A CHOICE-EXPERIMENT BASED ANALYSIS OF PROTECTION MOTIVATION THEORY: HEALTH RELATED BEHAVIOR OF CONSUMERS WITH CELIAC DISEASE

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Abstract

The underlying components of protection motivation theory (PMT; Rogers 1983) are explored through choice experiment-based analysis within a random utility framework, to account for some of the motivational, cognitive, and affective processes that likely affect celiacs' propensity to use a novel health-risk reducing product. Those four groups of variables that are aimed to capture threat appraisal and coping appraisal processes as part of the standard PMT (Rogers 1975, 1983; Floyd et al. 2000) are found to contribute significantly to explaining the adaptive response of celiacs. Self-assessed vulnerability and perceived product efficacy form a most significant part of respondents' threat appraisal process. Standard socio-demographic and lifestyle characteristics were found less useful in explaining the propensity to choose an adaptive response. Estimation results support an extended PMT model that accounts for risk attitudes, as measured by the psychometric scales of Weber et al. (2002), and outcome confidence (Zakay and Tsal 1993), since perceived ambiguity regarding the effectiveness of the novel health-risk reducing device affects consumers' outcome confidence. Results provide some support for loss aversion (Kahneman and Tversky 1991), but no support for the competence hypothesis of Heath and Tversky (1991).

Keywords: Celiac disease, protection motivation theory, choice experiments, confidence, risk perceptions, vulnerability, efficacy

JEL code: D03, D12,

1. Introduction

Celiac disease (CD) is an autoimmune disease that occurs in genetically predisposed individuals, due to an autoimmune response to gluten that causes progressive damage of the villi of the small intestine. Celiac disease affects about up to 1% of the western population (Fasano et al 2003; Green et al. 2008). There is no cure to this disease, but it can be effectively controlled for and mitigated by a strict compliance with a gluten free diet (GFD). However, complete adherence to a GFD can be difficult, since gluten is a common ingredient in many foods (Thompson 2000). Despite great caution of many celiacs, accidental gluten intake is not uncommon due to cross-contamination in food preparation (e.g. restaurants) or due to hidden sources of gluten in packaged foods. For this paper, we assume that the health threat from accidental gluten intake as well as the uncertainty behind labelled food products that they may or may not contain a threshold level of residual gluten which triggers pain upon consumption, are of key importance for celiacs' decision-making process when purchasing foods. We are interested in consumers' coping response to the potential health threat, in particular, in exploring to what extent consumers' decision-making process is impacted by a third factor, the availability of a novel gluten binding product (NGBP) by a University-based spin-off company in the marketplace. When the NGBP is taken before or right after a meal that is suspected to be contaminated with gluten, it binds with ingested gluten in the intestine and prevents it from trigging the immune response, or reduces the severity of reaction.

Made with eggyolk as carrier substance, the product is claimed to have very little side effects as they may occur due to the increase in consumers' cholesterol level, if a significant amount of NGBP doses are used on a daily basis (the product is currently undergoing Health Canada's approval). This information was conveyed to consumers through a questionnaire. More specifically, in order to explore consumers' decision-making processes when they encounter potential health threats due to accidental gluten intake, and to analyze the impact of this NGBP as it may affect consumers' effective coping response, we conducted a choice experiment as part of a survey in 2009. The survey consists also of a number of rating and ranking questions, so that information on (i) socio-demographic and lifestyle characteristics, (ii) general risk attitudes (iii), perceived confidence into consumers' ability to make an informed choice, (iv) perceived confidence into consumers' product choices in terms of outcome with regard to health impact, can be captured.

This survey approach has two consequences. First, we are able to control for *outcome confidence* (Zakay and Tsal 1993), in terms of confidence in the health outcomes being positive for the decision maker. Second, and considering the choice experiment, we assume that the health threat from accidental gluten intake is of key importance for celiacs' decision-making process when purchasing NGBP, i.e. we assume that consumers' protection motivation stems from the severity of and vulnerability to the possible health consequences that may occur due to accidental gluten intake from not consuming the NGBP, and from not strictly adhering to a gluten free diet. Therefore, since our analysis focuses on risk perceptions in terms of the perceived susceptibility to a health threat, and since we provide health risk information, our analysis aims to test elements from the Health Belief Model (HBM) of Rosenstock (1977) (we account for health risk as a result of cholesterol intake versus risk of accidental gluten intake), the Theory of Self-Regulation (Carver and Scheier, 1981) and the Protection Motivation Theory (Rogers, 1975; Maddux and Rogers, 1983).

The PMT is based upon two processes which attempt to match the cognitive processes that people use to evaluate threats [the threat-appraisal process] and to select among coping alternatives [the coping-appraisal process] (Rogers, 1975; Floyd, Prentice-Dunn and Rogers, 2000). In this paper, we assume that the threat appraisal process is a function of consumers' knowledge with regard to adaptive behavioural options, knowledge with regard to food labelling (ppm contents of gluten in labelled food products, and ppm gluten levels as they trigger an immune response in an individual), perceived vulnerability (which is assumed a function of consumers' current health state and lifestyle choices) and outcome confidence (Zakay and Tsal 1993) with regard to the likely health outcome of non-protection. This coping appraisal process is assumed to be driven by consumers' assessment of response costs and benefits (similar to the HBM), consumers' belief that health risk prevention will be effective (response efficacy) and consumers' self-assessment of their ability to cope with health risk through initiating and completing adaptive mitigation behaviour (self-efficacy). However, although the PMT assumes that the actions underlying these processes occur simultaneously, protection motivation is inherently a latent construct. In particular, our cross-sectional (survey) approach into studying consumers' cognitive processes for evaluating health threats and choosing coping options, relies on the assumption that health risk behaviour can be sufficiently explained by behavioural intentions (Ajzen, 1988).

To emphasize, a primary difference between the HBM and PMT is the way in which the two are organized (Prentice-Dunn and Rogers, 1986; Floyd et al., 2000). The HBM is organized as a

catalogue of variables contributing to behavior. PMT is organized along two processes that attempt to match the cognitive processes. Whereas HBM assumes that individuals are rational decision makers, PMT does not assume that individuals are rational (Floyd et al., 2000); indeed, the theory is derived from Kahneman and Tversky's (1991) prospect theory.

Considering that the focus of our analysis is on vulnerability and severity as they affect consumers' threat-appraisal processes, the analysis is also closely related to work on the severity of the consequences of food hazards. Slovic and Lichtenstein (1968) have established that the severity of the consequences of hazards is important to consumers in assessing food risks. The severity of the consequences of encountering hazards has also been found to importantly impact consumer risk perceptions (Slovic, 1987) and influence choice probabilities (Yeung and Morris, 2001).

Although PMT has been applied largely to non-food health-related behaviour, there is a large literature that encompasses applications to food and non-food hazards (Wolf, Gregory and Stephan, 1986; Milne, Sheeran and Orbell, 2000; Floyd et al., 2000).

Our approach in this paper is similar to the PMT application to functional foods of Cox et al. (2004) and Henson et al. (2010) with regard to the quantification of the underlying PMT variables (severity, vulnerability, product-efficacy and self-efficacy) through Likert-scale questions. However, Cox et al. (2004), employ univariate regression analyses for peoples' intention to consume. In contrast to Henson et al. (2010), who measure behavioural intention in terms of product consumption through a seven-point Likert scale ('please tell me how likely you would be to purchase the product to reduce your own level of blood cholesterol'), and who employ structural equation modelling, we measure behavioural (purchase) intentions as part of a repeated choice experiment so that we can quantify the behavioural predictors of the NGBP. Furthermore, we also integrate outcome confidence into the explanatory framework that encompasses the key constructs of PMT.

3. Survey Methodology, Data and Hypotheses

We conducted a web-based survey in 2009 among Canadian celiacs, which consisted of rating and ranking questions, as well as a repeated choice experiment. Prior to the stated choice survey, we conducted two focus group meetings, each consisting of 8-12 participants with CD. These meetings were held to facilitate the development of the choice experiments and survey

questionnaire in May and June of 2008. In the first focus group meeting, a semi-structured script was used to (i) develop health and lifestyle-related questions that help to profile individuals with CD, such as symptoms and the severity of symptoms, difficulties in following a GFD, one's health condition, and perceptions about the quality of life of celiacs, and (ii) solicit celiacs' opinion on the important attributes of a NGBP that is about to become available in Canada in the marketplace. The second focus group was used to get feedback on a questionnaire draft that contained stated choice tasks as well as rating and ranking questions.

Based on the first focus group meeting, feedback from Health Canada and the University's product development company's suggestions, the following product attributes were identified to be key descriptors: product form (table, powder, etc.), maximum allowable level of detectable gluten (MADG) by certifying agencies, country of certification, prescription requirement, and price. Levels of each attribute are shown in Table 1.

Table 1:
Product Attribute and Level in Stated Choice Experiments

Attribute	Level
Product form	Tablet Capsule Powder
Maximum allowable level of detectable gluten by certifying agency (MADG)	5ppm 20ppm 100ppm 200ppm
Country of certification	Certified in Canada Certified in U.S.
Prescription requirement	Over the counter By prescription only
Price for a package containing 60 doses	$6, $14.40, $22.80, $31.20, $39.60, $48

Based on the above attributes, a total of 24 choice sets each containing three alternatives plus an opt-out option (buy none of the products) were generated, based on a D-optimal design (Kanninen 2002). These choice sets were subsequently blocked into three groups of eight sets. Each individual was randomly assigned to one of the three blocks. Table 2 provides a list of

variables derived from these attributes. For categorical attributes like product form, country of certification and prescription requirement, dummy variables are used to indicate different levels of an attribute. For a three-level attribute, two dummy variables are created. A total of six variables are created to capture product attribute, and they are *Tablet*, *Capsule*, *MADG*, *Certified in Canada*, *By prescription and Price* (Table 2 panel 1). A random utility framework is employed to analyze stated choice data (Louviere, Hensher and Swait, 2000).

