Journal of
Theoretical and Applied Electronic Commerce Research

MDPI

Article

What Deters Online Grocery Shopping? Investigating the Effect of Arithmetic Complexity and Product Type on User Satisfaction

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Abstract: This paper explores the influence of product type and arithmetic task complexity on users' perceived mental effort and satisfaction in the context of online grocery shopping. A two-factor within-subject experiment was conducted with 32 participants. Results show that experience products and complex arithmetic tasks are associated with higher perceived mental effort compared to search products and simple arithmetic tasks. Perceived mental effort and satisfaction are negatively related. The more cognitive effort users need to invest in their online shopping tasks, the less satisfied they are likely to be with their online experience. Our results suggest that cognitive absorption mediates the relationship between cognitive effort and satisfaction. The study contributes to our understanding of online grocery shopping by explaining the effect of arithmetic complexity and product type on user satisfaction. It also offers shopping website designers a way to improve consumers' online grocery shopping experience by implementing simple technology features in their websites to help users reduce their mental effort.

Keywords: online groceries; experience products; search products; uncertainty; arithmetic complexity; cognitive load; mental effort; e-satisfaction; cognitive absorption

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Citation: Mirhoseini, M.; Pagé, S.-A.; Léger, P.-M.; Sénécal, S. What Deters Online Grocery Shopping? Investigating the Effect of Arithmetic Complexity and Product Type on User Satisfaction. *J. Theor. Appl. Electron. Commer. Res.* **2021**, *16*, 828–845. https://doi.org/10.3390/jtaer16040047

Received: 1 January 2021
Accepted: 5 February 2021
Published: 9 February 2021

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1. Introduction

Despite the exponential growth of Internet retailing, online grocery just occupies a modest market share in the digital world. In 2019, books, music, and video represented 50.8% of online sales while "food and beverages" represented only 2% in the United States [1] in spite of the fact that giant retailers such as Amazon have been offering groceries online for over a decade [2,3]. Similar situations appear in other countries such as Canada, the United Kingdom, and Australia [4–6]. In an effort to boost online grocery sales, large retailers such as Amazon, Walmart, Costco, and Target have invested in their ordering and delivery capabilities [7,8] as well as expanded their product assortment [2,9]. In 2017, Walmart added more than 400 online grocery pickup locations throughout the U.S., bringing the number of their pickup locations to 1000 [10]. To compete, in the same year Amazon introduced to the market new ready-to-eat meals produced using the technology built for the U.S. military [2]. The products are promised to have a longer shelf-life, have more nutrients, and be tastier than traditional processed food [2]. Meanwhile in Asia, China's e-commerce giant Alibaba plans to invest $200 million in an Indian online grocer [11].

1.1. Research Gap and Objectives

Besides retailers' efforts to lure users online, research has been conducted to identify factors that truly deter users from purchasing groceries online [5,12–18]. Online grocery shoppers are specifically convenience-oriented and look for an easy shopping experience [19]. It has been found that quality of products [5,14,15] and reliability of delivery

time [14] are major concerns significantly discouraging grocery shoppers from purchasing food online. Other factors such as delivery fees [5] and low prices [14,15] also affect consumers' shopping channel preference, albeit not as significantly. Most of these studies were conducted in the U.S. or Europe and are primarily focused on situational factors or social aspects. Little evidence exists to ascertain how the characteristics of online grocery shopping affect consumers' shopping experience and website usage. As opposed to other product categories, grocery shopping possesses unique attributes that must be addressed differently in the online environment. We posit that types of products and arithmetic complexity are the two important characteristics among others that make online grocery purchase less attractive to general consumers.

An understanding of how online grocery shopping characteristics influence consumers' behaviors and responses will inform online grocers about the specificities of their products so that shopping websites can be developed appropriately to improve users' experience. In particular, our research aims at understanding the effect of two important factors (arithmetic complexity and product type) on users' perceived mental effort, and the effect of the latter on satisfaction. We also hypothesize the mediating effect of cognitive absorption in the relationship between mental effort and satisfaction. A two-factor (Arithmetic complexity X product type) within-subject experiment is designed where participants performed four online grocery shopping tasks. Our results show that mental effort is influenced by product type, arithmetic complexity, and the interaction between the two factors, while consumer satisfaction is influenced by mental effort and its interaction with cognitive absorption.

1.2. Literature Review

1.2.1. Product Type

According to Nelson [20], products can be categorized into search and experience goods. The dominant attribute of search goods is that most information about the goods can be collected via information search whereas for experience goods, information needs to be obtained personally or can only be learned after the goods are purchased, used, or consumed [21]. Thus, experience products are associated with a higher level of uncertainty than search products [22], since it is difficult to assess the quality of the goods without physical inspection or actual trial [23]. Peterson and Balasubramanian [24] suggest that online shopping for search goods is more favorable than in-store because the uncertainty of quality associated with search goods can be substantially reduced through online information search, sharing, and comparison. The same advantage, however, cannot be obtained for experience goods [25]. For specific grocery items such as fresh fruits and vegetables, consumers often make purchase decisions after engaging in multisensory assessment of the items such as touching, smelling, examining, or even tasting the products. The physical interaction with these items gives consumers a sense of certainty about product quality which the online environment cannot provide [16,26]. The uncertainty issue mandates that two different types of communication strategies should be used for advertising search and experience goods. Pan, Torres [27] developed a taxonomy for advertising products based on their characteristics and suggest that informative advertising (i.e., providing direct information about the product characteristics) is more effective for search goods than experience goods, while persuasive strategy (i.e., giving indirect information about product quality) is more effective for advertising experience goods because it reduces the consumers' uncertainty regarding the goods' quality. Online grocery shopping is, therefore, associated with higher perceived risk in terms of product quality than in-store shopping [5] and this perception of risk dissuades consumers from getting groceries online [28].

