



# Consumer reactions to technology in retail: choice uncertainty and reduced perceived control in decisions assisted by recommendation agents

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## Abstract

The emergence of artificial intelligence technologies, such as recommendation agents, presents new challenges and opportunities for marketing. Recommendation agents assist consumers in their online grocery shopping decisions by analyzing data on preferences and behaviors. This research highlights that while recommendation agents can reduce choice overload and make purchase decisions easier for consumers, they are also associated with higher uncertainty in decision-making. Three experimental studies confirmed that purchases aided by recommendation agents are perceived as more uncertain and reduced perceptions of control over the choices explain this outcome. Furthermore, lower choice satisfaction and purchase intentions are confirmed as consequences of perceived uncertainty. Personal characteristics such as risk aversion and maximization tendencies are considered boundary conditions for these effects.

**Keywords** Smart retailing · Artificial intelligence · Choice overload · Maximization tendencies · Risk perception

## 1 Introduction

Emerging technologies are changing the business landscape and presenting challenges for companies. They impact how businesses interact with consumers, provide new data types that enable advanced analytic methods, and drive marketing innovation [24]. In retailing situations, consumers frequently interact with new technologies involving artificial intelligence (AI) in traditional and online purchase contexts. Among the diverse AI possibilities are digital screens, chatbots, assistance robots,

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smart mirrors, virtual reality, augmented reality, and recommendation agents (RA) [40, 55, 56].

The focus of this research is on recommendation agents, also known as recommendation systems, which are AI-based software tools used in marketing to assist consumers in their decision process, suggesting products that may be of consumer interest based on data analysis of their personal preferences and behaviors [27]. For companies, this technology is important since it enables well-targeted retailer-to-consumer product recommendations and increases sales potential and consumer loyalty [20]. Consumers may benefit from RAs because they allow the personalization of the shopping journey and simplify decision-making, reducing search complexity and the feeling of information overload [42]. This may be especially helpful in purchases that involve a wide variety of products to choose from. Besides offering a large number of items, grocery shopping also relates to food products that are frequently purchased and do not require high levels of consumer involvement in the decision [1].

In addition to the relevance of technology itself, there is still much to be understood about how RAs influence consumer behavior and how consumers' perceptions and responses change when a purchase decision is made with RA assistance rather than making the choice on their own. Besides the positive impacts of interacting with technology in the shopping journey, individuals may also face negative outcomes. Literature on the adoption of new technologies suggests that consumers may experience discomfort and uncertainty which can be associated with perceptions of threat and emotions such as fear. This "dark side" of technology can be driven by changes caused by these new tools, such as a reduced perception of control over how technology works [2, 12, 27]. As a result, perceived uncertainty may decrease the likelihood of an individual relying on technology [30] or influence purchase intentions and satisfaction with the choice made [22, 45]. Considering these potential negative impacts, we are especially interested in understanding the uncertainty consumers may experience with the choice when the purchase process is assisted by technology, such as a recommendation agent.

This perceived uncertainty can be influenced by personal characteristics such as being more risk averse or having a profile that tries to maximize the results of all decisions. Research focusing on consumer characteristics is mainly dedicated to demographic aspects such as age and gender [23, 54, 57], cultural traces [38], psychological aspects [36], or even situational elements [6, 17]. However, we still do not know the influence that maximizing tendencies have on purchasing decisions where artificial intelligence narrows down the number of options available, rather than consumers analyzing the entire product portfolio by themselves. Maximizing consumers are those who seek the best possible option in their choices [47], and decision-making oriented by this kind of characteristic can be frustrating because it takes more time and is cognitively exhausting [34]. Similarly, for more risk-averse consumers, the decision assisted by RA may be seen as more prone to negative outcomes, especially due to the fear generated by a lack of knowledge of how the technology works [29]. One explanation would be the reduced perception of control over the choices the consumer may associate with autonomous technologies, such as recommendation systems [2].

Our research aims to improve academic and managerial understanding of the variables that influence how consumers perceive and react to technology such as recommendation agents. We are especially interested in consumers' perceptions of uncertainty with the choice as a result of using RA on e-commerce platforms. Previous research on online grocery shopping has already focused on segmentation [5], consumer experience [1], and satisfaction with technology such as chatbots [28]. Furthermore, some authors have tried to understand the role played by recommendation agents, but their focus remained only on consumer loyalty [20], without taking into consideration the potential negative effects that technology may have on consumer responses.

We add to the literature by comparing consumers' perceptions of uncertainty in purchasing decisions aided by recommendation agents *versus* decisions based only on consumer autonomy. We also investigate potential explanatory mechanisms for the impact of technology on perceptions of uncertainty with the choice, such as reduced perceptions of control over the choice made. Moreover, we shed some light on the impact that personal characteristics, such as being a risk-averse or a maximizer consumer, may have on perceptions of an experience involving RAs. Finally, we assess purchase intentions and choice satisfaction as possible outcomes of feeling uncertain about a decision influenced by RA.

## 2 Uncertainty in decision making

Perhaps one of the most important gains that AI and RA provide to consumers is the possibility of personalization [24]. This concept encompasses the processing of a person's information to provide a unique consumption experience, tailored according to individual preferences and interests. The level of personalization of the experience can influence consumer judgment and decision-making [20]. However, personalization can also elicit negative outcomes, such as privacy concerns or uncertainty [15].

Uncertainty can be viewed from different perspectives: uncertainty about what the true state of the world is, uncertainty about what is desirable in a given situation, uncertainty about what possibilities are available, or uncertainty about the consequences of one's actions [4, 45]. In this research, the focus is the uncertainty associated with the consequences of an individual's actions, specifically perceived uncertainty about the purchase choice made.

Considering the influence of technology in retail, more perceived uncertainty in a decision domain reduces the propensity of decision-makers to adopt the assistance of technology and algorithms. The reason is that with greater uncertainty the gap between human and algorithmic performance is typically smaller, and therefore the use of technology may become relatively less attractive to those who choose it [16].