Given the small population of celiacs in Canada, we contacted the Canadian Celiac Association (CCA) for their assistance. The CCA has over 5240 members (Cranney et al., 2007) and has also supported the 2007 Canadian Celiac health Survey (CCHS) (Cranney et al., 2007). An online-survey was advertised with CCA endorsement through the spring edition of the 2009 CCA print Newsletter, which was mailed out across Canada during Spring of 2009. A total of 150 individuals participated in the survey, out of which 135 individuals completed both the choice task and the survey questionnaire sections. The following analysis is based on the data collected from these 135 individuals.

About 70% of respondents reported that they had accidental gluten intake over the past six months, and more than half of them (56%) indicated that they experienced moderate to severe symptoms as a result of accidental gluten ingestion. About 81% of participants are female, compared to 75% in the 2007 CCHS (Cranney et al., 2007). The mean age of our sample is 47, slightly younger than the mean age of 56 of the CCHS sample. The top three symptoms reported by our sample are fatigue (94%), bloating (90%) and digestive pain or discomfort (84%). The mean age when a celiac was first diagnosed is about 38 years old (47 years in the CCHS), excluding those who indicated that they were not diagnosed with CD, but that they follow a GFD.[1]

Other than the standard socio-demographic variables, respondents were asked about their health condition, manifested symptoms of CD should an accidental ingestion occur, the history of accidental gluten ingestions in the past six months, their knowledge regarding the maximum allowable detectable gluten in certified and non-certified gluten-free products, the perceived level of quality of life following a gluten free diet, health-related behaviour, their risk preference as derived from their social and recreational activities, their intended usage of the

[1] Due to the hereditary nature of the disease, some individuals self-diagnosed themselves with celiac disease if their family members were diagnosed with celiac disease, or if they had experienced an improved quality of life by following a gluten-free diet.

NGBP, if they decide to buy the gluten-binding product and their sources of health information. We considered it important to account for a set of variables that go beyond the core socio-demographic and lifestyle characteristics, since their influence on consumption behaviour has often been found to be less than psychological factors like attitudes, perceptions and motivations (e.g. Henson et al. 2009).

Similar to DeJong et al. (2003), Cox et al. (2004) and Henson et al. (2007; 2010), we group the above information into distinct categories that relate to the underlying constructs of PMT: a) basic socio-demographic information; b) lifestyle characteristics; c) self-reported severity of CD; d) perceived vulnerability of the threat; e) response efficacy of the gluten-free product; f) self-efficacy of using the product; g) long term side effect of the product; h) perceived ambiguity regarding the product information provided as a function of outcome confidence; i) knowledge about gluten-free food labelling and certification; j) risk behaviours in engaging social and recreational activities and in health and in adherence to a gluten free diet, and k) perceived quality of life. Based on these categories, we account for four psychological constructs that are widely used in analyses of the PMT: severity of a health risk, perceived vulnerability to a health threat, perceived efficacy of an intervention or a preventative measure, and perceived efficacy/ability to carry out the preventative measure. To emphasize, categories g) to k) have not been generated by DeJong et al. (2003), Cox et al. (2004) and Henson et al. (2007; 2010). The objective in our analysis in doing so is to be able to test for an extended version of PMT, in particular accounting for those constructs as reflected in Table 2. Table 2 provides a list of variables a) to k), which we now briefly introduce.

Socio-demographic characteristics include age, gender, income, household size, marital status, number of kids under 18, education, employment status and whether consumers were regular smokers or not (Table 2 panel *2a*). We also collect information on one's membership of a celiac association, since we assume that non-CCA member can access CCA's Newsletter through friends and family members. Over 92% of participants belong to CCA or one of its chapters, and about 2% belong to other international celiac associations. The information on one's health insurance coverage has also been collected, since this directly affects a consumers' cost-benefit view of engaging in health protection activities. Definitions and means or percentages of these variables are reported in Table 2, panel *2a*.

Information on individuals' lifestyle includes: how often they visit a doctor or a health professional, how often they consume organic products, how often they exercise, take vitamins, dine out, and participate in social events, what information channels they rely on to obtain information on celiac issues (Rogers 1983 used environmental sources and intrapersonal sources of information as inputs into the PMT model): from celiac societies, various media, health professionals, labels on packaging or from family and friends (Table 2 panel *2b*).

We use several different variables to capture the severity of CD (Table 2 panel *2c*). First, we asked respondents about their age at diagnosis (*Age_at_diagnosis*). The average age at diagnosis is 38 years old. Due to the fact that many symptoms of CD are similar to those of other diseases, delayed diagnosis is common. Delayed diagnosis may increase the severity of CD due to the continuous damage to the villi of the intestine, by not following a GFD (Zarkadas et al. 2006). We asked participants who had accidental gluten ingestion over the past six months to describe their symptoms.[2] We asked them to describe the number of times they had *Mild*, *Moderate* or *Severe* symptoms due to accidental ingestion. Four levels of frequency were used to capture the number of times: "less than 2 times", "2 to 5 times", "6 to 9 times" and "more than 10 times". We then construct a severity index (*Index_severity*) based on the different levels of severity of different symptoms for each individual to describe the overall severity of the threat (Table 2 panel *2c*). In addition, we directly asked respondents about their tolerable level of gluten intake before they would have a reaction: "What do you think is the average gluten intake (in terms of parts per million, ppm) that you can tolerate at one meal before you get mild to moderate symptoms?" They were asked to choose among these levels: 0, up to 10 ppm, up to 20 ppm, up to 50 ppm, up to 100 ppm, up to 200 ppm, greater than 200 ppm, and don't know. While nearly 60% of participants reported that they do not know about their own tolerance level, about 11.8% of respondents thought they have zero tolerance of gluten intake.

The next group of variables is used to measure the perceived vulnerability to accidental gluten intake (Table 2 panel 2*d*). We asked participants if they were diagnosed with food allergies, intestinal disease, respiratory diseases, heart diseases, cancer, diabetes and other diseases. Based on their responses, we created a health index variable to indicate one's health profile (*Indx_health*). The health index is a summation of the number of diseases a respondent has been

[2]The symptoms include digestive pain or comfort, fatigue, skin rash, anemia, heart palpitation, diarrhea, gas/bloating, frequent loose stool, depression and other symptoms. We also asked respondents if they had mild, moderate or severe reactions to a wide range of symptoms before they started gluten-free diet. However their response might be subject to recall errors since many celiacs have followed a gluten-free diet for many years.

diagnosed with (health information on the members of one's family was also collected, but is not included in Table 2). A high index indicates poor health. A dummy variable to indicate that respondents experienced accidental gluten ingestion over the past six months, is also included. We also want to know one's perception of the risk of accidental gluten intake. We asked if respondents agree with the statement "*Despite best efforts, it is possible that a gluten-free diet prepared at home may still contain small amount of gluten*." About 80% of participants agreed with this statement. Those who acknowledged the risk of cross-contamination, despite choosing gluten-free products, may have a stronger purchase intention for the NGBP. Since it is more difficult for celiacs to follow a GFD when they eat outside of their home, we then asked respondents about how often they participate in social events with friends (*Freq_social*), attend business-related social events (*Freq_business*) and dine-out (*Freq_dineout*).[3] We anticipate that the more often respondents attend social events, go on business trips or dine out, the more likely they are exposed to accidental gluten ingestion due to a lack of control in preparing for their food.

In terms of the perceived efficacy of the NGBP (Table 2 panel 2*e*), we asked respondent to indicate to what extent they agree with the statement "I trust the effectiveness of the product to reduce stomach pain and alleviate other undesirable symptoms." A five-point Likert scale (from "1 - strongly disagree" to " 5- strongly agree") was used to rate their response. About 47% of respondents agreed or strongly agreed with this statement.

In addition to the response efficacy of protective actions which are part of the coping appraisal process, the PMT also suggests that response costs (e.g. monetary, personal, time of shopping and meal preparation) and self-efficacy in carrying out an adaptive response (preventative behaviour) are important for coping appraisal and protection motivation behaviour (Floyd et al. 2000). In the context of our analysis, we capture direct response costs in terms of the price of the NGBP and the prescription requirement. We anticipate that the response cost are relatively low, thus having little impact on coping appraisal, since the price of the NGBP as well as the opportunity costs of shopping and meal preparation are likely to be acceptable low. The overall prediction from PMT is that response efficacy and self-efficacy will increase the probability of choosing an adaptive response, whereas response costs will decrease the probability of selecting the adaptive response (Floyd et al., 2000).

[3] Previous evidence suggests that some food adventurers may see a novel product as an opportunity to expand the variety of food they can eat, or to expand their social circle or even to enhance their job prospects (Lee A and Newman, 2003; Hallert et al., 1998),

We include two variables to examine perceived self-efficacy. The two variables are based on respondents' rating response to their understanding of daily use and emergency use of the NGBP (Table 2 panel *2f*). A high rating response is interpreted that respondents understand the commitment or the challenge involved in using the product appropriately. However, strictly speaking, perceived self-efficacy refers to consumers' self-assessment of their ability to cope with health risk through initiating and completing adaptive mitigation behaviour (Flynn et al. 2000). Therefore, since the above two variables are possibly better descriptors of respondents' understanding of the commitment and appropriate product handling, they may be somewhat poor proxies for perceived self-efficacy.