1.2.2. Arithmetic Complexity

One of the particular features of grocery shopping is the involvement of arithmetic calculation [18,29]. Grocery shoppers are found to frequently engage in arithmetic operations (i.e., division, multiplication, addition, and subtraction) for different purposes:

to justify choices, to determine the quantities of items to buy, or to compare between alternatives [29]. The complexity of these arithmetic activities may become higher in the online environment than in offline stores. In physical stores, shoppers can use external cues to facilitate the calculation and comparison. For instance, consumers can quickly glance at items already in their shopping cart to decide if additional products need to be purchased. For perishable products such as fruits and vegetables, which are often not sold in standardized packages, in-store shoppers decide which to buy and how many to buy by touching, holding, and lifting them. Research has shown that the sense of touch and dynamic hand contacts with an object (e.g., lifting, tapping) are efficient ways to assess its properties such as weight, volume, temperature, texture, and hardness [30]. In short, the in-store environment simplifies calculation, which requires less mental effort and is therefore preferred by consumers. It has been demonstrated that consumers are more likely to shop on the Internet if they believe that their effort invested is minimal [31,32].

1.2.3. Mental Effort

Mental effort, defined as the actual amount of cognitive resources being allocated to meet demand of a task [33], is considered as one of the determinants (negatively related) for the success of an e-commerce website [34]. The concept of mental effort is often taken as an index of cognitive load [35], which in the context of online shopping could be categorized as either intrinsic or extraneous [36,37]. Intrinsic mental effort is the energy required to deal with the complexity of the task such as arithmetic calculation, uncertainty of product quality. Extraneous mental effort is the effort spent to extract the information; how information is presented affects extraneous effort.

1.2.4. Cognitive Absorption

The notion of cognitive absorption (CA), developed by Agarwal and Karahanna [38], originates from the works on absorption, cognitive engagement, and the theory of flow. CA is defined as a state of deep involvement and is an individual's holistic experience when interacting with technology such as a website [38]. Cognitive absorption was proposed as one of the factors determining the continuance usage of electronic services [32,39]. Conceivably, CA is likely to be a driving force behind consumers' completion of an online transaction. Without being absorbed in the CA state, consumers may not be willing to spend time browsing websites, searching for products, adding products to cart, and finishing the checkout process. CA is particularly relevant for the online grocery context, since consumers engage in a long and possibly effortful online shopping experience [18].

1.3. Contributions

This study contributes to theory by identifying two unique characteristics of online grocery shopping and investigating their effect on consumers' mental effort and satisfaction with shopping satisfaction. Our study also suggests a way for shopping website designers to increase users' satisfaction with online grocery shopping, which is crucial given the low popularity of grocery shopping among online shopping consumers.

The remainder of this paper is organized as follows. First, the research model is presented and hypotheses are developed. Then, research methodology and results are presented. Finally, we discuss our results, contributions to theory, and implications for practice.

2. Hypotheses and Research Method

2.1. Hypotheses

The research model is presented in Figure 1.

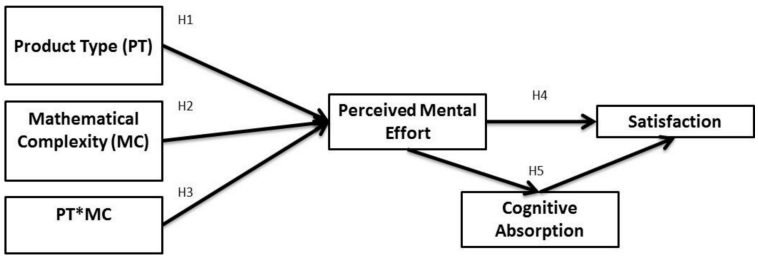

Figure 1. Research Model.

In the online context, the uncertainty of quality associated with experience goods is much higher than search goods [40]. With the Internet, the uncertainty of search goods can be easily resolved through information search, reviews, etc. For experience goods, evaluation of product quality requires touching or trying the products in person. Without physical contact, consumers may feel that high cognitive effort needs to be spent when judging the quality of experience goods. Therefore, the first hypothesis is postulated as follows:

Hypothesis 1 (H1). *In the online grocery context, experience products are associated with higher perceived mental effort than search products.*

Furthermore, grocery shoppers often engage in number calculation such as dividing price by quantity to compare unit price or computing the exact amount of ingredients needed for a recipe [18]. These arithmetic operations demand effortful thinking. The more complex the operations are, the higher the mental effort is expended. The second hypothesis is proposed as follows:

Hypothesis 2 (H2). *In the online grocery context, mathematical complexity positively influences perceived mental effort.*

We suggest that the arithmetic complexity and the types of products interacts to influence the perceived mental effort. The "high complexity—experience product" conditions will induce the greatest mental effort. For instance, purchasing unpackaged items to serve 7 people based on a 4-serving recipe is expected to generate more mental effort than shopping for packaged items to accommodate the exact number of servings indicated in the recipe. Therefore, we postulate that:

Hypothesis 3 (H3). *There is an interaction between arithmetic complexity and product type on perceived mental effort. That is, consumers exhibit highest mental effort when shopping for experience products in complex arithmetic tasks compared to other conditions.*

Consumer satisfaction is an emotional and cognitive response to a particular object that occurs after purchase or after consumption of the object [41]. Satisfaction with Internet retailing or e-satisfaction is defined as a result of consumer perceptions of online multivariate context including information about the products, design, and usability of ecommerce websites [42]. In this study, satisfaction is defined by two dimensions: Satisfaction with the online store and the overall satisfaction with the shopping experience. According to the principle of least effort [43], individuals prefer spending the least amount of effort in completing a task. Indeed, it has been reported that increase in cognitive effort induces negative emotion [44,45]. Perceived ease-of-use (PEOU), defined as the degree to which customers believe using a website is free of effort [46], has been studied as a measure of cognitive effort [47]. Schaupp [48] report that customers' PEOU is negatively related to website satisfaction. In the online shopping context, the more effort consumers put

into performing a shopping task, the less they enjoy their shopping experience [42,45,49]. Hence, the following hypothesis is posited:

Hypothesis 4 (H4). *In the online grocery context, perceived cognitive effort is negatively related to satisfaction.*

The CA construct is composed of five dimensions: Temporal dissociation (unaware of the passing time), focused immersion (excess concentration on a task), pleasure (also known as heightened enjoyment, is the experience of positive feeling when performing a task), control (the perception of being in charge), and curiosity (the desire to know and learn more) [38]. These dimensions associated with the concept of perceived mental effort [50]. For instance, the temporal dissociation and immersion dimension implies that a person is so immersed in a task that he or she does not feel any time constraints; therefore, his or her perceived cognitive load reduces and so does his or her perceived mental effort. Similarly, the states of heightened enjoyment, control, and curiosity (pleasure, control, and curiosity dimensions) all leads to the perception of little cognitive effort required in completing a task. In short, CA induces a motivational state which makes individuals perceive that little cognitive effort needs to be invested in performing an activity [38]. Hence, we expect that CA and mental effort are related.

Furthermore, the relationship between CA and satisfaction has been discussed in the literature [51–53]. CA is positively linked with productivity [54] and individual job performance [53] because it indicates that users are less likely to feel bored and that they are enjoying using the technology. CA increases satisfaction and is known as a predictor of the continuance intention of e-service usage [32]. Given the relationships between CA and mental effort, between CA and satisfaction, and the direct relationship between mental effort and satisfaction (as proposed in H4), we posit that CA mediates the relation between mental effort and satisfaction. The fifth hypothesis is therefore:

Hypothesis 5 (H5). *Cognitive absorption mediates the relationship between perceived mental effort and satisfaction.*

2.2. Methodology

2.2.1. Experimental Design and Tasks

A within-subject, 2 levels of arithmetic complexity (low/high) $\times$ 2 types of products (search/experience) experiment was conducted. Each participant performed 4 tasks corresponding to 4 scenarios (low complexity-search product, low complexity-experience product, high complexity-search product, and high complexity-experience products). The tasks were randomized to mitigate any potential order effect.

Participants were recruited through our institution subject panel. Each participant was compensated with a $30 gift card. For each task, participants were instructed to go to a specified website and buy ingredients for given recipes. Participants were asked to shop for non-perishable packaged food in the search good conditions and perishable unpackaged food in the experience good conditions. Descriptions of each task are given in Appendix A. The arithmetic complexity of the task is manipulated by the number of servings that the participants have to shop for. The low complexity tasks do not indicate the number of servings, while the high complexity tasks require participants to buy ingredients to accommodate a specific number of people. After each task, the subjects completed a questionnaire to report their perceived mental effort, satisfaction, and cognitive absorption.

2.2.2. Measures

Perceived mental effort was measured using a 7-point Likert scale (1 = strongly agree, 7 = strongly disagree) adapted from [33] (see Appendix B). Scale reliability was assessed with Cronbach's alpha (0.86). The satisfaction scale includes six items adapted from [55,56]. The items measure emotional and cognitive aspects of satisfaction as well as participants'

overall satisfaction with the shopping experience. All items were measured on a 7-point scale (1 = strongly agree, 7 = strongly disagree). The scale was reliable with an alpha of 0.80. Cognitive absorption was measured with the following five dimensions of Agarwal & Karahanna's (2000) scale: temporal dissociation ($\alpha = 0.67$), focused immersion ($\alpha = 0.71$), heightened enjoyment ($\alpha = 0.86$), control ($\alpha = 0.77$), and curiosity ($\alpha = 0.82$). All items were measured using a 7-point likert scale (1 = strongly agree, 7 = strongly disagree). One item was removed from curiosity (using the website arouses my imagination, $\alpha = 0.65$) and pleasure (using the website provides me with a lot of enjoyment, $\alpha = 0.68$) dimensions to increase reliability scores.

In order to check the arithmetic complexity manipulation, it was measured using a one-item 7-point Likert scale (from very easy to very difficult). A significant difference was observed between simple and complex tasks (M = 4.38 and M = 3.09, $p < 0.001$), indicating that task complexity was successfully manipulated. Individual characteristics of participants such as online shopping habits and demographic characteristics were collected at the beginning of the experiment.

2.2.3. Data Analysis

All hypotheses are tested using simple regression estimated by Maximum Likelihood (ML) method in STATA. For H1 and H2, the linear effects of product type and arithmetic complexity on mental effort were estimated, while for H3, the interaction term of the two independent variables was estimated. H4 was tested by calculating the direct effect of mental effort on CA dimensions. To test the partial mediation effect (H5), CA dimensions were added to the regression equation of H4, and the coefficient's absolute values were compared.

3. Results

3.1. Participants

A total of 32 people participated in the study. Most of the participants (97%) were between the age of 19 to 35 and 56% were male. Of the participants, sixty percent (60%) had performed grocery shopping prior to the experiment. Thirty-five percent (35%) considered themselves to be grocery shopping experts and 75% said they knew a great deal about buying groceries. Fifty-three percent (53%) purchased groceries more than four times per month. Among participants, only 13% had already bought groceries online. The average amount spent on groceries each week was $112. Eighty-four percent (84%) have made online purchase before. Table 1 presents participant demographics.

Table 1. Participant demographics.