Larger assortments, such as those found in online grocery shopping, usually offer a greater variety of options, thus increasing the likelihood of having a good fit between available choices and consumers' purchase goals. However, it may also reduce the motivation to make a choice due to the cognitive load generated by a large set of options [11] or restrict the consumer's attention and make it difficult to

process information on smaller screens, in the case of using smartphones for shopping online [25].

When making purchase decisions, consumers tend to seek more variety if they are assisted by AI agents rather than human frontline employees, especially in low-involvement purchases associated with grocery shopping [60]. However, larger sets of products increase choice complexity, which may be detrimental to consumer experience due to cognitive overload [10]. Decision-making assisted by AI addresses this issue by narrowing down the scope of options consumers consider; however, it may also increase consumer susceptibility to seller influence and increase the feeling of uncertainty about the choice [27]. Therefore, we suggest that:

**H1** The RA-assisted purchase decision will result in more perceptions of uncertainty with the choice than the decision made by the consumer alone (without RA assistance).

Perceptions of uncertainty in a situation may be associated with potential threats and a lack of personal control over the outcomes [19]. Perceived control is the belief that an individual can command and exert power over the outcome of a specific situation, and, among other things, it can influence the pleasure derived from an experience [14]. People desire control because it helps them see the world as organized and predictable, which means that greater perceived control can lead to more certainty [49].

In contexts involving persuasive technology, individuals may perceive differences in control, autonomy, and therefore potential risks [55]. The reason is that when assisted by technology during the purchase journey, consumers may perceive that the locus of control is external, meaning that the retailer or the machine has control over the process when usually people prefer the control to be internal. In other words, people generally prefer to be in control of their own choices and outcomes [40]. When there is an automated system that assists in decisions, such as a recommendation agent, consumers may feel a reduced perception of control over the choice, which in turn may increase uncertainty with the purchase made [2]. Hence, we suggest that:

**H2** The perceived control over the choice will mediate the relationship between the kind of choice (with x without RA assistance) and perceived uncertainty with the choice.

### 3 Maximization tendencies

Rational choice theory suggests that individuals make decisions to maximize their outcomes. Nonetheless, due to cognitive limitations in processing information, it is unlikely that humans can consider all options to make an optimal decision [48]. Thus, in choice situations, people usually aim to satisfy rather than maximize their outcomes [47]. However, there is a personal trait that can interfere

with the way individuals process information and make purchase decisions: maximization tendencies. According to this perspective, individuals could be classified as maximizers or satisficers. While maximizers try to assess all options and make the best possible choice given the circumstances, satisficers have a more subtle behavior, where they evaluate options until they find one that exceeds the acceptability threshold [34]. Therefore, satisficers are less prone to try to weigh all possible options and balance the pros and cons over a long period. When they find an option that meets their needs, they are likely to choose that option without giving much attention to the other possibilities.

Overall, maximizers have a greater dependence on others when making decisions, more avoidance of decision-making, and a greater tendency to feel that they could have made an even better choice. When making decisions, a maximizer will be willing to spend more time and energy evaluating options, while a satisficer, or an individual with less maximizing tendencies, will try to simplify the decision and trust their instincts. In other words, they will be more focused on the choice, which reduces the cognitive effort required when making the choice [9, 26].

Therefore, in a purchasing decision involving technology such as RA, we would expect that maximizers would rather use the technology instead of choosing by themselves because this increases their chances of making the optimal choice. In other words, they would not be concerned about aspects such as risk and uncertainty. Satisficers, on the other hand, may perceive more uncertainty because they are not so focused on optimizing the decision, but on making an easy decision with the resources they have available. Therefore, we suggest:

**H3** Maximization tendencies will moderate the relationship between the kind of decision (with  $x$  without RA assistance) and perceived uncertainty with choice.

## 4 Risk aversion

Risk aversion is the reduced willingness to engage in activities that are perceived as having negative outcomes [32]. Typically, risk-averse individuals try to avoid perceived threats or situations seen as risky [33]. Perceived threats trigger emotional reactions such as anxiety and increased vigilance, while reducing behavioral responses such as purchase intentions or technology adoption [3, 13].

Fearful individuals tend to perceive situations as threatening and therefore tend to avoid risks and prefer lower levels of uncertainty [29]. As many consumers do not know exactly how artificial intelligence works, especially recommendation agents, they may perceive decisions assisted by this technology as more threatening or risky [46]. Reduced perceptions of control and autonomy over the task may also increase perceptions of uncertainty regarding the decision being made [2]. In this sense, risk-averse consumers would associate an RA-assisted purchase choice as more uncertain due to potential negative outcomes. Thus, we develop the following hypothesis:

**H4** Risk aversion will moderate the relationship between the kind of decision (with x without RA assistance) and perceived uncertainty with the choice.

## 5 Studies

We ran three experiments with panel data from Prolific, all involving the purchase of a bottle of wine from an online grocery store (Appendix 2). Results from a pre-test with 109 respondents (49% male, Mage = 43 years old) showed that consumers perceive the purchase of this type of product as having a large variety of options and being moderately complex ( $M = 3.17$ ,  $SD = 1.56$ , 7-point Likert scale). Individuals also reported being familiar with the use of recommendation agents in grocery shopping ( $M = 5.15$ ,  $SD = 1.30$ ), which suggested that the purchase journey for a bottle of wine may be appropriate for analysis. Furthermore, the pretest allowed the verification of the manipulation, which will be described in the next session.

### 5.1 Study 1

#### 5.1.1 Procedures

We ran a randomized between-subjects experiment on Prolific, where participants received a small fee in exchange for their answers. We manipulated the independent variable “type of decision” to be assisted by AI *versus* no assistance in consumer choice.

