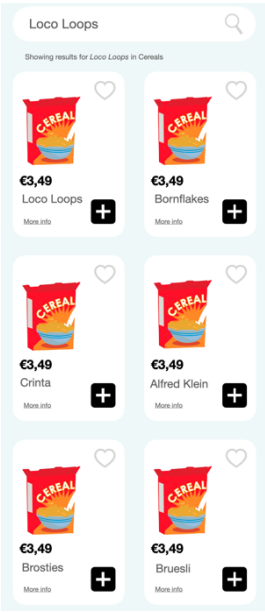

Figure 19. Control 1.6

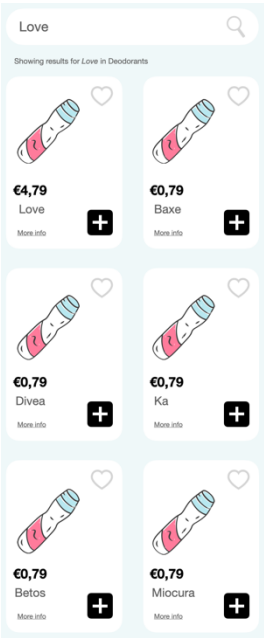

Figure 20. Control 1.7

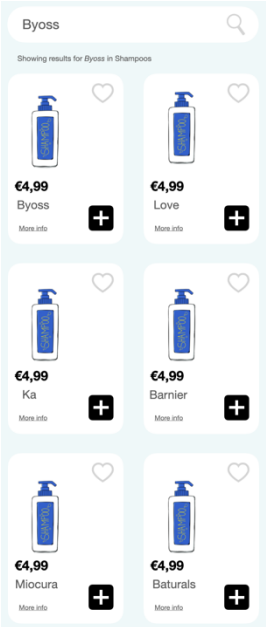

Figure 21. Control 1.8

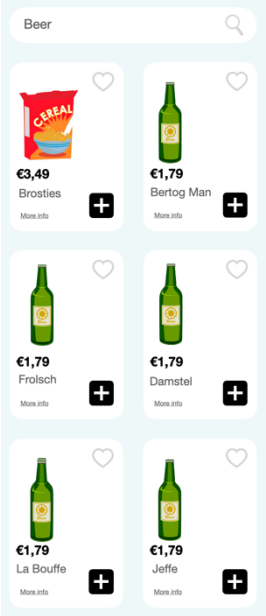

Figure 22. Control 2.1

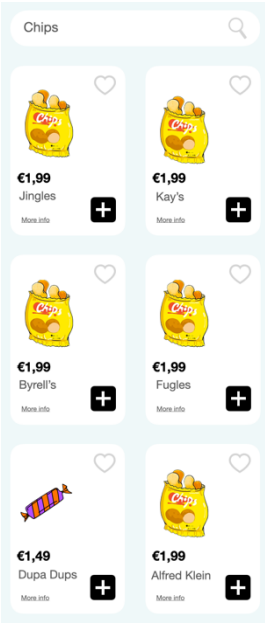

Figure 23. Control 2.2

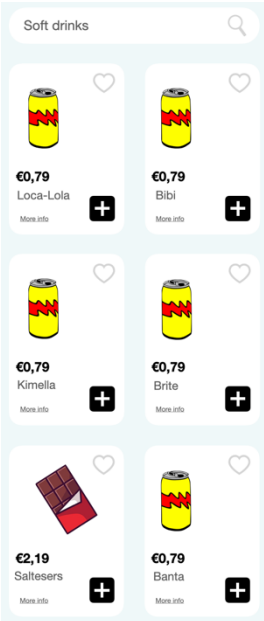

Figure 24. Control 2.3

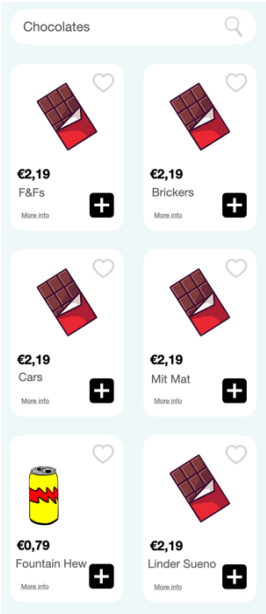

Figure 25. Control 2.3

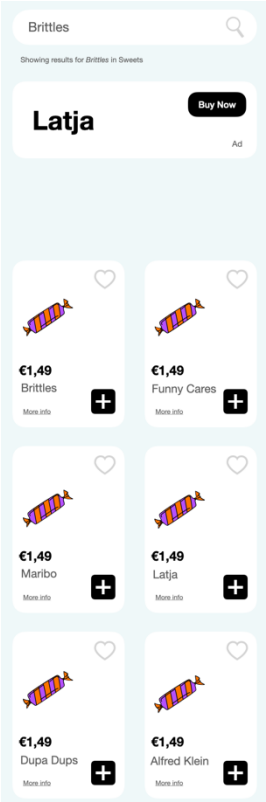

Figure 26. Treatment 1.1