Based on the current information available (Health Canada; product manufacturer) that was passed on to survey participants, we also attempted to control for possible long-term health risk and thus ambiguity with regards to health outcome. The only long term risk known today is related to the increase in the cholesterol level due to increased egg-yolk consumption in consuming the NGBP. To capture the level of the perceived long-term risk, we asked respondents after the choice experiment to rate the statement "I believe that there is a long-term risk of consuming these products daily" (from "1 - strongly disagree" to "5 - strongly agree").[4]

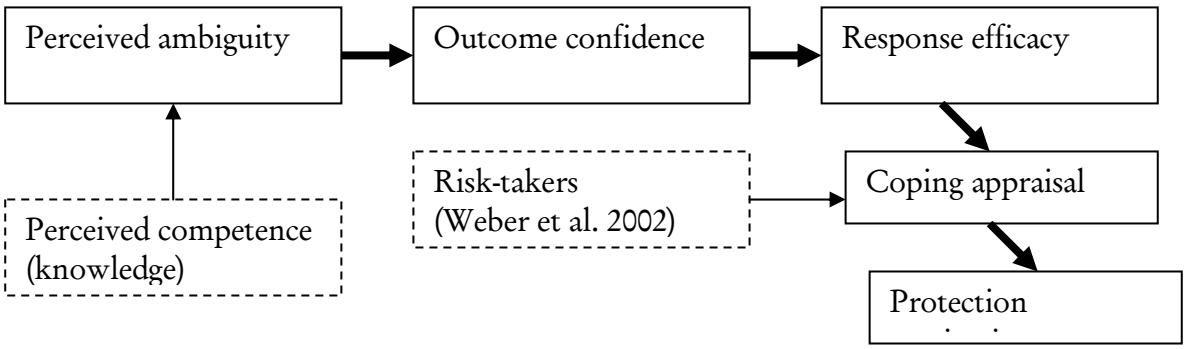
The idea of using the NGBP to cope with accidental gluten ingestion may seem to some celiacs to contradict their belief that a GFD is the only way to maintain or improve the overall health or wellbeing of the celiacs. The novelty of the product also adds to ambiguity about its efficacy and side effect, not to mention the lack of experience in handling the product. In order to control for perceived ambiguity regarding product effectiveness, we asked respondents to rate their confidence in the following statement "*How comfortable do you feel about your ability to make an informed choice based on the information that was provided to you (rating between 1 and 10)?"(Informed_choice).* A high confidence rating is thus interpreted as indicating low perceived ambiguity, such that high confidence in consumers' ability to make an informed choice based on information available is expected to lead to higher protection motivation in terms of purchase intentions of the NGBP. We also collected respondents' confidence rating

[4] In the survey, the potential of long-term risk of the product is introduced prior to the choice experiment as the following: "There is currently no evidence of long-term side effects of this natural food supplement, other than those associated with a higher intake of Cholesterol from eating eggs. The maximum daily cholesterol Intake recommended by Health Canada is 0.3g (0.5 grams of egg yolk powder corresponds to 0.0027 grams of cholesterol, hence you could eat about 55 doses of the novel product per day before the Health Canada recommendation would be exceeded)."

to the question "*To what extent do you feel confident that the outcome of your choices above will be satisfactory to you, in terms of their impact on your health (ranging from 1 –"not confident at all" to 10-"highly confident)?" (Impact_on_Health).* We consider that this question also enables us to capture o*utcome confidence* (Zakay and Tsal 1993), in terms of consumers' confidence in the health outcomes being positive. About 38% of respondents gave a rating of 7 or above, another 15% gave a rating below 4. Also considering the mean value of 5.86, it appears that outcome confidence is relatively high.

In our extended model view of PMT (Figure 1), we therefore predict that the perceived ambiguity regarding the effectiveness of the NGBP's health impact is low, hence that the *outcome confidence* (Zakay and Tsal 1993) is high (since celiacs are eager to overcome their constraints on quality of life).

Figure 1: Additional inputs into the coping appraisal process of PMT



Thus, an additional variable that we anticipate helps to explain protection motivation from the vulnerability to a health threat from accidental gluten intake relates to *outcome confidence*. In our extended model view of PMT, we assert that *outcome confidence* is a function of the perceived long-term health risks with consuming the NGBP daily as a preventative device, as well as respondents' confidence about the NGBP's impact on health. We expect that the stronger one believes there is a long-term risk and the lower is the confidence in a positive health impact, the lower is the willingness to try the NGBP or use the product on a daily basis, thus reducing *outcome confidence*.

In order to explore the *competence hypothesis* of Heath and Tversky (1991), we need to control for consumer knowledge. Many studies report that knowledge matters in one's decision to accept a new food product (e.g. Carlson et al. 2009). Considering the information on consumer

knowledge that we collected in the survey, including information on knowledge regarding the maximum allowable detectable gluten in certified and non-certified gluten-free products, we try to relate response efficacy to the *competence hypothesis* of Heath and Tversky (1991), which predicts that ambiguity aversion decreases with a decision-maker's perceived competence (knowledge). We assert that ambiguity regarding the effectiveness of the NGBP is influenced by consumers' confidence in their ability to make an informed choice. Viscusi et al. (1991, 1999) has established that ambiguity in making an informed choice due to conflicting or missing information is important in consumer decision-making. Other research has also shown that ambiguity causes people to be less willing to take action (e.g. Frisch and Baron, 1988).

We construct variables that measure consumer knowledge about gluten-free labeling and about the type of certification of GF foods. First, we examine whether celiacs know that there is a maximum allowable detectable amount of gluten even for certified GF food. Two dummy variables, *Misknowledge_1* and *Misknowledge_2* are used to explore whether respondents agree with the two statements that a food product labeled with either "gluten-free" or with "certified gluten-free" contains no detectable gluten. Those who agreed with the statement are considered as ill-informed about gluten-free labeling. Based on the above questions regarding perceived ambiguity regarding product effectiveness ("*How comfortable do you feel about …. "*) and outcome confidence ("*To what extent do you feel confident … .*") we created two variables, *Overconfidence_1* and *Overconfidence_2*. In order to test the *competence hypothesis*, we created an overconfidence index (*Overconfident*), which is a cross-product between the two *Misknowledge* variables and the two overconfidence variables (Table 2 panel *2i*). We also collected information about consumers' knowledge of the presence of gluten in certified gluten-free foods (*Knowledge_1*) and the safety of certified gluten-free foods despite the presence of gluten (*Knowledge_2*). Confidence ratings to these two responses are also collected (*Confidence_certified_GF* and *Confidence_safety_GF*). We use these two confidence variables to further explore celiacs' knowledge about GF food labeling and certification.

Since the judgment of relative risks likely affects vulnerability and is thus a component of the threat appraisal process of the PMT, we are also interested in controlling for respondents' risk perceptions. Based on a number of rating questions, we measure risk behaviour when respondents engage in risky activities in three different domains of risks: social, recreational and health. We adopt the psychometric scale proposed by Weber et al. (2002) to measure one's risk behaviour in engaging recreational and social activities, and in taking health risks. For each

domain of risk, respondents are asked to evaluate their likelihood of engaging in ten different types of activities on a five-point scale ranging from 1 – "Extremely unlikely: to 5 –"Extremely likely" (Weber et al. 2002). A total of 30 statements, ten in each domain of risks, were used to elicit the likelihood of engaging in these activities (Weber et al. 2002). *Risk_social*, *Risk_health* and *Risk_recreational* are created by summing the rating responses across ten activities in their corresponding domains (Table 2, panel *j*). A simple internal consistency check was performed, which suggests that these three variables are reasonably consistent (Cronbach's Alpha =0.77).

Furthermore, we attempt to measure respondents' risk attitudes toward the compliance with a GFD. Information on the compliance with a GFD was collected based on respondents' "Yes" or "no" responses to a few statements that indicate their level of compliance with a GFD. This information also reflects respondents' health belief toward a GFD lifestyle, and their level of health locus of control. For example, a "yes" response to the statement "*I only go to restaurants where I know that gluten-free meals are available*" (*Familiar_restaurant*) likely reflects upon a respondent's risk perception, as well as on her ability to be in control of her own health (which we anticipate to affect a respondent's self efficacy and thus coping appraisal).

The last group of variables measures consumers' perceived quality of life (Table 2, panel *2k*). Respondents were asked to indicate on a five-point scale how happy/satisfied they are with their current lifestyle, or if they desire an improvement. A low level of satisfaction with current quality of life may motivate the desire for change (protection motivation), thereby impacting adaptive intentions or purchasing behavior of NGBP.

Variables in group *i* and *j* are mostly psychometric or attitudinal, and are likely to be correlated. Factor analysis is conducted to extract factors from these variables and to reduce the number of variables to facilitate further analysis. A total of five factors are extracted based on the Kraiser Varimax method, which in total explains about 68% of variance in these 13 variables. The rotated factor loadings of each variable on these factors are included in the Appendix Table A2. The factor loadings indicate the level of correlation between a variable and a factor. We interpret the meaning of these factors by examining the relative size of factor loadings of each variable. Based on Table A2, we extract five factors, and they are, in the order of their explanation power, *Quality of life*, *Risk lovers*, *GFD conformer*, *More GF choices* and *Eat-out lovers*. These factors will replace the 13 variables for further analysis.

To emphasize, we include a wide range of variables to examine Celiacs' propensity of their adaptive intentions, including their intention to purchase the gluten-binding product. Some variables are "hard" information (DeJong et al. 2003) or exogenous, like socio-demographic information or lifestyle characteristics; while others are "soft information" – including perceived vulnerability, efficacy of the product, ambiguity, knowledge, risk preferences, and measures of perceived quality of life. In the following analysis, we will examine how each group of these variables contributes to explaining the purchase intention or the heterogeneity in preference for the gluten-binding product, so that we can derive insights into the range of factors that determine Celiacs' propensity to purchase the gluten-binding product. We anticipate that this analysis will enable us to explore the extent to which variables that are underlying the cognitive processes of the PMT (which allows for individuals not to be rational decision makers) as well as variables which are part of the catalog of behavioral variables underlying The Health Belief Model (which assumes that individuals are rational decision makers) contribute to explaining respondents' motivation to take health-promoting actions and thus purchase intentions for the NGBP.