In both conditions, respondents saw a scenario where they were buying wine online at their regular grocery store, with a display including 18 different options. The individuals in the condition without technology were instructed to consider the shopping experience with the products they would select from that list of options without the assistance of technology or a salesperson. Individuals in the technology condition read the following: “*This website has a recommendation system based on Artificial Intelligence (AI). In other words, the AI will analyze your previous behavior and recommend a set of 3 products that match your purchase habits, so you can choose from a set of 3 wines instead of analyzing all the products*”. It is important to point out that in both conditions the respondents only saw the image with the large product assortment.

#### 5.1.2 Measures

The manipulation was checked with one item (“Do you believe the wine choice would be based on...”) and respondents could choose on a Likert scale ranging from “your own analysis of the products” to “the analysis of the product assisted by AI”. Perceived uncertainty was measured with 3 items [10]. Maximizing tendencies were measured with 6 items [39] from a scale that is a shorter version of the original scale [41]. We also controlled for choice overload and assortment complexity [53, 58], respectively]. All items were measured on a 7-point Likert scale, ranging from

totally disagree to totally agree. We also assessed the frequency of online purchases influenced by recommendation agents and demographic questions, such as age and gender. Measurements are described in Appendix 1.

### 5.1.3 Results

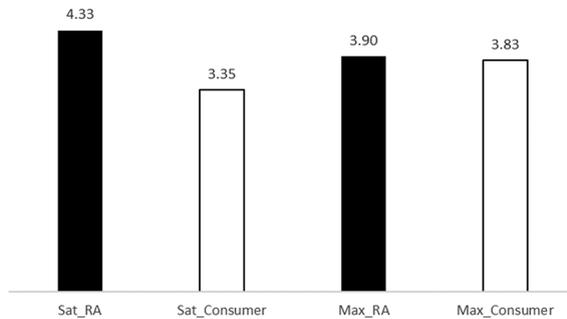
Two hundred and ten Prolific participants (50% male, Mage = 43 years old) took part in this study. Individuals perceived the purchase decision as moderate in complexity ( $M=3.30$ ,  $SD=1.56$ ) and were familiar with recommendation agents in e-commerce settings ( $M=5.18$ ,  $SD=1.22$ ). Manipulation check worked as expected ( $F(1, 209)=127.91$ ,  $p=0.001$ ), and subjects in the RA condition perceived that the decision was assisted by AI ( $M=5.08$ ,  $SD=1.79$ ), while those in the condition without technology reported that the decision was made by themselves ( $M=2.38$ ,  $SD=1.66$ ).

The main effect of the type of decision on perceived uncertainty with the choice was also significant ( $F(1, 208)=9.64$ ,  $p=0.002$ ); respondents assisted by a RA felt more uncertainty ( $M=4.12$ ,  $SD=1.36$ ) than those who decided without the assistance of technology ( $M=3.53$ ,  $SD=1.39$ ). This result confirms H1.

We used PROCESS model 1 [21] to test the moderating effect of maximizing tendencies on uncertainty associated with the kind of purchase decision. Since the moderator was measured with a Likert scale, we divided the respondents by the median, where lower levels were in the group of “satisficer consumers” and higher levels were considered “maximizer consumers”. The interaction was significant ( $b=-0.92$ ,  $t(204)=-2.38$ ,  $p=0.018$ ). However, when we analyze the conditional effect in the different moderator levels, the results are significant only for lower levels ( $b=0.99$ , CI 0.50–1.48), but not for higher levels of maximizing tendencies ( $b=0.07$ , CI  $-0.52$  to 0.66). This means that the satisficer consumers perceive more uncertainty when the decision is assisted by AI than when they choose by themselves (Fig. 1). However, for maximizers, there is no difference in perceptions of uncertainty with decision-making if it is assisted by technology or not. Therefore, H3 is also confirmed.

### 5.1.4 Discussion

The results confirmed that a consumer’s purchase decision is associated with lower perceived uncertainty than a decision assisted by a recommendation agent, even though the AI considers the consumer’s past behavior and purchase choices. Overall, consumers seem to perceive more uncertainty when making decisions with the influence of recommendation agents. However, there is an influence of a personality trait (maximization tendency) on this main effect. More perceived uncertainty holds for satisficers, but if the consumer is a maximizer, there is no difference in perceptions and reactions towards his/her own choice of products or the decision based on a set of products recommended by the AI. In other words, a satisficer may perceive RA assistance negatively, but maximizers perceive the influence of recommendation systems similarly to when they decide on their own. When using technology, previous research has suggested that maximizer consumers value utility over privacy [7],



**Fig. 1** Effect of moderation on perceived uncertainty with the choice—Study 1. Notes: (1) Sat\_RA—satisficer consumer in the decision with RA condition; Sat\_Consumer—satisficer consumer in the decision without RA condition; Max\_RA—maximizer consumer in the decision with RA condition; Max\_Consumer—maximized consumer in the decision without RA condition. (2) The differences in uncertainty levels are only significant for satisficer consumers (lower maximizing tendencies). For high maximizer consumers significance levels are  $p > 0.05$

which could help explain this effect. Since artificial intelligence increases the likelihood of choosing the best option, it seems that maximizers are willing to take risks that could potentially be associated with technology adoption.

In summary, Study 1 confirmed the impact of the type of decision on perceived uncertainty and the moderation effect of the maximization tendency. However, there were some uncontrollable factors: first, consumers may respond differently to the recommendation agent’s participation in wine selection, especially if the product is important to them and they perceive it as a high-involvement decision [16]. Second, some personality characteristics, such as the need for control and the need for autonomy may similarly alter participants’ reactions [2]. We, therefore, address these issues in Study 2.

## 5.2 Study 2

### 5.2.1 Procedures

The goal of Study 2 was to confirm the results of Study 1, but also to verify the role played by risk aversion. Therefore, the design and manipulation used were the same as in Study 1, with the inclusion of new measures. Respondents who usually purchase groceries online were recruited on Prolific for a small fee.