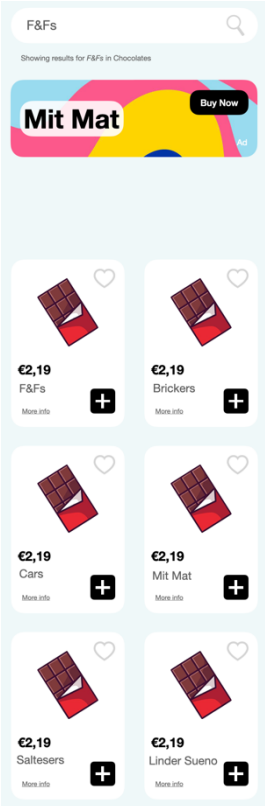

Figure 27. Treatment 1.2

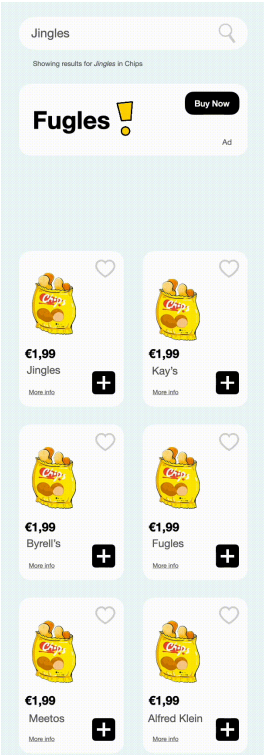

Figure 28. Treatment 1.3 (animated exclamation mark)

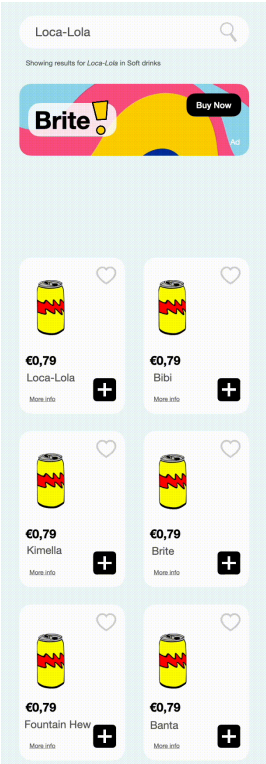

Figure 29. Treatment 1.4 (animated exclamation mark)

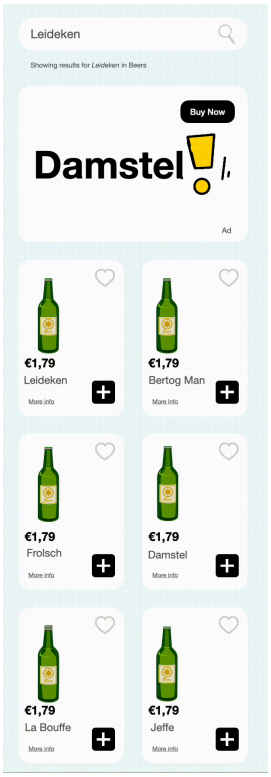

Figure 30. Treatment 1.5 (animated exclamation mark)

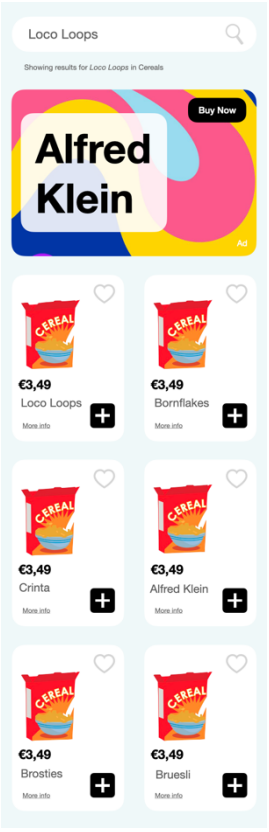

Figure 31. Treatment 1.6

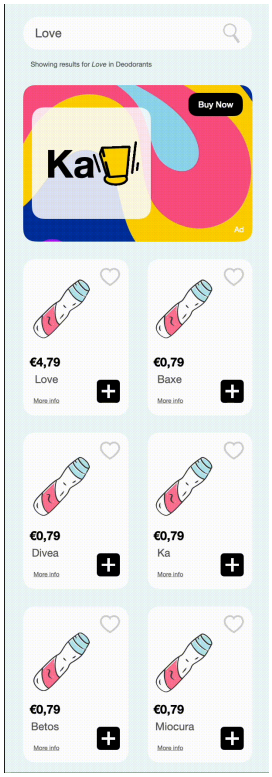

Figure 32. Treatment 1.7 (animated exclamation mark)