	Number	Percentage
Gender		
Female	14	44%
Male	18	56%
Age		
19–35	31	97%
35 and older	1	3%
Education		
College/BA	29	91%
Graduate	3	9%

3.2. Descriptive Statistics

The perceived mental effort is strongest in the "high complexity—experience product" condition (M = 4.881) and is lowest in the "low complexity—search product" condition (M = 3.188). Table 2 summarizes the mean and standard deviation of the variables in each experimental condition.

Table 2. Mean and standard deviation of perceived mental effort, e-satisfaction, and cognitive absorption dimensions.

Arithmetic Complexity	Product	Effort Mean (Std)	Satisfaction Mean (Std)	Cognitive Absorption				
				Time Mean (Std)	Curiosity Mean (Std)	Immersion Mean (Std)	Pleasure Mean (Std)	Control Mean (Std)
High	Experience	4.881 (0.978)	4.229 (1.113)	4.500 (0.916)	4.078 (1.033)	5.094 (1.024)	4.097 (1.300)	4.328 (1.560)
High	Search	4.019 (1.006)	4.396 (1.100)	4.333 (0.955)	4.297 (1.294)	4.906 (1.098)	4.391 (1.113)	4.813 (1.268)
Low	Experience	3.329 (0.990)	4.667 (0.749)	4.281 (1.033)	4.581 (0.984)	5.356 (0.783)	4.672 (0.930)	4.855 (0.985)
Low	Search	3.188 (0.977)	4.814 (0.974)	4.146 (0.954)	4.234 (1.225)	5.452 (0.876)	4.766 (1.000)	5.156 (0.937)

Table 3 presents the correlation between variables. All dimensions of CA, except temporal dissociation, are correlated with the satisfaction ($p < 0.05$). Meanwhile, only pleasure ($r = -0.26$, $p < 0.05$) and control ($r = -0.22$, $p < 0.05$) are correlated with perceived mental effort. There is a negative correlation between mental effort and satisfaction ($r = -0.36$, $p < 0.05$).

Table 3. Correlations between mental effort, satisfaction, and cognitive absorption dimensions.

	Variables	1	2	3	4	5	6
1	Perceived mental effort						
2	Satisfaction	−0.36 *					
3	CA Temporal dissociation	0.16	0.18				
4	CA Curiosity	−0.03	0.55 *	0.37 *			
5	CA Immersion	−0.06	0.35 *	0.25 *	0.38 *		
6	CA Pleasure	−0.26 *	0.78 *	0.26 *	0.50 *	0.32 *	
7	CA Control	−0.22 *	0.63 *	0.18 *	0.41 *	0.34 *	0.63 *

* $p < 0.05$.

3.3. Hypothesis Tests

First, Maximum Likelihood (ML) regression was conducted to check if perceived cognitive effort is influenced by the presentation order of the tasks (the learning effect). The result shows that the order effect is not significant ($\beta = -0.012$, $p > 0.05$, see Table 4).

Table 4. Effects of task order, types of products, and arithmetic complexity on perceived mental effort.

Variables	β	Std.Err.	*p* Value	95% CI Upper	95% CI Lower
Intercept	3.899	0.334	<0.001	3.245	4.554
Order	−0.012	0.088	0.894	−0.183	0.16
Intercept	3.603	0.160	<0.001	3.289	3.917
Product (H1)	0.515	0.189	0.006 *	0.147	0.883
Goodness of fit	Chi2 = 59.33		<0.001		
Intercept	3.256	0.151	<0.001	2.960	3.552
Complexity (H2)	1.194	0.152	<0.001 **	0.896	1.492
Goodness of fit	Chi2 = 62.33		<0.001		

Dependent variable: perceived mental effort; β: regression coefficient; Std.Err.: standard error; * $p \leq 0.05$, ** $p \leq 0.001$; CI: confidence interval.

For hypothesis tests, we also performed ML regression analyses. The results presented in Table 4 show that the perceived mental effort is higher for experience products than for search products ($\beta = 0.515$, $p < 0.05$) and the more complex the task, the greater the perceived mental effort ($\beta = 1.194$, $p < 0.001$). Hypotheses 1 and 2 thus are supported.

We found a significant interaction between the arithmetic complexity and types of products ($\beta = -0.012$, $p < 0.001$). The impact of product type on perceived mental effort is more prominent in complex tasks than in simple tasks, as depicted in Figure 2. In other words, the difference in mental effort between experience products and search products is much greater in high complexity than in low complexity situations. The mental effort associated with experience products is greatest in high complexity tasks. Therefore, Hypothesis 3 is supported.

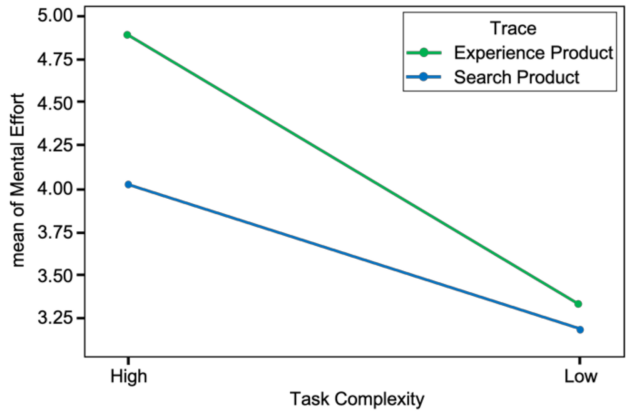

Figure 2. The effect of task complexity on perceived mental effort by product type.

We found that the more the consumers expended their mental effort, the less they were satisfied with their online experience ($\beta = -0.278$, $p < 0.05$, Table 5). The result confirms Hypothesis 4.

Table 5. Effect of perceived mental effort on satisfaction.