### 5.2.2 Measures

We included a measure of risk aversion [35] (“I do not feel comfortable about taking chances”). Other control measures were the need for privacy with 3 items [7], the need for autonomy with 1 item [31], and trust in technology with 1 item [12]. Furthermore, we did not intend the purchase context to be too low or too high in involvement since involvement levels are known to confound uncertainty perceptions

in decision-making [60]. Therefore, we measured the perceived importance of wine purchase (“How important do you perceive buying a bottle of wine to be?”) to rule out involvement levels as one of the explanatory mechanisms. All other variables were kept the same.

### 5.2.3 Results

One hundred and ninety-six participants (49% male,  $M_{age}=41$  years old) took part in Study 2. Individuals perceived the purchase decision as moderate in importance ( $M=3.41$ ,  $SD=1.73$ ), which suggests that it was not a high-involvement decision, and reported being familiar with RAs from previous e-commerce experiences ( $M=5.26$ ,  $SD=1.19$ ).

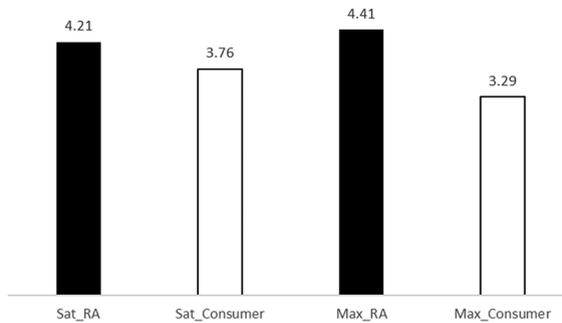
Manipulation check worked as expected ( $F(1, 194)=141.62$ ,  $p=0.001$ ) and subjects in the RA condition perceived that the decision was assisted by AI ( $M=5.50$ ,  $SD=1.60$ ), while those in the condition without technology reported that the decision was based on their assessment of products ( $M=2.60$ ,  $SD=1.80$ ). Regarding the potential covariates that we measured, there was no significant impact of trust on technology ( $p=0.481$ ), neither the need for privacy ( $p=0.066$ ) nor the need for autonomy ( $p=0.488$ ) on perceived uncertainty. Therefore, we did not consider these variables in data analysis.

We tested the main effect and H1 was again confirmed for higher levels of perceived uncertainty in the RA-assisted purchase ( $F(1, 194)=4.37$ ,  $p=0.038$ ;  $M=3.98$ ,  $SD=1.31$ ) compared to the decision without technology support ( $M=3.58$ ,  $SD=1.37$ ).

We used PROCESS model 2 [21] to test the double moderation of maximization tendencies and risk aversion (considering one standard deviation above for higher levels and one below for lower levels). Before running the test, we checked for a correlation between these constructs, which was small ( $r=0.107$ ). Considering risk aversion in the model, the interaction of maximization tendencies alone was not significant ( $b=-0.15$ ,  $t(190)=-0.40$ ,  $p=0.689$ ), whereas the interaction of risk aversion was significant ( $b=0.28$ ,  $t(190)=2.12$ ,  $p=0.035$ ). Moreover, when we analyze the conditional effects of the double moderation, the results are significant for both maximizers ( $b=0.68$ ,  $CI\ 0.01-1.36$ ) and satisficers ( $b=0.31$ ,  $CI\ 0.23-1.44$ ) at higher levels of risk aversion. However, for individuals with low-risk aversion, the effect was not significant for maximizers ( $b=-0.11$ ,  $CI\ -0.81\ to\ 0.59$ ) nor satisficers ( $b=0.05$ ,  $CI\ -0.55\ to\ 0.64$ ). This means that when we consider individuals with high levels of risk aversion as a personal characteristic, both maximizers and satisficers perceive higher levels of uncertainty in the decision assisted by recommendation agents than in a decision made by the individuals themselves (Fig. 2). This effect, however, does not hold for consumers who have lower traces of risk aversion. Therefore, H4 is confirmed.

### 5.2.4 Discussion

The results confirmed that a purchase decision made with the assistance of RA is considered more uncertain than when individuals make the choice based on their



**Fig. 2** Effect of moderation on perceived uncertainty with the choice (individuals with high levels of risk aversion)—Study 2. Notes: (1) Sat\_RA—satisficer consumer in the decision with RA condition; Sat\_Consumer—satisficer consumer in the decision without RA condition; Max\_RA—maximizer consumer in the decision with RA condition; Max\_Consumer—maximized consumer in the decision without RA condition. (2) Significance levels are  $p < 0.05$  in all groups

assessment, reinforcing the results found in Study 1. This main effect is stronger for consumers who are satisficers and have higher risk aversion traces, corroborating the double moderation of the maximization tendency and the perceived risk. Nonetheless, maximizers also perceive more uncertainty in online grocery purchases made with the help of a recommendation agent if compared to decisions made by themselves.

This is an intriguing result because usually maximizing tendencies are related to risk-taking behaviors to optimize the results. Recent research, however, has suggested that in some situations the connection between maximization and risk-taking is reduced and this can be explained, for instance, by the difference in expectations between the available options [43]. In other words, expectations between the outcomes from one's assessment of all available products could be different from the expected outcomes of a complex decision that is assisted by artificial intelligence. This gap could help explain why respondents who reported having maximizing tendencies but being individuals with risk aversion traces, also perceive the purchase assisted by RA as uncertain. Other potential variables that could help explain the effects of risk aversion could be loss aversion and mental accountability [44].

Despite these interesting results, so far boundary conditions are related to personal characteristics. We still lack a deeper understanding of the variables that explain why using technology may result in a negative outcome, such as a higher perception of uncertainty regarding the choice. Since technology is expected to have positive impacts on consumers, like reducing choice overload and decision complexity [42], it is necessary to understand what explains the increase in uncertainty. Literature suggests that users of autonomous systems based on artificial intelligence may have reduced perceptions of control over the choices and decisions made [30], which could help explain this increased perception of uncertainty [19]. Therefore, Study 3 will assess this potential explanatory mechanism.