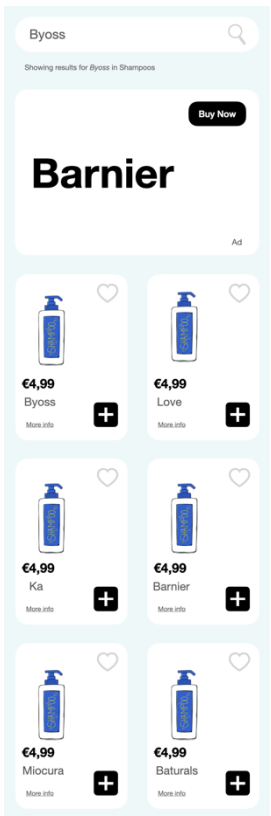

Figure 33. Treatment 1.8

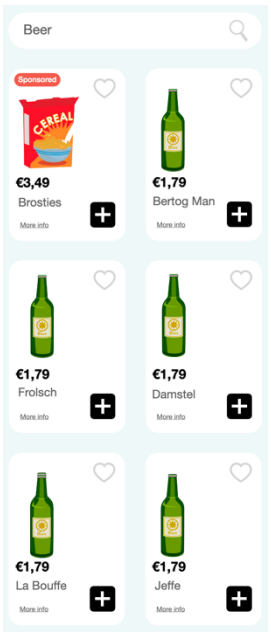

Figure 34. Treatment 2.1

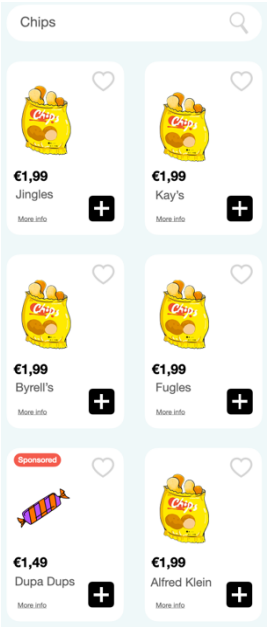

Figure 35. Treatment 2.2

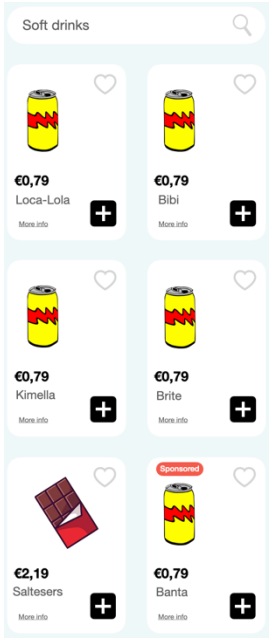

Figure 36. Treatment 2.3

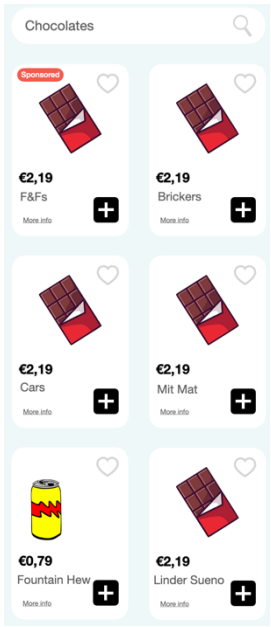

Figure 37. Treatment 2.4

Appendix C – STATA Output

```
sum

    Variable |        Obs        Mean    Std. dev.       Min        Max
-------------+---------------------------------------------------------
          id |        134        67.5    38.82654         1        134
         age |        134    36.58955    16.03765        16         60
      gender |        133    .6315789    .4842001         0          1
        user |        134    .6940299    .4625463         0          1
```