Variables	β	Std.Err.	*p* Value	95% CI Upper	95% CI Lower
Intercept	5.595	0.25	<0.001	5.106	6.085
Effort (H4)	−0.278	0.053	<0.001 **	−0.382	−0.173
Goodness of fit	Chi2 = 25.37		<0.001		

Dependent variable: perceived mental effort; β: regression coefficient; Std.Err.: standard error; ** $p \leq 0.001$; CI: confidence interval.

To test if cognitive absorption mediates the effect of perceived mental effort on satisfaction (H5), we followed the steps suggested by [57], which includes comparing the regression coefficients of three different models: 1-(independent variable) → mediator, 2-(independent variable) → dependent variable, and 3-(independent variable, mediator) → dependent variable. The mediation is established if 1-the first model is significant, 2-the independent variable impacts the mediator in the second model, 3-the mediator impacts the dependent variable in the third model, and 4-the effect of the independent variable on the dependent variable is less in the third model compared to the second model. Following these steps, first, satisfaction was regressed on effort. This is actually the test for H4. Second, CA was regressed on mental effort. Because CA has multiple dimensions, we performed regression for each dimension of CA. Time ($\beta = 0.113$, $p < 0.05$), immersion ($\beta = -0.146$, $p < 0.01$), pleasure ($\beta = -0.25$, $p < 0.01$), and control ($\beta = -0.209$, $p < 0.01$) dimensions are significantly related to mental effort (see Table 6).

Table 6. Effect of perceived cognitive effort on each cognitive absorption (CA) dimension.

	Time	Curiosity	Immersion	Pleasure	Control
β	0.113	−0.066	−0.146	−0.250	−0.209
p value	**0.027** *	0.362	**0.007** *	**0.001** *	**0.007** *
Chi2	3.87	1.44	6.95	11.49	23.97

Independent variable: perceived mental effort; β: regression coefficient; * significant effect.

Moreover, quadratic effects are observed for the pleasure ($\beta = 0.093$, $p < 0.05$) and control ($\beta = 0.095$, $p < 0.05$) dimensions as seen in Table 7. As mental effort increases, the feeling of enjoyment (pleasure) and certainty (control) decreases until the mental effort passes a certain threshold. The relationship is illustrated in Figure 3.

Table 7. Quadratic effect of perceived cognitive effort on each CA dimension.

	Time	Curiosity	Immersion	Pleasure	Control
β (x^2)	0.020	−0.020	0.027	0.093	0.095
p value	0.514	0.658	0.416	**0.038** *	**0.046** *
β (x)	−0.047	0.089	−0.357	−0.989	−0.959
p value	0.851	0.803	0.178	**0.007** *	**0.013** *
Chi2	5.32	1.94	7.55	11.49	27.91

Independent variable (x): perceived mental effort; β: regression coefficient; * significant effect.

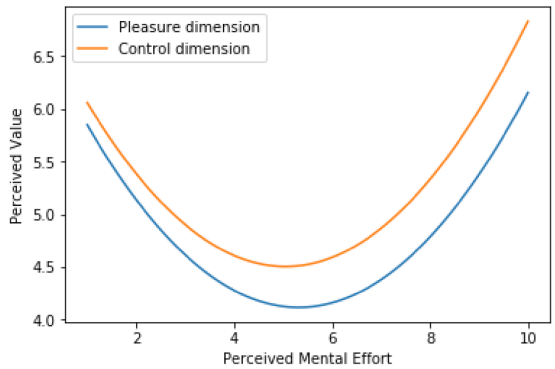

Figure 3. The relationships between mental effort and CA dimensions (pleasure and control).

Third, we regressed satisfaction on both CA and mental effort. As presented in Table 8, mental effort ($\beta = -0.119$, $p < 0.01$) and CA dimensions (curiosity $\beta = 0.199$, $p < 0.001$, pleasure $\beta = 0.389$, $p < 0.001$ and control $\beta = 0.13$, $p < 0.05$) are significantly associated with satisfaction. Time and immersion dimensions show no relationships with satisfaction. Additionally, the coefficient's absolute value of the mental effort in the presence of CA in Table 8 is smaller than the coefficient's absolute value of the mental effort in Table 5 ($0.119 < 0.278$). As a result, a partial mediating effect of CA is confirmed (H5): Cognitive absorption is a partial mediator in the relationship between perceived mental effort and satisfaction.

Table 8. Effect of mental effort and CA dimensions on satisfaction.

Variables	β	Std.Err.	*p* Value	95% CI Upper	95% CI Lower
Intercept	1.578	0.456	0.001	0.684	2.473
Effort	−0.119	0.044	0.007 *	−0.205	−0.032
Time	−0.04	0.067	0.55	−0.172	0.091
Curiosity	0.199	0.057	<0.001	0.088	0.31
Immersion	0.071	0.069	0.305	−0.064	0.205
Pleasure	0.389	0.065	<0.001 **	0.261	0.517
Control	0.13	0.059	0.027 *	0.015	0.246
Goodness of fit	Chi2 = 113.34		<0.001		

Dependent variable: e-satisfaction; β: re gression coefficient; Std.Err.: standard error; * $p \leq 0.05$, ** $p \leq 0.001$; CI: confidence interval.

Results are summarized in Table 9.

Table 9. Summary of results.