So far, these findings also do not clarify whether perceived uncertainty offers positive or negative implications for consumers and companies adopting technology

on e-commerce platforms to improve the shopping experience. The potential outcomes of having more certainty about a choice are satisfaction with the decision and purchase intentions [22, 45]. Hence, to further deepen our understanding of the effect of perceived uncertainty on consumers' responses, we will assess satisfaction with decisions and purchase intentions in the next study.

### 5.3 Study 3

#### 5.3.1 Procedures

The goal of Study 3 was to verify other potential explanatory mechanisms, such as perceptions of control, and to assess the impact of perceived uncertainty on consumers' perceptions of satisfaction with their choices and intentions to purchase on the website.

#### 5.3.2 Measures

We included a 3-item measure of perceived control [14]. Satisfaction with the decision and purchase intention were measured with one item each [22]. We also added two control variables, a 3-item measure for choice difficulty [52], a 3-item for privacy concern [30], and a 3-item scale for trust [18]. All other variables were kept the same.

#### 5.3.3 Results

Two hundred and seven participants (50% male, Mage = 43 years old) from Prolific participated in the study. As in Studies 1 and 2, the screening of participants included English-speaking individuals, located in the United Kingdom, who purchase groceries online at least once a month. The control measures related to their habits and perceptions towards wine purchase were moderate on a 7-point Likert scale, considering aspects such as purchase frequency ( $M = 3.59$ ,  $SD = 2.06$ ), importance ( $M = 3.04$ ,  $SD = 1.86$ ) and pleasure associated with this task ( $M = 3.90$ ,  $SD = 1.85$ ). Respondents also did not consider themselves wine experts ( $M = 2.06$ ,  $SD = 1.39$ ) and there was no difference in these variables considering the two groups.

There was a relevant impact of technology usage on respondents' privacy concerns ( $F(1, 205) = 7.83$ ,  $p = 0.006$ ), with a higher level of concerns reported by respondents in the RA condition ( $M = 4.32$ ,  $SD = 1.73$ ) than in the no-technology situation ( $M = 3.66$ ,  $SD = 1.65$ ). There was no difference in perceptions of choice complexity between groups ( $p = 0.688$ ), nor trust levels ( $p = 0.865$ ).

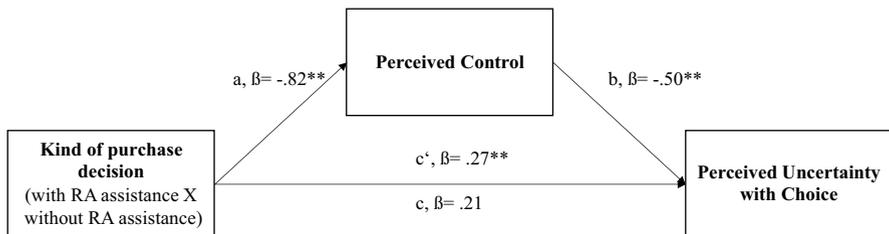
The manipulation worked as expected ( $F(1, 205) = 99.60$ ,  $p = 0.001$ ) and subjects in the RA condition perceived that the decision was assisted by AI ( $M = 5.18$ ,  $SD = 1.84$ ). In contrast, those in the condition without technology reported that the decision was based on their assessment of products ( $M = 2.65$ ,  $SD = 1.81$ ). We tested the main effect and H1 was again supported for higher levels of perceived uncertainty in the RA-assisted purchase ( $F(1, 205) = 9.15$ ,  $p = 0.003$ ;  $M = 4.27$ ,  $SD = 1.53$ )

compared to the decision without technology support ( $M=3.65$ ,  $SD=1.40$ ). When we control for privacy concerns as a covariate, the results were not significantly different ( $F(1, 205)=5.24$ ,  $p=0.023$ ).

We used PROCESS model 4 [21] to check for mediation effects, considering 5000 bootstrap samples. There is a significant effect of the kind of choice on perceived control ( $b=-0.82$ ,  $t=-4.64$ ,  $p=0.001$ ), with subjects in the technology-assisted purchasing condition perceiving less control ( $M=4.06$ ,  $SD=1.41$ ) than individuals in the scenario without technology assistance ( $M=4.88$ ,  $SD=1.10$ ). Furthermore, there is a significant negative effect of perceived control on uncertainty ( $b=-0.50$ ,  $t=-6.88$ ,  $p=0.001$ ). Interestingly, when we consider perceived control as a mediator, the direct effect of the kind of choice on perceived uncertainty is no longer significant ( $b=0.21$ ,  $t=1.07$ ,  $p=0.288$ ) and the impact on uncertainty related to the purchase choice is explained by the indirect effect of perceived control ( $b=0.27$ ,  $CI 0.14-0.44$ ), confirming a full mediation (Fig. 3) and supporting H2.

Furthermore, we again verified the moderation of maximization tendencies and risk aversion (model 2), and the results confirmed previous findings from Study 2. Considering risk aversion in the model, the interaction of maximization tendencies alone was not significant ( $b=-0.55$ ,  $t=-1.33$ ,  $p=0.184$ ), whereas the interaction of risk aversion was significant ( $b=0.79$ ,  $t=1.92$ ,  $p=0.055$ ). Moreover, when we analyze the conditional effects of double moderation, the results are significant for both maximizers ( $b=0.70$ ,  $CI 0.02-1.38$ ) and satisficers ( $b=1.25$ ,  $CI 0.51-1.98$ ) at higher levels of risk aversion. However, for individuals with low-risk aversion, the effect was not significant for maximizers ( $b=-0.09$ ,  $CI -0.84$  to  $0.65$ ) nor satisficers ( $b=0.45$ ,  $CI -0.19$  to  $1.10$ ).