Table 2 Sample Descriptive Statistics

	Definition	Mean/ Percentage
	1) Product attributes	
Buy none	Alternative specific constant, takes value of 1 for the opt-out option.	25%
By prescription	1 if a product is only available by prescription, and 0 if it is available over-the-counter.	33.4%
Certified in Canada	1 if a product is certified in Canada, 0 if it is certified in U.S.	37.4%
MADG	Maximum allowable detectable of gluten in ppm.	61%
Capsule	1 if a product is available in Capsule, and 0 otherwise.	25%
Tablet	1 if a product is available in Tablet, and 0 otherwise.	25%
Price	Price of a bottle of the gluten-binding product of 60 doses.	20.26 (17.0)
	2a) Socio-demographic characteristics	
Female	1 if female	81%
Age	Age in years	46.78 (17.75)
HHsize	Household size	2.47
Kids	Numbers of kids under 18 in a household	0.39
College	1 if one's education level is higher than college	63.7%
Income	Annual household income	$60,970 (24,091)
CCA member	1 if Canadian Celiac Association member.	92%
Smoker	1 if a respondent smokes regularly.	5.92%
Health Coverage	% of health insurance one has on his/her drug, from 0-25% to 90%-100%.	74.5% (0.26)
	2b). Lifestyle Characteristics	
Freq_organic	The frequencies of consuming organic products, ranging from "1 - 0-2 per year" to "6 - more than once per week".	4.40 (1.75)
Freq_Vitamin	The frequencies of taking vitamins, ranging from "1 - 0-2 per year " to "6 - more than once per week.".	5.29 (1.63)
Freq_exercises	The frequencies of engaging physical activities, ranging from "1 - 0-2 per year " to "6 - more than once per week".	5.62 (0.89)
InfoLabel	Dummy variable for those who ranked nutritional label as the top three most important source of information.	72.52%
Infoexpert	Dummy variable for those who ranked health professional as the top three most important source of information.	49.23%
InfoCCA	Dummy variable for those who ranked Canadian celiac association (CCA) as the top three most important source of information.	94.7%

Table 2
Sample Descriptive Statistics (cont'd)

	Definition	Mean/ Percentage
	2c). *Severity*	
Age_at_diagnose	A respondent's age at diagnose	38.76 (17.9)
Tolerance	Self-reported maximum tolerance level of gluten, ranging from 0 to 5: 0 indicates 0 ppm and 5 indicates greater than 50 ppm.	1.99 (1.13)
Mild	Number of times a respondent had mild symptoms after accidental ingestion in the past six months if they indicate they had mild symptoms, ranging from "1 - less than 2 times" to " 4- more than 10 times".	0.96 (1.02)
Moderate	Number of times a respondent had moderate symptoms after accidental ingestion in the past six months if they indicated they had moderate symptoms, ranging from "1 - less than 2 times" to " 4- more than 10 times".	0.62 (0.86)
Severe	Number of times a respondent had severe symptoms after accidental ingestion in the past six months if they indicated they had severe symptoms, ranging from "1 - less than 2 times" to " 4- more than 10 times".	0.42 (0.92)
Indx_severity	The severity index of Celiac disease: indx_severity= Mild + 2* Moderate +3* Severe.	8.207 (6.499)
	2d). Vulnerability	
Indx_health	Number of other diseases (e.g, heart disease, cancer, diabetes and etc.) that an individual has.	0.68 (0.83)
Ingestion_Accident	Dummy variable indicates if accidental gluten ingestion occurred in the past six months	70.37%
Risk_cross_contamination	Dummy variable indicates if one agrees with the statement "Despite best efforts, it is possible that a gluten-free diet prepared at home may still contain small amounts of gluten."	0.8 (0.40)
Freq_business	Frequency of attending business-related social events with colleagues/co-workers, ranging from 1 to 6: 1 indicates 0-2 per year and 6 indicates more than once per week.	2.45 (1.59)
Freq_dineout	Frequency of dining-out (restaurants)/ take-away, ranging from 1 to 6: 1 indicates 0-2 per year and 6 indicates more than once per week.	3.30 (1.37)
Freq_social	Frequency of participating in social events with friends, ranging from 1 to 6: 1 indicates 0-2 per year and 6 indicates more than once per week.	4.16 (1.26)
	2e). Response Efficacy	
Efficacy	Rating response to "I trust the effectiveness of the product to reduce stomach pain and alleviate other undesirable symptoms." ranging from "1 - strongly disagree" to "5 - strongly agree".	3.39 (0.87)
	2f). Self-efficacy	
Daily_use	Rating response to "daily use means that I must consume the product even when I follow a gluten-free diet." ranging from "1 - strongly disagree" to "5 - strongly agree"	3.27 (1.40)
Emergency_use	Rating response to "For emergence uses, I must adjust the number of units of a product proportionally to the amount of gluten intake." ranging from "1 - strongly disagree" to "5 - strongly agree"	3.45 (1.01)

Table 2
Sample Descriptive Statistics (cont'd)

	Definition	Mean/ Percentage
	2g) Long-term side effects	
Longterm risk	Rating response to "I believe that there is a long-term risk of consuming these products daily", ranging from "1 - strongly disagree" to "5 - strongly agree"	3.27 (0.91)
	2h). Ambiguity in the effectiveness	
Informed_choice	Confidence rating about "how comfortable do you feel about your ability to make an informed choice based on the information that was provided to you?" ranging from "1 –not confident at all" to "10- highly confident"	5.72 (2.24)
Impact_on_health	Confidence rating responses to "To what extent do you feel confident that the outcome of your choices above will be satisfactory to you, in terms of their impact on your health?" ranging from "1 –not confident at all" to "10- highly confident".	5.86 (2.16)
	2i). Knowledge, Confidence /Overconfidence in gluten free labelling	
MisKnowledge_1	If one agrees with the statement that "A food product that is labeled "gluten-free" contains no detectable gluten." "yes=1" and "no=0"	87.4%
OverConfidence_1	Confidence rating when one agrees with the statement that "A food product that is labeled "gluten-free" contains no detectable gluten." ranging from 1 to 10	7.58 (1.85)
MisKnowledge_ 2	If one agrees with the statement that "A food product that is labeled "gluten-free" contains no detectable gluten." "yes=1" and "no=0"	97.8%
OverConfidence_2	Confidence level when one agrees with the statement that "A food product that is labeled "gluten-free" and certified by an independent certification body for gluten-free processing contains no detectable gluten," ranging from 1 to 10	8.71 (1.33)
Overconfident	An index indicates that one is overconfident = Misknowledge1* Overconfidence_1+ Misknowledge2*Overconfidence_2	15.31 (4.07)
Knowledge_1	If one agrees with the statement that "Even a certified "gluten-free" may contain detectable traces of gluten." "yes=1" and "no=0"	59.3%
Confidence_certified_GF	Confidence rating when one agrees with the statement that "Even a certified "gluten-free" may contain detectable traces of gluten," ranging from 1 to 10	7.05 (2.023)
Knowledge_2	If one agrees with the statement that "A certified "gluten-free" food product, which may contain detetable traces of gluten, is safe for Celiacs to consumer." "yes=1" and "no=0"	28.9%
Confidence_safety_GF	Confidence rating when one agrees with the statement that "A certified "gluten-free" food product, which may contain detectable traces of gluten, is safe for Celiacs to consumer," ranging from 1 to 10	7.881 (1.932)

Note: variables in bold are used in model estimation.

Table 2
Sample Descriptive Statistics (con'td)

	Definition	Mean/ Percentage
	2j). Risk behaviours	
Risk_Social	The sum of scores to 9 psychometric scales measuring an individual's risk in engaging recreational activities, ranging from 0 to 45;	22.85 (7.88)
Risk_Recreation	The sum of scores to 10 psychometric scales measuring an individual's risk in engaging recreational activities, ranging from 0 to 50;	21.62 (8.082)
Risk_Health	The sum of scores to 10 psychometric scale measuring an individual's attitudes toward health risks, ranging from 0 to 50;	16.07 (5.585)
Avoid_gluten	I always try to avoid all gluten, 1 if yes, 0 otherwise	99% (0.25)
Known_ ingestion	I do not knowingly consume products containing gluten, 1 if yes, 0 otherwise	95% (0.35)
Bring_ ownfood	When I attend social-gatherings / events at friends' residences, I always bring my own meal or avoid eating any processed food, 1 if yes, 0 otherwise	72% (0.53)
Avoid_eatout	I avoid eating out., 1 if yes, 0 otherwise	33% (0.66)
Familiar_ restaurant	I only go to restaurants where I know that gluten-free meals are available, 1 if yes, 0 otherwise	66% (0.56)
Try_ newrestaurant	I like to try out new restaurants, 1 if yes, 0 otherwise	73% (0.63)
	2k). Perceived Quality of life	
Healthy	Rating response to the statement "I believe I am healthy." ranging from "1 - strongly disagree" to "5 - strongly agree".	4.07 (1.01)
Social	Rating response to the statement "I participate in social events as often as non-celiacs." ranging from "1 - strongly disagree" to "5 - strongly agree".	3.46 (1.43)
Happy	Rating response to the statement "Considering my health and lifestyle, I am happy with how I live my life." ranging from "1 - strongly disagree" to "5 - strongly agree".	3.89 (1.22)
MoreGF	Rating response to the statement My life would improve with increased gluten-free options, ranging from "1 - strongly disagree" to "5 - strongly agree".	4.43 (0.99)

Note: standard deviations are in parenthesis.

Table 3

Factors Exacted from Risk Preference Variables

Factor	Name	Interpretation	Rotation sums of squared loadings	
			Total	% of variance explained
I	*Quality of life*	High level of satisfaction with current quality of life	2.471	19.008
II	*Risk lovers*	Risk takers in engaging recreational and social activities and is willing to take some health risks	2.125	16.346
III	*GFD conformers*	Strong health locus control , strict compliance with a gluten-free diet	1.900	14.617
IV	*Eat-out lovers*	Enjoy eat-out and food adventurer	1.196	9.201
V	*More GF choices*	Want more GF food options	1.186	9.123

4. Model Estimation

4.1 Basic Conditional Logit model specification

First, we estimate a simple Conditional Logit (CL) model to explain Celiacs' preference for product attributes assuming homogeneous preferences. Based on our choice experiment design (Table 1), seven product attributes are included in the indirect utility associated with choosing a gluten-binding product. They are *Buy None*, *By Prescription*, *Certified in Canada*, *Maximum allowable detectable gluten (MADG)*, *Capsule*, *Table* and *Price*. *Buy None* is used to capture the utility associated with not buying any of the gluten-binding products. The estimated coefficient on *Buy None* is used to indicate the negative of the propensity to consume. A model estimated with these variables has a log-likelihood (LL) value of -1322.95 and adjusted R-square of 0.095, which indicates a poor model fit (Appendix Table A2, Model A1.1).