Hypothesis	Regression Test	Result
H1	Product type → Mental Effort	Supported
H2	Arithmetic complexity → Mental Effort	Supported
H3	Product types × Arithmetic complexity → Mental Effort	Supported
H4	Mental effort → Satisfaction	Supported
H5	Mental effort → CA dimensions Mental effort × CA dimensions → Satisfaction	Supported

4. Discussion and Conclusions

The main objective of this study was to investigate the impact of online grocery characteristics (product type and arithmetic task complexity) on mental effort and the influence of mental effort on satisfaction and consumers' cognitive absorption. The results indicate that product and arithmetic complexity influence perceived mental effort, which in turn, negatively influences satisfaction. This may explain in part why users are more reluctant to purchase unpackaged products online compared to packaged products. This is in line with previous research on product type and cognitive load. For instance, Mirhoseini and Léger [58] suggest that evaluating perishable products on a website is associated with uncertainty since consumers are unable to access the critical information related to the products' quality. They found that this uncertainty makes consumers exert high cognitive effort in search of other cues to infer product quality (Mirhoseini, Léger [58]).

Our study also finds that cognitive absorption partially mediates the relationship between perceived mental effort and satisfaction. The more effort is invested in the task, the less satisfied consumers are. However, if the devoted effort passes a certain threshold, consumer engagement (CA state) is likely to occur. This complements Debue and Van De Leemput [59]'s study that investigated the association between CA dimensions and different types of cognitive load. They found that germane load (i.e., the cognitive resources used by working memory to acquire and automate schemata in long-term memory) is associated with three CA dimensions that represent use motivation.

Our study makes two main contributions to the electronic commerce literature. First, it suggests a new understanding of the unique characteristics of online grocery shopping and explains why consumers are reluctance to purchase their groceries over the Internet. To our best knowledge, no study has yet shown the impact of arithmetic complexity and uncertainty associated with product type on perceived mental effort during online grocery shopping. Second, the study contributes to the work of Nelson [20] on experience and search products by showing that consumers' perceived mental effort is higher for

experience products than for search products in the online environment. The relationship between perceived mental effort and satisfaction is also confirmed in this work.

This study has implications for practitioners in the online grocery shopping domain. As companies try to gain a competitive advantage in the market through e-commerce, understanding user experience with online technology has become a critical issue. In the current study, we suggest that online grocery shoppers are mainly influenced by the arithmetic complexity and the uncertainty associated with the grocery products, especially experience goods. These features of online grocery impose a high level of mental effort which in turns reduces consumers' satisfaction with their online experience. The reported results imply that managers and e-commerce website designers should consider these characteristics of online grocery to develop appropriate strategies and measures for improving consumer satisfaction. More specifically, technology features can be implemented in online grocery websites to reduce consumers' mental effort and consequently increase their satisfaction with shopping experience. For instance, a simple tool which calculates the desired amount of each grocery item given the party size and what consumers already have at home can be useful for consumers.

As with any research endeavor, this research has limitations that need to be acknowledged. First, participants were mainly students between 20 and 30 years old with low average income. On average, this group spends less on grocery shopping than other consumer groups. Second, only one online grocery retailer's website was used. Participants had no control over which sites were use or which retailers to choose to shop from. Future research assessing the reasons behind their satisfaction or their perceived mental effort may provide more insights into the phenomenon.

For future studies, focus could be on identifying factors that help mitigate consumers' perceived mental effort such as website design or information load. It has been suggested that online photos can facilitate consumers' understanding of products and elicit positive attitude toward the online shopping experience [18]. The connection between mental effort, consumer satisfaction, and consumer spending on online grocery is also an interesting avenue for future research.

Author Contributions: All authors contributed equally towards conceptualization, study design, analysis, and writing-review. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by Natural Sciences and Engineering Research Council of Canada (NSERC).

Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Ethics Committee of HEC Montreal.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy concerns.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Measurement Scales.

Variables	Cronbach Alpha
Perceived mental effort	0.8
I invested a lot of mental effort in the task;	
The task required a high level of mental effort;	
The task required a lot of concentration;	

Table A1. *Cont.*

Variables	Cronbach Alpha
Perceived mental effort	0.8
The task did not require a high level of mental effort;	
I had to work mentally hard on the task.	
Scale: Likert 7 points (strongly disagree—strongly agree)	
Adapted from [33]	
E-satisfaction	0.86
By shopping products on the website, I felt surprised, amazed or astonished.	
By shopping products on the website, I sometimes felt angry, enraged or annoyed.	
The choice to shop for products on the website was a wise choice	
I think I made a bad choice in deciding to purchase products on the website.	
I am satisfied with my overall experience with the online grocery site.	
Overall, I am not satisfied with the online grocery site.	
Scale: Likert 7 points (strongly disagree—strongly agree).	
Adapted from [55,56].	
Cognitive absorption	
Temporal dissociation	0.67
Time passed very quickly when I was using the website.	
At times, I did not notice the time passing when I was surfing the website.	
I spent more time than expected to browse the website than I had thought.	
Immersion	0.71
When I used the website, I was able to focus on what needed to be done.	
When I interacted with the website, I was absorbed in the task at hand.	
When on the website, I did not get distracted easily from my task.	
Pleasure	0.86
The use of the website was nice.	
The use of the website made me happy.	
The use of the website bored me.	
Control	0.77
I felt I had complete control of how I used the website.	
I can use the various features of the website.	
Curiosity	0.82
Using the website evokes my interest.	
Interaction with the website made me curious about it.	
Interaction with the website made me curious (honest) about the information technology of this type in general.	
Scale: Likert 7 points (strongly disagree—Completely agree)	
Adapted from [38].	