Additionally, we assessed the potential outcomes of having more uncertainty associated with purchase choices assisted by recommendation agents. For this purpose, we measured satisfaction with the choice and intentions to purchase from the website that uses RAs. A double mediation analysis (model 6) with kind of choice as the independent variable (IV), perceived control and perceived uncertainty as mediators, and choice satisfaction as the dependent variable (DV) confirmed the main effect of kind of choice on satisfaction ( $b=-0.41$ ,  $t=-2.40$ ,  $p=0.017$ ). Moreover, the impact of the kind of choice on perceived control was significant ( $b=-0.50$ ,  $t=-6.88$ ,  $p=0.001$ ), as was the influence of perceived uncertainty in



Note:  $** = p < .001$

**Fig. 3** Mediation of perceived control.  $**p < 0.001$

choice satisfaction ( $b = -0.29$ ,  $t = -6.58$ ,  $p = 0.001$ ), with individuals with more perceived uncertainty reporting more satisfaction ( $M = 6.00$ ,  $SD = 0.93$ ) compared to individuals with higher levels of perceived uncertainty regarding the choice ( $M = 2.38$ ,  $SD = 1.30$ ). Considering an indirect path through perceived control and uncertainty, the impact of the kind of choice on satisfaction with the choice is significant ( $b = -0.09$ ,  $CI -0.17$  to  $-0.04$ ) and the direct effect of IV on DV confirms a full mediation ( $b = 0.19$ ,  $t = 1.59$ ,  $p = 0.114$ ). The results were not different when we controlled for privacy concerns.

When we consider a mediation analysis with purchase intentions as the dependent variable, the effect is similar to the mediation effects on choice satisfaction. In addition to the significant effect of kind of choice on perceived control, which influences uncertainty, there is also a significant effect of perceived uncertainty on purchase intentions ( $b = -0.21$ ,  $t = -3.27$ ,  $p = 0.001$ ). In the same way that there is a significant direct effect of the kind of choice in purchase intentions ( $b = 0.61$ ,  $t = 3.37$ ,  $p = 0.001$ ), there is an indirect effect considering perceived control and uncertainty as mediators ( $b = -0.06$ ,  $CI -0.11$  to  $-0.02$ ), with individuals with less perceived uncertainty reporting more purchase intentions ( $M = 5.00$ ,  $SD = 1.51$ ) than those respondents with more perceptions of uncertainty ( $M = 3.00$ ,  $SD = 1.85$ ). Therefore, there is a partial mediation.

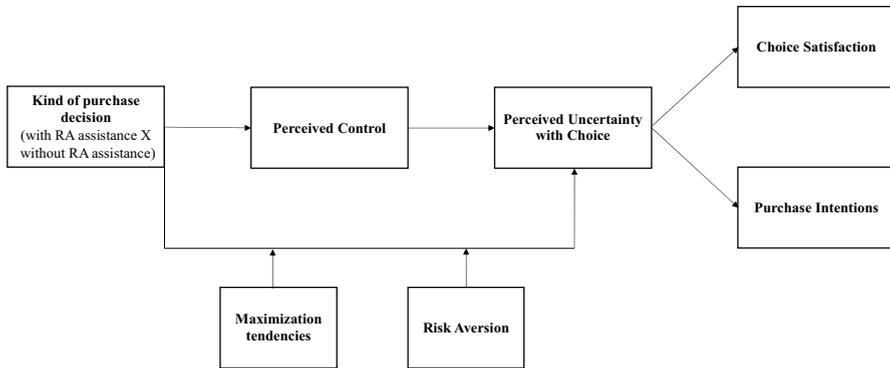
### 5.3.4 Discussion

The results of this study confirmed not only that purchase decisions aided by technology, such as recommendation agents, result in more uncertainty regarding the choice but also evidenced that perceived control is the mechanism that explains the increase in uncertainty. Furthermore, when we consider individuals with high levels of risk aversion as a personal characteristic, both maximizers and satisficers perceive more uncertainty in decisions involving RAs than in a decision made by individuals without the assistance of technology. This effect, however, does not hold when we consider low-risk aversion consumers.

Moreover, Study 3 also sheds some light on understanding if uncertainty triggered by technology is a good or a bad thing for consumers and companies. Research findings suggest that more perceived uncertainty results in lower levels of satisfaction with the choice and reduced purchase intentions, which is consistent with the literature on choice certainty and its outcomes [22, 45]. To the best of the authors' knowledge, this effect has not been previously considered as a result of the use of technology in the consumer purchase journey.

## 6 Conclusion

Recently, there has been increased interest in understanding how recommendation agents influence shopping experiences [56], consumer risk perceptions [46], technology adoption intentions [50], and loyalty to online grocery retailers [20]. However, no research has compared consumer perceptions and reactions related to



**Fig. 4** Variables and relationships confirmed in the three experimental studies

purchase decisions made with the assistance of recommendation agents and without any technological support.

Feelings of increased uncertainty and low choice confidence are likely whenever consumers feel overloaded [22]. Intuitively, we would expect that tools designed to reduce cognitive effort and overload perceptions when choosing from a larger or more complex set of items would reduce uncertainty. Nonetheless, this research evidenced a counterintuitive effect, which is the technology increasing the perceived uncertainty regarding the choice when assisted by an RA. Furthermore, personal characteristics play a role in these outcomes, namely the levels of maximizing tendencies and risk aversion. Moreover, this research has shown that perceptions of uncertainty associated with technology may have negative effects on consumers by reducing satisfaction with choice and purchase intentions. Figure 4 summarizes the relationships confirmed by the three experimental studies.

## 6.1 Theoretical contributions

This research adds to the literature in three ways. First, we contribute to the comprehension of consumer perceptions when their online purchase choices are assisted by artificial intelligence, specifically recommendation agents. Previous research has suggested that in grocery purchases, the perceived cognitive effort, and the level of involvement that consumers associate with the purchase decision influence how individuals respond to artificial intelligence or product recommendations [20, 60]. By developing research that compares consumers' perceptions and reactions to choices made based solely on their judgment of available products to decisions assisted by an AI tool, which among other benefits can reduce the cognitive effort made by consumers when grocery shopping, we add to the knowledge about the implications of using technology in online grocery shopping.

It is important to better understand the influence that risks associated with algorithms and autonomous technologies have on consumer behavior [2, 16]. We bring a new perspective on the negative effects of RA in eliciting uncertainty perceptions

in decisions with potential choice overload. To the best of our knowledge, this is the first research to focus on perceptions of uncertainty stimulated by the use of RAs.