We test whether the model fit could be improved, if we account for *loss aversion* (Kahneman and Tversky 1991) when the *MADG* of a product, as revealed by respondents' choice in the choice experiment, exceeds one's self-reported maximum tolerable level and the prescription effect on the perceived price of the product. To allow for possible loss aversion, we construct an indicator variable, MADGL: it takes the value of 1 when the maximum level of detectable gluten under which a certifying agency would be allowed to label the product as "certified

gluten free" exceeds the level of a consumer's own perceived maximum tolerable level of gluten.[5]

The model that accounts for loss aversion improves model fit significantly (LL=-1313.28, Appendix Table A2, Model A1.2). Another problem in the current model is that the effective price of the different gluten-binding products may be different depending on the prescription requirement of respondents. For a prescription drug, a respondent may not care about its price if he or she has a 100% drug coverage plan. Therefore, we re-estimate the model in two ways. First, we directly discount the price for the product, if it needs a prescription according to the claimed percentage of health insurance coverage (Model A1.3). Second, we add an interaction term between prescription and health insurance coverage (Model A1.4). The "effective price model" (Model A1.3) has a worse model fit than the base model Model A1.1. We believe that this occurred for two reasons. One is possibly due to the heterogeneity in "discounting product price" by the coverage of health insurance. While some respondents might take into account the health coverage on prescription product when choosing among different gluten-binding products, others might not. Another reason might be due to poor data (recording) quality on the health insurance coverage caused by misreporting and the use of the mid-point of an interval based on the interval response of health coverage.[6] However, the model that accounts for the effect of health insurance coverage on price through interaction slightly improves model fit (Model 1.4). Therefore, we choose to use the interaction term between prescription and health coverage to control for the prescription effect on actual price of the product.

Considering the above estimation strategy, a base model (Model A1.5) is estimated with seven product attributes, a loss aversion variable and an interaction term between prescription and insurance coverage, assuming homogeneous preferences for the gluten-binding product. The results for model A1.5 and willingness-to-pay estimates are presented in Table 4.

[5] For those respondents who were not sure about their own maximum tolerance level, we assume that their tolerance level is 200pm, which is the highest level of MADG in the gluten-binding products that could be selected.

[6] The data on health insurance coverage are self-reported interval data, varying between 0-25%, 25-50%, 50-75% and 75-90% and 90-100%.

Table 4
Simple Conditional Logit Model

	Coefficient	WTP Estimate
Buy none	-0.497**	-20.557**
By prescription	-0.121	
*By prescription * % health insurance coverage*	0.522**	11.053**
Certified in Canada	0.705**	29.128**
Maximum allowable detectable gluten (MADG)	-0.002**	-0.083**
Dummy variable indicates the level of MADG exceeds one's self-reported maximum tolerance level	-0.569**	-23.500**
Capsule	0.726**	30.187**
Tablet	0.705**	29.095**
Price	-0.024**	
Number of observations	1080	
Log-likelihood	-1311.438	
Adj-R-square	0.102	

Note: [a]denotes WTP for "by prescription" is evaluated at the mean health insurance coverage of the sample: 74.5%. ** denotes the 5% significance level and * denotes 10% significance level.

Table 4 shows that, in general, Celiacs prefer to purchase the gluten-binding products rather than not (since they derive negative utility from the opt-out option). About 71.5% of the respondents chose to buy the NGBP. Although the main effect of prescription is not significant, the coefficient on the interaction term between prescription and percentag health insurance coverage is highly significant and positive. Celiacs with an average insurance coverage of 74.5% are willing to pay (or accept) about $11 higher a price for a gluten-binding product that requires a prescription. It seems that consumers were so eager about the NGBP that they did not compare the effective price of the product as a drug versus as a food supplement, by taking into account their own insurance coverage. Not surprisingly, respondents also strongly prefer the product to be certified in Canada rather than in U.S., and they prefer the product in the form of a capsule or tablet, rather than powder. Striking is consumers' preference for MADG. Although on average, respondents are willing to pay only about 0.83 dollar less for a product with 10 ppm higher level of MADG when the MADG does not exceed their own tolerance level, for every 1 unit increase in ppm at the level that exceeds their own perceived tolerance level, their willing to pay is reduced by $23.5. Since the average price of a package of the product is about $20, the result suggest that, on average, respondents are likely to reject a product with a MADG higher than their own perceived tolerance level.

4.2 Estimated CL Models with covariates

Since we are interested in the key factors that contribute to explaining respondents' motivation to take health-promoting actions and thus factors that affect purchase intentions for the NGBP, we re-estimate the CL model in Table 4 by adding socio-demographic, psychological and cognitive variables that may explain the heterogeneity in the preference for the opt-out decision. Since only the difference in the utility derived from each alternative matters in a random utility framework, these variables enter a CL model through interactions with the opt-out alternative specific constant (ASC). The variables listed in Table 2 are the candidate variables. Although we recognize that individuals with different characteristics, attitudes or risk perceptions might also have different preferences for product attributes, allowing these factors to interact with all product attributes would substantially increase the number of parameters of a model and thus cause an issue with regard to degrees of freedom. Therefore, we focus on explaining the heterogeneity in preferences for the opt-out decision only. Because the number of candidate variables is large, we decided to take a stepwise approach to adding the interactions between the *Buy none* ASC and these covariates. In other words, we progressively add different groups of variables as listed in Table 2 (group *a* to *j)*, and the factors in Table 3 (as the last group) should a null hypothesis of a restricted model is rejected.

Table 5 reports the model fit of different CL models with different groups of variables explaining the heterogeneity in the preference for the opt-out option (*Buy None*). For the first group of interactions, we interact *Buy none* with six socio-demographic variables: *Age*, *College*, *Kids*, *HHsize*, *Income* and *Smoker*. This is Model 1 in Table 5. A Likelihood Ratio (LR) test is conducted between Model C0, the base model estimated in Table 4, and Model C1. The LR test suggests that we should reject the null that Model 0 is the true model. Socio-demographic variables do matter in explaining the Celiacs' acceptance of the gluten-binding product. So are lifestyle variables, perceived severity of CD, perceived vulnerability to accidental ingestion, perceived efficacy of the product in reducing the stomach pain, perceived long-term risks, ambiguity regarding product effectiveness and outcome confidence, knowledge and overconfidence, and one's risk behavior as well as perceived quality of life. In fact, all groups of variables matter except for variables measuring self-efficacy. Based on the LR tests, we report the CL model estimated with *Buy none* interacting with all groups of covariates except for the self-efficacy group. For each group, only variables in bold in Table 2 are included in the modelling exercises, based on the preliminary analysis of the effect of these variables on the propensity to reject the product. Although the perceived long-term

health risks from consuming the NGBP is considered part of vulnerability (Table 2), we attempt to explore the distinct effect of long-term health risk in Model C7, separate from the 'Vulnerability Model C4' (Table 5). Based on the LR test results, we use Model C10 to explain the effect of the key determinants of respondents' propensity to purchase the gluten-binding product. Table 6 reports the estimates for Model C10. To emphasize, Model 6, which captures the essential variables (four factors) of the threat-appraisal process and the coping-appraisal process of the PMT, receives strong support.

Table 5
Model fit of CL models explaining the propensity to consume the NGBP

	Model	Log-likelihood	# of Para.	Adj-R square	LR test for interaction effects
Model C0	CL with no covariates	-1311.438	9	0.102	-
Model C1	Model C0 + Buy none * socio-demographic characteristics	-1281.800	15	0.121	**59.276**
Model C2	Model C1+ Buy none * lifestyle characteristics	-1270.038	19	0.129	**23.524**
Model C3	Model C2 + Buy none * Severity	-1251.297	21	0.14	**37.482**
Model C4	Model C3 + Buy none * Vulnerability	-1230.924	26	0.153	**40.746**
Model C5	Model C4 + Buy none * Response Efficacy	-1225.754	27	0.156	**10.34**
Model C6	Model C5 + Buy none * Self-efficacy	-1225.517	29	0.156	0.474
Model C7	Model C5 + Buy none * long-term side effects	-1219.007	28	0.160	**13.494**
Model C8	Model C7 + Buy none * Ambiguity in choice	-1216.034	30	0.162	**5.946**
Model C9	Model C8 + Buy none * Knowledge and Overconfidence	-1199.532	33	0.173	**33.004**
Model C10	Model C9 + Buy none * Factors	-1162.888	38	0.197	**73.288**

Note: Model 6 corresponds to a version of the PMT model (Flyn et al. 2000). A LR test of Model C6 (the PMT model) against Model 2 is rejected at the 1% significance level (LR=89.79, df=11, P<0.000), which suggests that the PMT is superior in explaining the purchase intention for the NGBP.

The model fit of Model C10 improves significantly compared to Model C0. The adjusted R square is close to 0.2, almost twice as high as that of Model C0. The estimated coefficients on the alternative specific attributes of Model C10 are very similar to those in Model C0, except

for those on *Buy none,* on the interaction between *by prescription* and on the *percentage of health insurance* coverage.