Appendix B. Tasks

Low arithmetic complexity and search products
Recipe: Chocolate, almond and Chaï spice biscotti

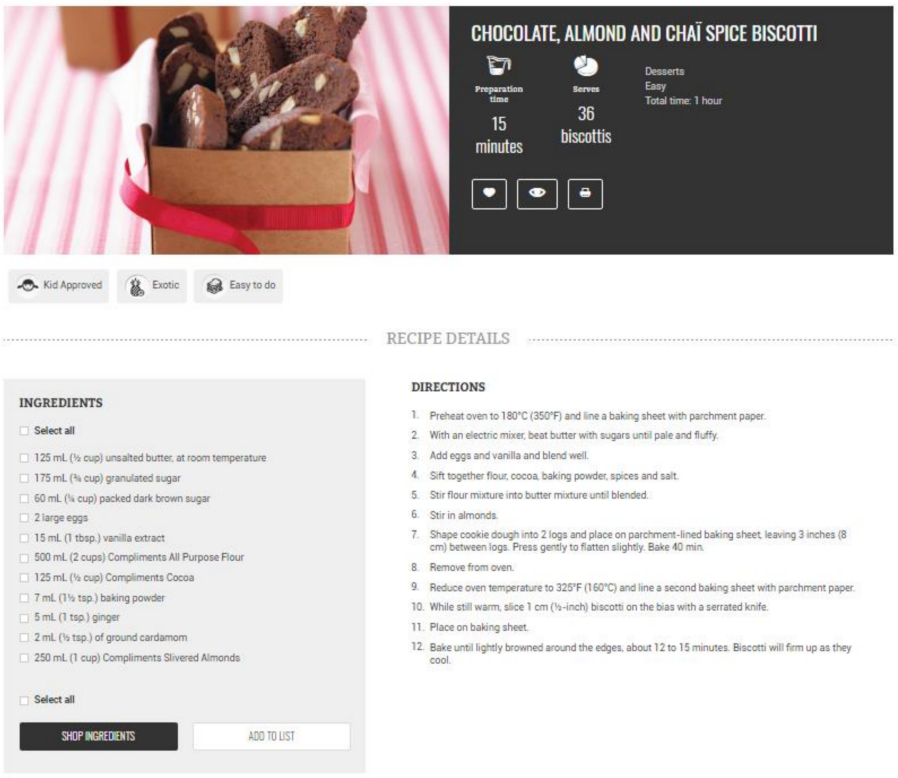

Figure A1. Recipe used for the condition with Low arithmetic complexity and search products.

Instruction: You need to buy ingredients for this recipe. Here are the ingredients you already have:

- Butter
- eggs
- Vanilla extract
- Ginger
- Cardamom
- Almonds

- Your order must be over $45.00 for free shipping.
- You have no budget limit.
- If you can not find the exact product, find products that are the most similar.

Low arithmetic complexity and experience products
Recipe: veal shoulder braised with fall vegetables (4 servings)

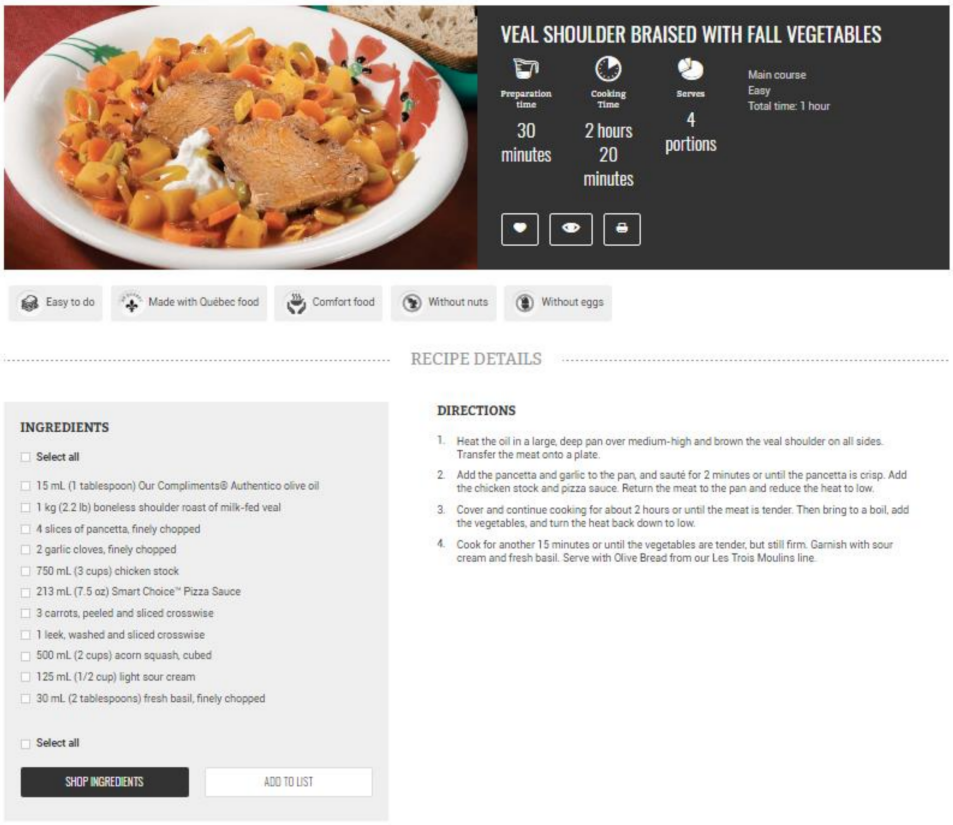

Figure A2. Recipe used for the condition with Low arithmetic complexity and experience products.

Instruction: You need to buy ingredients for this recipe. Here are the ingredients you already have:

- Olive oil
- Clove garlic
- Pizza Sauce
- Chicken broth
- Sour cream
- Pancetta

- Your order must be over $45.00 for free shipping.
- You have no budget limit.
- If you can not find the exact product, find products that are the most similar.