Second, our study provides valuable information about the influence of individual characteristics on consumers' perception of technology within the context of the retail shopping journey. In response to the proposition of previous research [2], we address the imperative to deepen our understanding of the role that variables such as maximizing tendencies play in shaping consumers' intentions to adopt technology and their perceptions regarding purchase decisions, which can be influenced entirely or partially autonomously by a recommendation system. By delving deeper into the analysis of satisficer consumers, we discovered the heightened sense of what may arise from this human-technology interaction. This serves to clarify that, despite the intent to enhance the consumer experience, certain technological interventions may inadvertently evoke adverse user reactions. This notion is particularly salient given the users' persistent pursuit of optimizing their choices.

Furthermore, our study sheds some light on the nuanced impact of personal characteristics, such as risk aversion, on perceptions concerning experiences involving recommendation agents. Notably, risk-averse individuals appear to exhibit a more intense perception of uncertainty in their purchase decision-making process, despite their inherent maximizing inclinations. Although prior literature has briefly addressed the subject of risk perception about recommendation agents [46], our research considers risk aversion as an intrinsic individual trait, recognizing its potential variability across subjects within a broader population.

Third, this investigation focuses on delineating the technological ramifications inherent in shaping decisions in online grocery shopping and extant literature has laid the foundation for this domain [17]. Given the propensity of recommendation agents to be perceived as autonomous decision aids [2], and sometimes a mystery to users concerning their operational rationale and recommendation criteria [46], these findings yield interesting insights. The literature contemplates the far-reaching repercussions of consumers entrusting part of their experiential journey to artificial intelligence [42]. This research confirmed that the increased uncertainty perception is explained by reduced perceived control in the sense of agency vis-à-vis the decision-making process. Consequently, the perceived relinquishment of decisional control may raise concerns surrounding data privacy and evoke perceptions of technology-related threats [37], potentially increasing the dichotomy of uncertainty and confidence inherent in the decision-making process. To offer a seamless online purchase experience, in which consumers maintain perceptions of control over their choices without succumbing to the dangers of choice overload, emerges as a plausible solution to this puzzle.

## 6.2 Managerial contributions

This research also provides valuable insights for retail managers concerning the nuanced conditions under which recommendation agents may induce heightened uncertainty perceptions rather than be perceived favorably. In this realm, companies have the opportunity to nurture customers' distinctiveness by orchestrating AI

interactions that give users a semblance of control over the process. This strategic approach aligns with the observation that individuals tend to embrace technology more readily and are more prone to adopt loyal behaviors when the experience is personalized, fostering a sense of ownership [8, 20].

The empirical findings confirmed the notion that individuals characterized by risk aversion manifest a higher perception of uncertainty when engaging in purchase decisions assisted by RAs. Notably, these individuals exhibit a propensity to avoid situations perceived as threatening or risky [33]. Therefore, the implications of this finding may extend beyond the immediate context, potentially influencing several behaviors. For instance, such individuals might opt for alternative online grocery retailers without recommendation agents, thereby circumventing the uncertainty that may permeate their shopping journey. Another option would be to choose a traditional touchpoint to interact with the grocery retailer on a channel that is familiar and does not trigger risk and uncertainty perceptions. This rationale enhances the relevance of retailers offering an omnichannel experience even for purchases that do not have high involvement a priori. E-commerce and online shopping platforms are a reality for brands operating in B2C markets, such as grocery purchases; nonetheless, some customers may prefer to use brick-and-mortar channels for the sake of perceived control and risk management.

Since companies have limited agency to deal with consumers' personal characteristics, one potential course of action would be to focus on aspects that companies can influence and change. Recent research suggests that context-related elements, such as retailer trustworthiness, mitigate perceived risk when consumers use autonomous retailing technology [51]. Brand actions focused on conveying a trustworthy image, such as being transparent and open, and demonstrating organizational privacy ethical care could reduce risk perception. These brand strategies would not influence risk aversion as a personality trait, nonetheless, they could work as a buffer for the negative impact that personal characteristics have on the perception of uncertainty and choice satisfaction related to smart retailing technologies.

As companies navigate the intricate landscape of the omnichannel retail environment and contemplate integrating multiple technologies into the shopping journey, privacy-related challenges arise [15]. Striking a delicate balance between enhancing the consumer's online grocery experience to evoke positive responses, such as purchase intent and loyalty, while simultaneously mitigating the levels of risk and uncertainty perceptions, emerges as an important consideration for companies [1]. These conflicting goals require strategies to not only generate a feeling of trust but also alleviate possible resistance among consumers.

### 6.3 Limitations and future research

Recent academic research has shown a noteworthy phenomenon: the difficulty inherent in making purchase decisions can engender a positive influence on the confidence associated with the choice and the subsequent satisfaction [41]. Considering these empirical findings, it becomes imperative for managers to gain insights into strategies that companies can deploy to enrich the consumer

experience, thereby improving cognitive effort while concurrently bolstering consumers' confidence levels. In this context, future research efforts should investigate potential mechanisms capable of mitigating the adverse repercussions often associated with artificial intelligence assistance in the context of online grocery purchases. For instance, this research did not assess perceived technology autonomy, nor algorithm aversion, which could also influence how individuals respond to technology suggestions. Hence, future studies could also consider these variables as potential explanatory mechanisms for the impact on perceived uncertainty. Furthermore, we did not consider perceptions of uncertainty at different moments of the purchase journey (e.g., pre-purchase and post-purchase uncertainty), which could elicit different consumer feelings and responses.

Additionally, it is prudent to recognize the plausibility of these findings being contingent upon the specific channel in question [37]. Thus, there is an avenue for further investigations that delve into online shopping experiences that transcend the boundaries of conventional websites, such as app-based online grocery shopping. Such research efforts could potentially yield insights regarding the intricate dynamics of consumer-technology interaction across multiple touchpoints in the omnichannel journey. Future research could also investigate the impact of RAs on different grocery choices, as we have products with different levels of involvement and purchase frequency in this context. Furthermore, settings beyond the grocery shopping context (i.e., RAs for video and music streaming platforms, clothing, books, and accommodation websites) could be explored in future studies.