Table 6: Conditional Logit models with Covariates explaining the propensity of not buying the gluten-binding product

Variable	Coefficient	WTP Estimate
Buy none	-2.445	-
By prescription	0.057	
*By prescription * % health insurance coverage*	0.303	11.533**
Certified in Canada	0.704**	28.735**
Maximum allowable detectable gluten (MADG)	-0.002**	-0.088**
Dummy variable indicates the level of MADG exceeds one's self-reported maximum tolerance level	-0.536**	-21.503**
Capsule	0.743**	30.309**
Tablet	0.708**	28.917**
Price	-0.025**	

Variables interacting with Buy None

	Coefficient	P-value
a) Socio-demographic characteristics		
Age	0.045**	0.002
College	0.173	0.567
Kids	-0.566**	0.009
Hhsize	0.035	0.805
Income	0.018	0.760
Smoker	2.025**	0.000
b) Life-style characteristics		
InfoLabel	-0.050	0.859
Freq_vitamin	-0.124*	0.100
Freq_exercises	0.037	0.835
Freq_organic	0.038	0.610
c). Severity		
Age_at_diagnosis	-0.032**	0.000
Indx_severity	-0.061**	0.014
d). Vulernability		
Risk_Cross_Contamination	-0.549**	0.058
Indx_health	0.679**	0.000
Freq_social	0.046	0.691
Freq_business	0.473**	0.000
Freq_dine-out	0.355**	0.004
e) Response Efficacy		
Efficacy	-0.113	0.474
f). Long-term side effects		
Long_terrm_risk	0.212	0.154
g). Ambiguity		
Informed_choice	-0.309**	0.000
Impact_on healthy	0.157**	0.041
h). Knowledge and Over-Confidence		
Overconfident	-0.082**	0.026
Knowledge_certified_GF	-0.082**	0.023
Confidence_safety_GF	0.138**	0.000
i). Risk behaviour and Quality of life		
Quality_of_ life	-0.554**	0.000
Risk lovers	-0.778**	0.000
GFD conformers	0.893**	0.000
Eat-out lovers	0.631**	0.000
More GF choices	-0.090	0.503
Number of parameters	38	

Log-likelihood	-1162.888

Note: [a]denotes WTP for "by prescription" is evaluated at the mean health insurance coverage of the sample: 74.5%. ** denotes the 5% significance level and * denotes the 10% significance level. WTP for *Buy None* is not provided since it is no longer meaningful on its own due to many added interactions between *Buy None* and its covariates.

Table 5 and 6 suggest that Celiacs' acceptance for the gluten-binding product is affected by age, the number of kids under 18 and whether they smoke or not. Older people and people who smoke regularly are less likely to buy the gluten-binding product. Individuals with more kids at home are likely to buy the product. This latter finding is not surprising, since Celiacs might buy the product for their kids which are perceived to be more vulnerable to accidental gluten ingestion.

Lifestyle characteristics as a whole seem not to affect the purchase intention of the NGBP, although Celiacs who take vitamins often are more likely to try the gluten-binding product. Those who take vitamins regularly may believe in the health benefits of dietary supplements in general, and they may thus be more likely to accept the gluten-binding product as a dietary supplement.

Severity, vulnerability and response efficacy are found to be important in explaining the propensity to purchase (except for the perceived long term risks from side effects, which was expected). Age at diagnosis and the severity index are used to capture the severity of the health threat of accidental gluten intake. The older a respondent has been first diagnosed with CD, and the more severe ones' symptoms are, the more likely we find respondents to try the NGBP. Not surprisingly, Celiacs are also more likely to have a higher protection motivation and thus purchase propensity if they perceive that they are vulnerable to accidental ingestion. As to be expected, *Risk_Cross_Contamination,* which is employed to describe respondents' belief about the level of risk of accidental ingestion,,has a negative effect on choosing the opt-out option. The results suggest that those respondents who believe that the exposure to accidental ingestion is inevitable, are more likely to have a high protection motivation and thus will likely take the NGBP as a preventative measure. Celiacs who have a poor health condition are less likely to buy the product, and so are those attend business event often and dine out often. The former is somewhat unexpected, although those consumers' protection motivation may be so low, because they do not perceive that the NGBP helps to counterbalance the severity of their symptoms. Celiacs who often attended business events maybe be the ones who are competent about managing their own health. Therefore, their high

ability to cope with and avert the danger of accidental gluten intake, i.e. their coping appraisal, may be such that the probability of selecting an adaptive response is low.

The effect of perceived efficacy of the NGBP in terms of reducing stomach pain (*Efficacy*) on the opt-out option is highly significant and negative effect in Model C5. However, it is no longer significant in Model C10. A Model with additional interaction terms that attempts to measure self-efficacy (the ability to cope with the health risk through initiating and completing adaptive mitigation behavior) does not improve model fit significantly. We attempt to test for whether the inputs to the PMT help to predict protection motivation and coping in terms of intention to select an adaptive response (the NGBP), by conducting a LR test of a model estimated with four psychological constructs (severity, vulnerability, response efficacy and self-efficacy) against a model without such constructs. Model C6 is the model specified with these four constructs comprising the threat-appraisal and coping-appraisal process. A LR test is performed to test Model C6 against Model 2. The null hypothesis of the effect of the four constructs on *Buy none* is zero. The hypothesis is rejected significantly (LR=89.79, df=11, $p<0.000$). Therefore, we conclude that our data supports the validity of the inputs to the PMT, in terms of predicting protection motivation and coping with regard to the intention to select an adaptive response (the NGBP).

However, we also find support for our extended view of PMT (Figure 1), in terms of the impact of ambiguity regarding product effectiveness and outcome confidence, knowledge about GF labeling and certification. The results suggest that the more confident respondents are about the product information provided, the more likely it is that they choose the NGBP as an adaptive response. We consider *Impact_on_health* to measure outcome confidence (Zakay and Tsal 1993), in terms of how confident respondents are about the impact of this gluten-binding product on overall health. This variable has a positive sign and is significant, which suggests that the greater respondents' outcome confidence, the lower is the likelihood of choosing the NGBP as an adaptive response. The latter also increases with overconfidence and more knowledge about certification, and decreases for respondents with higher levels of trust in the safety of the certified GF product. Considering that higher levels of product knowledge and higher levels of confidence about information provided both predict an increasing likelihood of choosing the NGBP as an adaptive response, the results do *not* seem to support the *competence hypothesis* of Heath and Tversky (1991), which predicts that ambiguity aversion decreases with a decision-maker's perceived competence (knowledge).

Further, the results suggest that general risk behavior, risk perception and perceived quality of life also affect the likelihood of choosing the NGBP as an adaptive response. The more satisfied respondents are with their health or lifestyle, the more likely they are to choose the NGBP as an adaptive response. Perhaps this captures general optimism rather than satisfaction. Optimistic people may be more open to trying out new options, including the NGBP. Perhaps choosing the NGBP is for these respondents part of adopting a more healthy lifestyle: previous research suggests that people who adopt a healthy lifestyle are on average happier and more often satisfied with their life than others (deJonge, Hupkens and Bruggink 2009). Considering our results based on the psychometric scales of Weber et al. (2002), respondents who are in general risk lovers are also more likely to try the product, whereas strong GFD conformers are less likely to choose the NGBP as an adaptive response. Further, our results suggest that individuals who love to eat-out (and thus again may be more open to trying out new options) have a greater propensity to choose the NGBP as a self-protection measure when they knowingly expose themselves to higher levels of risk of accidental ingestion.

One problem with these findings is that a CL model fails to account for the correlation across choices made by one individual. Consider that we have a relatively small sample size of 135 individuals, and that each individual completed eight choice tasks. It is a little surprising to find that so many factors have a significant effect on the propensity to choose the NGBP as an adaptive response. Therefore, a Random Parameters Logit (RPL) model is estimated, controlling for the correlation across choice tasks. Similar to the CL, our focus is on finding factors that affect respondents propensity to choose the NGBP as an adaptive response. Therefore, we specify a RPL model that only allows for a random effect on the preference for the opt-out option, while the effects of all product attributes on the probability of choosing a gluten-binding product are assumed to be fixed as they are in a CL model.[7]

[7] A RPL model specified with random parameters on all variables except for price is estimated and is included in Appendix Table A4. Although there is significant heterogeneity in preference in product attributes (by prescription, certified Canada, MADG and Tablet), the mean effects of these attributes are similar to those of the RPL model specified with only one random parameter on the *Buy None* ASC.

4.3 Estimated RPL Models with covariates explaining the opt-out decision

Based on Table 7, only socio-demographic characteristics, vulnerability, efficacy, long-term side effects (again considered separate from other vulnerability constructs) and risk factors seem to matter in explaining the mean effect of the *Buy none* variable. However, the number of significantly estimated shifting effects is small. The last column of Table 7 lists those variables that have statistically significant effects as well as their estimated signs and significance levels. These are *Smoker, Index_severity, Index_health, Freq_business, Efficacy, Long-term risk, Overconfident, Quality of life, Risk lovers and GFD conformers*. These estimated effects of these variables on the estimated mean of *Buy none* are consistent with those found in the CL models. Smokers, Celiacs with a poor health condition, and those who attend business events often are less likely to choose the NGBP as an adaptive response. Perceived efficacy of the product in reducing the stomach pain increases one's propensity to choose the NGBP as an adaptive response, the perceived long-term health effects decreases it. Individuals who are overconfident about their knowledge about GF labeling, who think they have a high quality of life, and who are risk lovers are more likely choose the NGBP as an adaptive response, whereas those who are strong GFD conformers are less likely to cope by choosing the NGBP.

Based on the LR tests, we attempt to generate a RPL with the five groups of variables as shifters in the mean effect of *Buy none*. However, convergence cannot be achieved for such a model. We therefore had to choose only some of these variables in each group, based on hypothesis testing. A RPL model is specified with the ten variables listed in the last column in Table 7 as shifters is estimated to explain the mean effect of *Buy none* (Model R12 in Table 7). Table 8 reports the estimated Model R12. The WTP estimates for product attributes are similar to those based on CL models. Only four variables are found to have a significant effect on the mean effect of the *Buy none* ASC. These are *Smoker, Index_health* (high health index indicates poor health), *Freq_business, and Risk lovers*. Their estimated effects are the same as those in CL models and in the estimated RPL models reported in Table 7. These results suggest that Celiacs choose the NGBP as an adaptive response largely based on self-assessed vulnerability and perceived efficacy of the gluten-product in reducing the stomach pain. Risk attitude is also an important predictor of respondents' decision to choose the NGBP as an adaptive response. The coefficients on the other six variables (*Index_severity, Efficacy, Long-term risk, Overconfident, Quality of life and GFD conformers*) have the same signs as

those estimated in RPL Models R1 to R11, although they are no longer statistically significant. The relatively small sample size might be the reason for the insignificant effects of these six variables. Considering the consistency in the estimated effects of these ten variables across different CL and RPL models, especially the four significantly estimated variables, we conclude that the effects of these variables on the choice of the NGBP as an adaptive response are robust.