High arithmetic complexity and search products
Recipe: Sweet Potato Chocolate Chip Cookies (28 cookies)

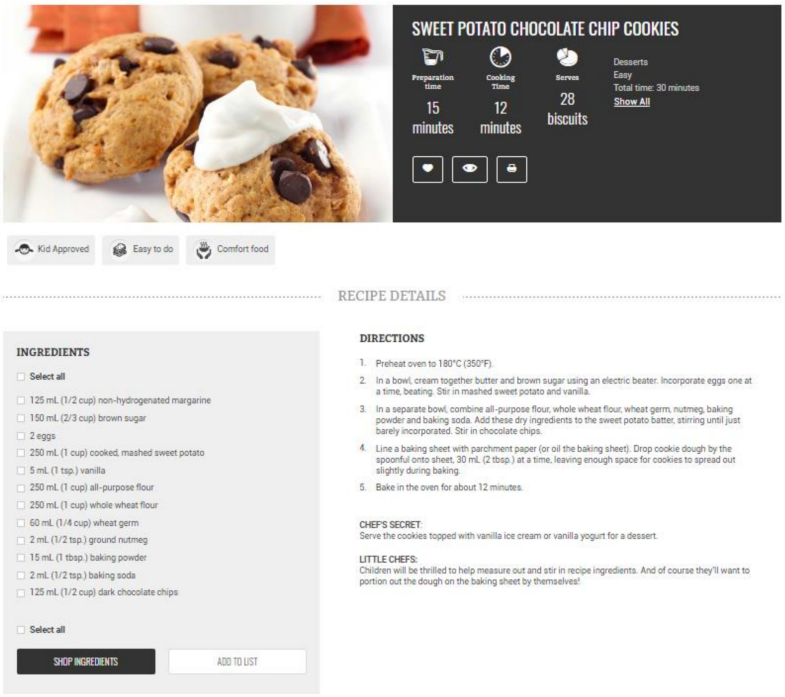

Figure A3. Recipe used for the condition with High arithmetic complexity and search products.

Instruction: You need to buy ingredients for this recipe to serve 20 people (assume that each consumes 7 cookies). Here are the ingredients you already have:

- 100 mL non-hydrogenated margarine
- 100 mL brown sugar
- Eggs
- Sweet potatoes
- Vanilla
- All purpose flour
- Whole wheat flour
- Baking soda
- Baking powder
- 250 mL dark chocolate chips

Note: 500 g = 250 mL, 1000 g = 1 kg

- Your order must be over $45.00 for free shipping.
- You have no budget limit.
- If you can not find the exact product, find products that are the most similar.

High arithmetic complexity and experience products
Recipe: Veal stew à la Québécoise (4 servings)

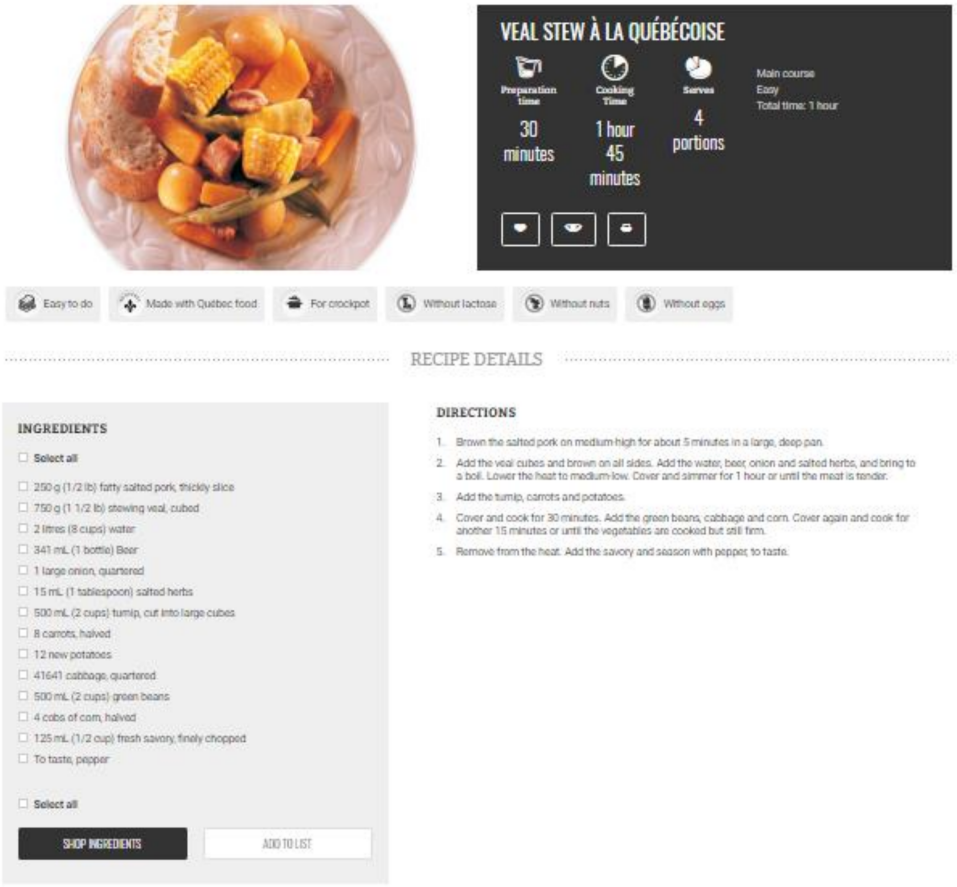

Figure A4. Recipe used for the condition with high arithmetic complexity and experience products.

Instruction: You need to buy enough ingredients for this recipe to serve 18 people instead of 4. Here are the ingredients you already have:

- 150 g of salt pork streaky
- Veal stew cubes
- Water
- Beer
- Onion
- salted herbs
- Turnip
- Green beans
- 5 carrots
- 15 bells potatoes
- Corncobs
- Pepper

Note: 500 g = 250 mL, 1000 g = 1 kg

- Your order must be over $45.00 for free shipping.
- You have no budget limit.
- If you can not find the exact product, find products that are the most similar.

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