This research considered data collected using an online panel with a limited sample size. Furthermore, the experimental manipulation was based on written scenarios and perceptions were self-reported by respondents. Ideally, future research would include a behavioral outcome to show how the effect of RAs impacts actual purchase behavior in consumption and retailing contexts. This would increase external validity and generalizability, especially considering the managerial application of these findings. Furthermore, other dependent variables could be assessed, such as consumer recommendations or word-of-mouth intentions.

Moreover, the intriguing results regarding the impact of risk aversion on the behavior of consumers with maximizing tendencies could also be further investigated. Potential mechanisms for the increase in uncertainty perceptions not only for satisficers (who are by definition less prone to take chances and assume risk) but also for maximizers, need to be elucidated. Literature on decision-making and economics suggests paths, such as loss aversion, mental accountability [44], and expectation gap [43]. Future research could also manipulate these moderators, therefore increasing the external validity of these findings.

Finally, an intriguing avenue for further exploration entails longitudinal studies that track these effects over an extended period. This investigative trajectory promises to unravel whether an adaptation effect gradually unfolds with prolonged exposure to the technology [59], or whether perceived uncertainty remains an enduring hallmark of decisions facilitated by AI assistance.

## Appendix 1: Measurements and scales

Variable	Items	Source
Perceived uncertainty with choice	I have a sense of uncertainty in this purchase	[10]
	I think there is a lot of uncertainty about this purchase choice	
	I am not sure this choice could meet my expectation	
Perceived control	I felt in control of the purchase decision	[14]
	The technology used by this grocery store lets me be in charge of my purchase decisions	
	The technology used by this grocery store gives me more control over the process	
Satisfaction	I would feel satisfied about this purchase decision	[22]
Purchase intentions	I would likely purchase wine from this website	
Maximizing tendencies	When I am in the car listening to the radio, I often check other stations to see if something better is playing, even if I'm relatively satisfied with what I'm listening to	[39]
	No matter how satisfied I am with my job, it's only right for me to be on the lookout for better opportunities	
	I often find it difficult to shop for a gift for a friend	
	Choosing movies to watch is really difficult. I'm always struggling to pick the best one	
	No matter what I do, I have the highest standards for myself	
Risk aversion	I never settle for second best	[35]
	Compared to others, I find it more important to keep personal information to myself	
	It would be risky to provide my personal information to this Website	
Privacy concerns	I do not feel comfortable about taking chances	[30]
	I would be concerned that too much personal information is collected when I use this website	
	I would have doubts about how well my privacy is protected when I use AI	
Need for privacy	I would be concerned with the security of sensitive information when I use AI	[58]
	Compared to others, I am more sensitive when it comes to handling my data	
	I prefer that other people don't know my personal data	
Trust	Compared to others, I find it more important to keep personal information to myself	[18]
	I felt like the website has my best interest at heart	
	I believe this website provides accurate information	
Need for autonomy	I felt I could rely on this store's suggestion of products	[31]
	I would like to be free and independent right now	
Choice overload	I had too many options to choose from	[58]
Choice complexity	This assortment of wine would be too complex to choose from	[53]

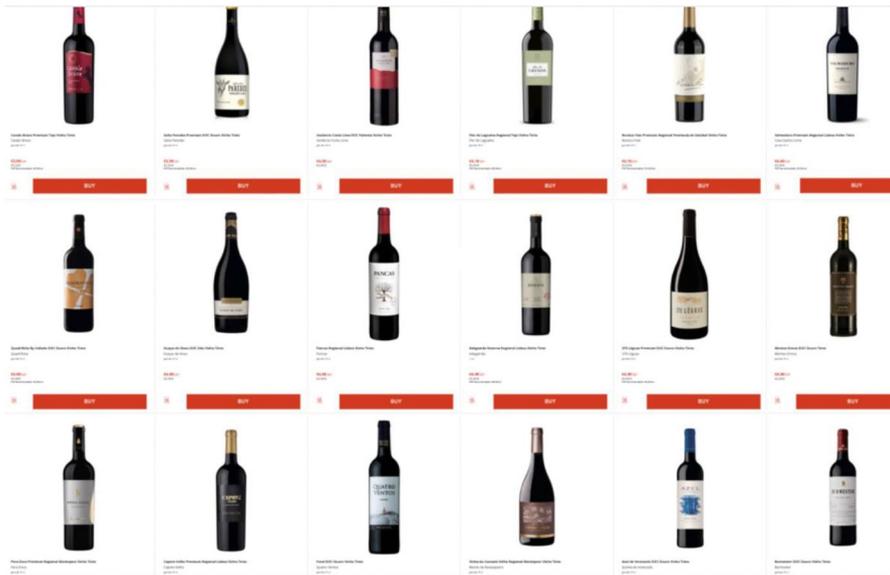
Variable	Items	Source
Choice difficulty	How much do you perceive this choice to be difficult/frustrating/tiring	[52]

## Appendix 2: Manipulation of the kind of purchase decision

### All scenarios

Imagine that you are purchasing groceries online and you usually purchase wine.

You can choose the product you want from a list of several wine options the website shows you. This is an example of the merchandise:



For each option, you will have information about the winery, the grapes, the year of production, and the price, among other details.

### With RA assistance

However, this website has a recommendation system based on Artificial Intelligence (AI). In other words, the AI will analyse your previous behaviour and recommend a set of 3 products that match your purchase habits, so you can choose from a set of 3 wines instead of analysing all the products.

Please answer the following questions considering your shopping experience with the products recommended by this artificial intelligence.

## Without RA assistance

Please answer the following questions considering your shopping experience with the products you would select from this list, without the assistance of technology or a salesperson.

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