In summary, basic socio-demographic and lifestyle characteristics are found to be less useful in explaining the propensity to choose the NGBP as an adaptive response, except for health-related behaviour and health profile (e.g., smoking and health conditions). This is interesting, since it supports the explanatory role of smoking in the context of other research related to perceived health risks (e.g. deJonge et al. 2009; Steiner and Yang 2010). Celiacs who often attend business events may be those who are more competent in managing their own health and therefore are less likely to buy the novel product (they are likely to have a high ability to cope with and avert the danger of accidental gluten intake, impacting their coping appraisal). We also found that risk attitude, as measured by the psychometric scales of Weber et al. (2002), is a good predictor to explain the choice of NGBP as an adaptive response.

Finally, to examine the extent to which the standard PMT (Rogers 1983; Floyd et al. 2000) contributes to predict the intention to choose NGBP as an adaptive response, we estimate a RPL with the four groups of variables that are aimed to capture threat appraisal and coping appraisal processes (Model R7, Table 7). We then conduct a LR test between Model R7 and Model R3. The LR test result is in support of Model R7. Therefore, we find support that those four groups of variables that are aimed to capture threat appraisal and coping appraisal processes as part of the PMT contribute to an adaptive response of celiacs in terms of increasing the likelihood of choosing the NGBP.

Table 7

Model fit of Random Parameters Logit models with Covariates explaining the propensity of not buying the NGBP

	Shifters in the estimated mean of *Buy none*	Log-likelihood	# of Para.	Adj-R square	LR test	Significant Effects
Model R0	No shifter	-1141.650	10	0.218		
Model R1	Model R0 + Socio-demographic variables	-1135.020	16	0.238	**13.26**	*Smoker (+)***
Model R2	Model R0+ lifestyle characteristics	-1140.213	14	0.235	2.874	
Model R3	Model R0+ Severity	-1140.041	12	0.236	3.218	*Indx_Severity (-)***
Model R4	Model R0 + Vulnerability	-1134.254	15	0.239	**14.792**	*Indx_health (+)**, Freq_business(+)**
Model R5	Model R0 + Response Efficacy	-1139.198	11	0.236	**4.904**	*Efficacy(-)**
Model R6	Model R0 + Self-efficacy	-1141.457	12	0.235	0.386	
Model R7	Model 3+ Vulnerability + response efficacy +self-efficacy (the PMT model)	-1131.01	20	0.223	**21.29**	*Index_Severity(-)**, Indx_health (+)**, Freq_business(+)**
Model R8	Model R0 + Long-term side effects	-1138.710	11	0.237	**5.88**	*Longterm risk (+)**
Model R9	Model R0 + Ambiguity in choice	-1140.955	12	0.235	1.390	
Model R10	Model R0 + Knowledge and Overconfidence	-1138.722	13	0.220	5.856	*Overconfidence (-)**
Model R11	Model R0 + Factors	-1134.660	15	0.222	**13.98**	*Quality_of_life(-)**, Risk lovers (-)**, GDF conformers(+)**
Model R12	Model R0 + ten key variables	-1120.708	20	0.230	**41.88**	*Smoker(+)**,Indx_health (+)**, Freq_business(+)**,, Risk lovers (-)**

Note: ** denotes the 5% significant level and * denotes the 1% significance level. We only tried to explain the heterogeneity in the preference for *Buy none*. The coefficient on buy none is assumed to be normally distributed. Due to computational difficulties, we add shifters by group, one at a time to evaluate the explanation power of shifters. All LR tests are carried out against Model 0. LR values in bold indicate that the null is rejected at the 5% significance level.

Table 8

Estimated RPL models with Covariates explaining the propensity of not buying the gluten-binding product

Variable	Coefficient	WTP Estimates
Buy none	-2.811	-
By prescription	-0.150	11.859**[a]
*By prescription * % health insurance coverage*	0.599**	
Certified in Canada	0.704**	28.230**
Maximum allowable detectable gluten (MADG)	-0.002**	-0.098**
Dummy variable indicates the level of MADG exceeds one's self-reported maximum tolerance level	-0.383**	-15.352**
Capsule	0.751**	30.081**
Tablet	0.714**	28.603**
Price	-0.025**	
Standard Deviation_*Buy None*	2.698**	
Variables as shifter explaining the mean effect of Buy None		
Smoker	2.920**	
Indx_severity	-0.076	
Index_health	0.955**	
Freq_business	0.594**	
Efficacy	-0.564	
Long-term risk	0.410	
Overconfidence	-0.053	
Quality_of_life	-0.460	
Risk lovers	-0.967**	
GFD conformers	0.424	
Number of parameters	20	
Log-likelihood	-1120.708	

Note: [a]denotes WTP for "by prescription" is evaluated at the mean health insurance coverage of the sample: 74.5%. ** denotes the 5% significance level and * denotes the 10% significance level. WTP for *Buy None* is not provided since it is no longer meaningful on its own due to many added shifters in explaining the mean effect of *Buy None*.

In a final step, we are interested in the relative power of the different types of variables in explaining the propensity of choosing the NGBP as an adaptive response. We compare the mode fit of models that are specified without any factors, with models with socio-demographic and lifestyle characteristic ("Hard information") only, with models with variables that are constructed based on the standard PMT (Rogers 1983), and models with a full range of variables including additional psychological and cognitive factors (our "extended view" of PMT; Figure 1). Table 9 summarizes the model fit of both CL and RPL models with different hypotheses about the determinants of the propensity of choosing the NGBP, possibly as a the result of protection motivation.

Table 9

Factors Explaining the Propensity to Buy the Gluten –Binding Product

	Log-likelihood	# of Para.	LR tests Against: No covariate model	LR tests Against: "Hard information" model
CL models				
No covariate (Model C0)	-1311.438	9	-	
"Hard information" only (Model C2)	-1270.038	19	**82.800**	-
"Hard information" + the PMT variables (Model C6)	-1225.517	29	**171.842**	**89.042**
Full set of covariate (Model C10)	-1162.888	38	**297.100**	**125.258**
RPL models				
No covariate (Model R0)	-1141.65	10	-	-
"Hard information" only	-1132.788	20	17.724	-
The PMT variables only (Model R7)[a]	-1131.005	20	**21.280**	-
RPL with 10 key covariates (Model R12)	-1120.708	20	**41.880**	-

Note: "Hard information" refers to socio-demographic and lifestyle characteristics information; A RPL model specified with hard information and PMT variables does not converge. LR test values in bold indicate that the null is rejected at the 5% significance level.

The last two columns report the LR test values of each model which was tested against a no covariate model, and against a "Hard information" only model. For a CL specification, all null hypotheses are rejected, which suggests that "Hard information", the standard PMT variables and additional psychological and cognitive variables of an extended PMT all contribute to the explanation of the propensity to choose the NGBP as an adaptive response. For a RPL specification, Table 9 suggests that the "Hard information" model does not contribute significantly to the explanation this propensity, whereas the standard PMT variables and the additional variables of an extended PMT are more important to explaining the propensity to choose the NGBP as an adaptive response. Our finding of the weak explanation power of "Hard information" in the propensity to choose the NGBP is similar to the findings in the literature on functional foods (e.g. Henson et al. 2010). Results based on both CL and RPL models support the power of the PMT theory in predicting health-related behaviour.

5. Conclusion

This study has attempted to understand health attitudes and behaviours of consumers suffering from celiac disease. We employ an analysis of the underlying components of protection

motivation theory (PMT) to explore some of the motivational, cognitive, and affective processes that affect celiacs' propensity to use a novel health-risk reducing product (a novel gluten-binding product) as an adaptive response to the exposure of accidental gluten intake. A total of 135 individuals with celiac disease participated in a web-based stated choice experiment survey in Spring of 2009 across Canada. The results suggest that four groups of variables (s*everity, vulnerability, response efficacy and self efficacy*) that are aimed to capture threat appraisal and coping appraisal processes as part of the standard PMT (Rogers 1983; Floyd et al. 2000) are likely to contribute to explaining the adaptive response of celiacs, in terms of increasing the likelihood of choosing the novel gluten-binding product (NGBP). In particular, the results suggest that celiacs choose the NGBP as an adaptive response largely based on self-assessed vulnerability and perceived product efficacy as part of their coping appraisal process.

Similar to analyses of functional foods, which have employed other methodological approaches, such as structural equation modeling (e.g. Henson et al. 2010) or univariate regression analyses (Cox et al. 2004) to explore the PMT, our results suggest that standard socio-demographic and lifestyle characteristics are less useful in explaining the propensity to choose an adaptive response (the NGBP in our case), except for health-related behaviour and respondents' health profile (smoking and health conditions). The latter finding supports the explanatory role of smoking in the context of other research related to perceived health risks (e.g. deJonge et al. 2009; Steiner and Yang 2010). Celiacs who often attend business events were found to have a high ability to cope with and avert the danger of accidental gluten intake, which is assumed to impact their coping appraisal, and may help to explain our finding that these consumers are less likely to choose the NGBP as an adaptive response. Our results also suggest that that risk attitude, as measured by the psychometric scales of Weber et al. (2002), is an additional good predictor to explain adaptive responses to health risk. Therefore, we consider that our estimation results support an extended PMT model.

Furthermore, the results provide some support for loss aversion (Kahneman and Tversky 1991). Although a significant proportion of celiacs do not know their maximum tolerance level of gluten, those who know their tolerance level derive strong loss aversion from a product with a higher level of maximum tolerable level of gluten than their own. Respondents are willing to pay only about 0.83 dollar less for a product with a 10 ppm higher level of maximum tolerance of gluten, when this level does not exceed their own tolerance level.