Figure 38. Sample description

```
sum recall advertise size animation colour age gender past_user

    Variable |        Obs        Mean    Std. dev.       Min        Max
-------------+---------------------------------------------------------
      recall |        520    .7769231    .4167104         0          1
  advertise  |        520    .5230769    .4999481         0          1
        size |        272          .5    .5009217         0          1
  animation  |        272          .5    .5009217         0          1
     colour  |        272          .5    .5009217         0          1
-------------+---------------------------------------------------------
         age |        520    38.58462    15.74253        20         60
      gender |        512        .625    .4845964         0          1
  past_user  |        520    .7230769     .447909         0          1
```

Figure 39. Summary statistics H1-H4

```
. logit recall advertise age gender past_user

Iteration 0:   log likelihood = -273.96572
Iteration 1:   log likelihood = -243.32135
Iteration 2:   log likelihood = -241.39472
Iteration 3:   log likelihood = -241.39073
Iteration 4:   log likelihood = -241.39073

Logistic regression                                     Number of obs =    512
                                                        LR chi2(4)    =  65.15
                                                        Prob > chi2   = 0.0000
Log likelihood = -241.39073                             Pseudo R2     = 0.1189

------------------------------------------------------------------------------
      recall | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
  advertise  |      1.3084   .2430406     5.38   0.000     .8320493    1.784751
         age |   -.0266366   .0078148    -3.41   0.001    -.0419532   -.0113199
      gender |    -.174801   .2581082    -0.68   0.498    -.6806838    .3310818
   past_user |   -1.111562   .3072242    -3.62   0.000     -1.71371   -.5094134
       _cons |    2.696376   .4748499     5.68   0.000     1.765687    3.627065
------------------------------------------------------------------------------
```

Figure 40. Regression results (H1)

```
. logit recall advertise size animation colour age gender past_user

note: advertise omitted because of collinearity.
Iteration 0:   log likelihood = -98.521272
Iteration 1:   log likelihood = -92.835527
Iteration 2:   log likelihood = -92.477782
Iteration 3:   log likelihood = -92.476815
Iteration 4:   log likelihood = -92.476815

Logistic regression                                     Number of obs =    272
                                                        LR chi2(6)    =  12.09
                                                        Prob > chi2   = 0.0600
Log likelihood = -92.476815                             Pseudo R2     = 0.0614

------------------------------------------------------------------------------
      recall | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
  advertise |          0  (omitted)
        size |   .1484866   .3857847     0.38   0.700    -.6076375    .9046108
   animation |  -.4472677    .390219    -1.15   0.252    -1.212083    .3175475
      colour |  -.2974101   .3874182    -0.77   0.443    -1.056736    .4619156
         age |  -.0158092   .0140751    -1.12   0.261    -.0433959    .0117774
      gender |  -.9349948   .4676048    -2.00   0.046    -1.851483   -.0185061
   past_user |  -.5597039    .430803    -1.30   0.194    -1.404062    .2846545
       _cons |   3.959905   .8153168     4.86   0.000     2.361913    5.557896
------------------------------------------------------------------------------
```

Figure 41. Regression results (H2, H3, H4)

```
. predict pr
(option pr assumed; Pr(recall))
(8 missing values generated)

. * Levene's Test *

. robvar pr, by(advertise)

           |        Summary of Pr(recall)
 advertise |        Mean   Std. dev.       Freq.
-----------+------------------------------------
         0 |         .65   .11737779         240
         1 |  .88235294   .06257848         272
-----------+------------------------------------
     Total |   .7734375   .14829456         512

W0  = 152.817493   df(1, 510)     Pr > F = 0.00000000

W50 =  82.249998   df(1, 510)     Pr > F = 0.00000000

W10 = 156.220817   df(1, 510)     Pr > F = 0.00000000
```

Figure 42. Levene's test (H1)

```
. * Welch's t-test *

. ttest pr, by(advertise) welch

Two-sample t test with unequal variances

   Group |     Obs        Mean    Std. err.   Std. dev.   [95% conf. interval]
---------+--------------------------------------------------------------------
       0 |     240         .65    .0075767    .1173778    .6350744    .6649256
       1 |     272    .8823529    .0037944    .0625785    .8748827    .8898231
---------+--------------------------------------------------------------------
Combined |     512    .7734375    .0065538    .1482946    .7605619    .7863131
---------+--------------------------------------------------------------------
    diff |           -.2323529    .0084737               -.2490179   -.215688
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t = -27.4205
H0: diff = 0                     Welch's degrees of freedom =  355.208

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 1.0000
```

Figure 43. Welch's test (H1)

```
sum recall advertise position relevance age gender past_user

    Variable |        Obs        Mean    Std. dev.       Min        Max
-------------+---------------------------------------------------------
      recall |        276    .692029    .4624931          0          1
  advertise  |        276   .4347826     .496629          0          1
   position  |        120          .5    .5020964          0          1
  relevance  |        120          .5    .5020964          0          1
        age  |        276   34.71014    16.01281         16         58
-------------+---------------------------------------------------------
     gender  |        276   .6376812    .4815434          0          1
  past_user  |        276   .6666667    .4722608          0          1
```

Figure 44. Summary statistics (H5, H6, H7)

```
. logit recall advertise age gender past_user

Iteration 0:   log likelihood = -170.42106
Iteration 1:   log likelihood = -160.44705
Iteration 2:   log likelihood = -160.32379
Iteration 3:   log likelihood = -160.32374
Iteration 4:   log likelihood = -160.32374

Logistic regression                                     Number of obs =    276
                                                        LR chi2(4)    =  20.19
                                                        Prob > chi2   = 0.0005
Log likelihood = -160.32374                             Pseudo R2     = 0.0592

------------------------------------------------------------------------------
      recall | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
  advertise  |   .0451767   .2737978     0.17   0.869    -.4914571    .5818104
         age |    -.03299   .0088634    -3.72   0.000     -.050362    -.015618
      gender |  -.1988051    .307292    -0.65   0.518    -.8010862    .4034761
   past_user |  -.2760841   .3003857    -0.92   0.358    -.8648293    .3126611
       _cons |   2.311793   .4214946     5.48   0.000     1.485679    3.137908
------------------------------------------------------------------------------
```

Figure 45. Regression results (H5)

Appendix D – Background for Additional Findings (4.7)

The total number of brands recalled per screenshot is treated as count data since the number of brands recalled can only consist of non-negative integer values (0-6). Thus, the model will be modelled using a Poisson regression, as it is known to be suitable for modelling count data (Roback & Legler, 2020). A Poisson regression assumes that the mean is equal to the variance – this may not always be the case (discussed further in the results section). Therefore, the count data will first be analysed using a negative binomial regression, which defaults to a Poisson distribution in the case that the data is, in fact, not overdispersed. A Poisson regression where $E(Y_i) = Var(Y_i) = \lambda_i$ (Y_i refers to the number of brands recalled by individual i) is modelled as follows:

$$\log(\lambda_i) = \beta_0 + \beta_1 Advertised \quad (1)$$

$$\therefore E(Y_i) = \lambda_i = e^{\beta_0 + \beta_1 Advertised} \quad (2)$$

Equation 2 allows us to compare the expected number of brands recalled by respondents when they are exposed to in-app advertising versus when they are not.

As with any modelling technique, there are certain assumptions that must be accounted for. In the case of a Poisson regression, there are four assumptions (Roback & Legler, 2020) one must take care of, and they are as follows:

1. The dependent variable must be in line with the requirements of a Poisson distribution. Therefore, count data such as the number of brands recalled by a given respondent aligns with this format.
2. The observations must be independent of each other – this is indeed the case for this study, as participants were exposed to a randomised set of screenshots to observe, thus eliminating the risk of learning effects, etc.
3. One of the key features of a Poisson distribution is that the mean of the variable of interest is equal to its variance – this can be a challenging and restrictive condition when it comes to analysing results from an experiment.

However, as previously mentioned, STATA checks for this when instructed to perform a negative binomial regression, and defaults to a Poisson regression in the case that this criterion is satisfied.

4. The final condition is that $\log(\lambda_i)$ must be linearly related to the independent variable. In the case of the main hypotheses, this assumption holds because of the binary nature of the independent variable – this inherently leads to a linear relationship.

The results indicate that a significant Poisson regression was found (LR $\chi^2(1) = 4.55, p = 0.0329$)) with a pseudo-$R^2$ of 0.0022.

	Brands Recalled
Advertise (Banner)	-0.096** (0.045)
Constant	1.375*** (0.032)
Number of observations	520

Notes: Model 1 makes use of a Poisson regression to estimate the effect of in-app banner ads on $\log(\lambda_i)$. Standard errors are reported in parentheses; significance stars correspond to the following significance levels: *p<0.1, **p<0.05, ***p<0.01.

The results from model 1 show that there was indeed a significant difference in recall levels within respondents that were exposed to in-app banner ads versus those that were not. Specifically, on average, the $\log(\lambda)$ value for a respondent who was exposed to in-app banner ads was -0.096 units lower than someone who was not exposed to in-app banner ads, and this difference is significant at a 5% level. To put this difference into perspective, we can substitute the results back into equation 1. Accordingly, the expected number of brands recalled on average are 3.955 and 3.593 for those that are not exposed to in-app advertising versus those who are, respectively.