However, for every one unit increase in ppm at the level that exceeds their own perceived tolerance level, their willing to pay is reduced by $23.5. Currently, Health Canada uses a maximum limit of 20 ppm for food products labeled as “gluten free”. About 22% respondents in our sample who report their maximum tolerable level of gluten is up to 10 ppm would therefore likely reject such “gluten free” food, had the information made known to these consumers. However, considering missing data, we were unable to explore a stricter view of loss aversion, by considering how consumers value the trade-off between taking the NGBP as health risk prevention rather than to reduce negative health impacts (receive health benefits) after the accidental intake of gluten through the consumption of NGBP.

Considering the average health insurance coverage of respondents (75%), participating celiacs prefer the novel health-risk reducing device to be available by prescription, and they are willing to pay on average about $11 higher for the product if it is available over the counter. This information could be useful for public health agencies in assessing the benefits and costs of introducing a product as prescription drug into the marketplace.

Our results also suggest that outcome confidence (Zakay and Tsal 1993) in terms of health outcomes is important, such that industry and public health service agencies should provide less ambiguous information about the efficacy and potential long-term side effects to facilitate consumer decision making, through labeling and other information channels that can be effectively employed to account for consumer heterogeneity.

However, our analysis likely faces a number of limitations. For example, it does not account for commitment costs (Corrigan, Kling and Zhao 2008), and thus WTP estimates may be overestimated, considering the amount and type of information that was provided to respondents as part of the choice experiment. Further, our results could be biased for those respondents that have a high locus of health control which affects their coping appraisal process. For those respondents, the low probability of risks of accidental gluten intake may lead to consumers placing excessive importance to low probabilities of risks, thus leading to misperception of risks (Magat and Viscusi 1993). However, respondents with a high locus of health control were found to have a lower propensity to select the NGBP as an adaptive response and associate lower health risks with their choices, suggesting that they may not misperceive risks.

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Appendix

Table A1
An Example of Choice Task

	Product A	Product B	Product C	
Product form	Capsule	Powder	Tablet	
Maximum allowable level of detectable gluten by certifying agency	5ppm	20ppm	200ppm	
Country of certification	U.S.	Canada	Canada	Buy None of Above
Prescription requirement	By prescription only	By prescription only	Over the counter	
Price for a bottle containing 60 tablets	$31.20	$6.00	$48.00	
I choose	☐	☐	☐	☐

Table A2 Rotated Factor Matrix

	Factors				
	I	II	III	IV	V
	Quality of life	Risk lovers	GFD believer	More GF Choice	Eat-out lovers
Happy	**.833**	.004	.155	-.108	-.020
Healthy	**.800**	-.129	.099	.163	-.101
Social	**.796**	-.032	-.099	-.092	.269
Risk Behaviour in Social	-.085	**.883**	-.035	.030	-.109
Risk Behaviour in Recreation	.163	**.876**	-.005	-.007	-.087
Risk Behaviour in Health	-.189	**.694**	-.011	.132	.169
Avoid_gluten	.142	.015	**.749**	-.149	.030
Known_ingestion	.215	.014	**.692**	-.078	.111
Familiar_restaurant	-.201	-.044	**.581**	.417	.049
Avoid_eatout	-.460	-.228	**.553**	.133	-.219
Improvelife	.046	.134	-.095	**.898**	-.001
Try_newrestaurant	.148	-.054	.059	-.017	**.907**
Bring_ownfood	-.301	.051	.399	.324	**.411**

Table A3
Estimated Homogeneous CL Models

Variable	Model 1.1	Model 1.2	Model 1.3	Model 1.4	Model 1.5
	Base model	Loss aversion model	Real price model	Prescription and coverage interaction model	General model
Buy none	-0.373**	-0.489**	-0.562**	-0.384**	-0.497**
By prescription	0.271**	0.270**	-0.299**	-0.181	-0.121
Certified in Canada	0.699**	0.704**	0.738**	0.700**	0.705**
Maximum allowable detectable gluten (MADG)	-0.003**	-0.002**	-0.003**	-0.003**	-0.002**
Capsule	0.741**	0.736**	0.718**	0.736**	0.730**
Tablet	0.706**	0.703**	0.674**	0.707**	0.704**
Price	-0.024**	-0.024**	-	-0.024**	-0.024**

Dummy variable indicates the level of MADG exceeds one's self-reported maximum tolerance level	-	-0.587**	-	-	-0.569**
Real price (price of a product by prescription is discounted by % of health coverage)	-	-	-0.030**	-	-
By prescription * health insurance coverage	-	-	-	0.605**	0.522*
Number of parameters	7	8	8	8	9
Adj. R-square	0.095	0.101	0.091	0.096	0.102
Log-likelihood	-1322.951	-1313.279	-1328.058	-1320.473	-1311.438

Note: ** denotes the 5% significance level and * denotes the 10% significance level.

Table A4 Significantly Estimated Variables in Different CL Models

	Model specification	Significant variables
Model 1	Model 0+ socio-demographic variables	Age(+)**, Kids(-)**, HHsize(+)**, Smoker(+)**
Model 2	Model 1+ lifestyle variables	Age(+)**, HHsize(+)*, Smoker(+)**, InfoLabel(-)**, Freq_vitamin (-)*, Freq_exercises (+)**, Freq_organic(+)**
Model 3	Model2+ Severity	Age(+)**, Kids(-)**, HHsz(+)**,Smoker(+)**,Freq_vitamin(-)**, Freq_exercises (+)**, Freq_organic (+)**, Age_at_diagnose(-)**, Indx_Severity(-)**
Model 4	Model 3 + Vulnerability	Age(+)**, Kids(-)**, HHsize(+)**,Smoker(+)**,Freq_vitamin (-)**, Freq_exercises (+)*, Age_at_diagnose(-)**, Indx_Severity(-)**, less healthy(+)**, Freq_business(+)**
Model 5	Model 4 + Response Efficacy variables	Age(+)**, Kids(-)**, HHsize(+)*,Smoker(+)**,Freq_vitamin (-)**, Age_at_diagnose(-)**, Indx_Severity(-)**, less healthy(+)**, Freq_business(+)**, Efficacy(-)**
Model 6	Model 4 + Self-efficacy	Age(+)**, Kids(-)**, HHsize(+)*,Smoker(+)**,Freq_vitamin (-)**, Age_at_diagnose(-)**, Indx_Severity(-)**, less healthy(+)**, Freq_business(+)**, Efficacy(-)**
Model 7	Model 5+ Side effects	Age(+)**, Kids(-)*, Smoker(+)**,Freq_vitamin (-)**,Freq_organic (+)*, Age_at_diagnose(-)**, Indx_Severity(-)**, less healthy(+)**, Freq_businesstrip(+)**, Efficacy(-)**,Longterm-sideeffect(+)**
Model 8	Model 7+ Knowledge and Confidence	Age(+)**, Smoker(+)**, Freq_organic (+)*, Age_at_diagnose(-)**, Indx_Severity(-)**, Indx_health(+)**, Freq_business(+)**, Efficacy(-)**,Long_term_risk(+)*, Informed_choice (-)*, Overconfident(-)**, knowledge_certified_GF(-)**, Trust_certification(+)**
Model 9	Model 8+ risk preference factors	Age(+)**, Kids(-)**, Smoker(+)**, Age_at_diagnose(-)**, Indx_Severity(-)**,*Risk_Cross_Contamination*(-)**, Indx_health (+)**, Freq_social(+)**, Freq_business(+)**,Freq_dineout(+)**,Healthimpact(+)**, Comfort(-)**, Overconfident(-)**, knowledge_certified_GF (-)**, Trust_certification (+)**, Quality_of_ life (-)**, Risk lovers (-)**, GFD conformers (+)**, Eat-out lovers (-)**

Table A5
Estimated LCM models

	Value Seekers		Novel Seekers		Suspicious Rejecters	
Variable	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Probability	0.554		0.322		0.124	
Buy none	-1.425**	0.000	-2.313**	0.000	1.809**	0.011
By prescription	-0.627*	0.064	0.422*	0.082	-3.053	0.163
*By prescription * % health insurance coverage*	1.147**	0.006	-0.036	0.912	3.953	0.118
Certified in Canada	0.898**	0.000	0.835**	0.000	0.398	0.324
Maximum allowable detectable gluten (MADG)	0.003**	0.000	-0.028**	0.000	-0.017**	0.001
Dummy variable indicates the level of MADG exceeds one's self-reported maximum tolerance level	0.243	0.340	-0.289	0.143	-0.743	0.101
Capsule	0.926**	0.000	0.787**	0.000	0.360	0.525
Tablet	0.867**	0.000	0.401**	0.007	1.395**	0.008
Price	-0.036**	0.000	-0.029**	0.000	-0.048**	0.002
Number of parameters	29					
Number of Observations	1080					
Log-likelihood	-1016.124					

Table A6
Estimated RPL model

	Mean		Standard Deviation		Cumulative Density Probability <0
Variable	Coefficient	P-value	Coefficient	P-value	
Buy none	-3.637**	0.000	4.072**	0.000	81.41%
By prescription	-1.066**	0.045	1.204**	0.000	81.20%
*By prescription * % health insurance coverage*	1.862**	0.006	0.086	0.771	0.00%
Certified in Canada	1.210**	0.000	1.403**	0.000	19.43%
Maximum allowable detectable gluten (MADG)	-0.011**	0.000	0.025**	0.000	67.69%
Dummy variable indicates the level of MADG exceeds one's self-reported maximum tolerance level	-0.527	0.199	1.614**	0.000	62.80%
Capsule	1.168**	0.000	0.303	0.367	0.01%
Tablet	1.094**	0.000	0.591**	0.001	3.21%
Price	-0.047**	0.000	-		-
Number of parameters	17				
Number of Observations	1080				
Log-likelihood	-953.55				

Note: Coefficients on all variables except for price are specified as normally distributed.