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Label reading, numeracy and food & nutrition involvement

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ABSTRACT

The purpose of this study was to investigate objective performance on a nutrition label comprehension task, and the influence of numeracy and food-related involvement on this performance level. A pilot study (n = 45) was run to prepare the scales in French. For the main study (n = 101), participants provided demographic information and answered the nutrition label survey, the short numeracy scale and two different food-related involvement scales (i.e. the *food* involvement scale and the *nutrition* involvement scale). Both studies were conducted online, and consent was obtained from all participants. Participants answered correctly only two-thirds of the nutrition label task items. Numeracy and food involvement scores were positively correlated with performance on this task. Finally, food involvement interacted with numeracy. Specifically, people scoring low in numeracy performed generally more poorly on the task, but if they had high food involvement scores, their performance increased. This suggests that high food-related motivation may compensate for poor numeracy skills when dealing with nutrition labels.

The prevalence of obesity is continuously increasing worldwide, despite a heightened awareness of the matter. Many factors contribute to growing obesity rates, such as food marketing, the tendency towards sedentary behavior in everyday life, as well as increased consumption of processed foods (French, Story, & Jeffery, 2001; Popkin, 1998; Stuckler, McKee, Ebrahim, & Basu, 2012; Swinburn, Caterson, Seidell, & James, 2004). Overweight and obesity are largely preventable. Making healthier food choices and ensuring regular physical activity are the easiest (i.e., most accessible, available and affordable) ways to prevent overweight and obesity (World Health Organisation, 2016).

Nutrition information labeling on foods is one of the aids that has been implemented to help people make more appropriate judgments about certain aspects of a food, such as its caloric content, portion information (Cowburn & Stockley, 2005) and therefore its healthiness. However, it is unclear how well consumers process nutritional information, and which individual differences may impact on their performance in using it. In particular, it is unclear how food-related involvement and numeracy may impact consumer performance with nutrition labels.

The present research contributes to this general question by investigating the role of food-related involvement, numeracy and their interactive effects on performance with food-related estimates and comparisons of nutrition labels. Numeracy relates to general capacities in dealing with numeric computations. Food-related involvement is measured with two separate scales, tapping into (i) specific nutritional interest and (ii) more general interest in food, respectively. These various concepts and how we expect them to relate to performance in dealing with nutrition labels information are explained in the introduction.

1. Nutrition labels and their use

Regulations for nutrition labeling exist globally in, e.g., the United States, Canada, Australia and Europe. The new European Regulation on food information given to consumers (No 1169/2011) was accepted on December 13, 2014 and has made it mandatory to provide nutrition information as of December 13, 2016. Nutrition labeling is aimed at informing consumers about the nutrient content of a food (e.g., amount of sugar, fat or calories), as well as information on possible allergens, engineered nanomaterials, and origin of some foods (e.g., for certain meats). This information, together with basic knowledge about what constitutes a healthy food choice, is intended to help individuals make informed food purchase decisions.

Previous research has reported associations between food labeling and food choice, although different consumers reported using different types of labels (Barreiro-Hurlé, Gracia, & De-Magistris, 2009). Because most adults encounter food labels while purchasing or preparing their food, the potential impact of these labels for public health may be substantial (French et al., 2001). The latter conclusion is valid, however, only if consumers are able to process this information accurately

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(Grunert, Celemín, Storcksdieck genannt Bonsmann, & Wills, 2012).

To date, however, it remains unclear how capable consumers are of using information found in a nutrition information table, and more specifically how well they perform on tasks requiring use of this information, e.g., when comparing products or computing the caloric content of a food portion. This is because most studies investigating nutrition labeling used subjective measures of understanding, and frequency of use (see Cowburn & Stockley, 2005; and Grunert & Wills, 2007 for two reviews). Self-reports likely overestimate both frequency and performance in using nutrition labels (Grunert & Wills, 2007).

Two studies that used a more objective method (i.e., a verbal protocol analysis) suggested that consumers might simply look at the nutrition information panel but not process the information any deeper (Cowburn & Stockley, 2005). The first study that used objective measures of food label use and comprehension, examined primary care patients' comprehension of food labels, along with the relationship between comprehension and their literacy and numeracy skills (Rothman et al., 2006). On average, patients in this study answered 69% of the food-label questions correctly, and label comprehension was strongly associated with low-level literacy and numeracy skills. However, this study was carried out amongst a patient sample, and it has not been replicated. The second study that used objective measures of food label use and comprehension (Malam et al., 2009) focused on the front of package labeling (i.e., traffic light labeling, which is not used everywhere) and not on the mandatory nutrition labeling. Therefore, it is important to provide further information on how people perform on such tasks and to uncover which factors may impact performance. The first aim of this study is to investigate how consumers from a non-patient sample perform on a label task.

2. Numeracy

Several studies have shown that consumers have difficulty using the information that is presented on nutrition labels (e.g., Huizinga et al., 2009; Rothman et al., 2006). The most common reasons for not using nutrition labels include lack of time, size of print, lack of understanding of terms, and concerns about the accuracy of the information (Cowburn & Stockley, 2005). More critical to the present research endeavor, the complexity of nutrition labeling and problems with technical terms, numerical calculations and percentages seem to be correlated with problems regarding understanding nutrition information (Grunert & Wills, 2007). Numeracy is particularly relevant in this regard.

Numeracy encompasses a multitude of skills ranging from basic calculations, to understanding measurements and estimations, and even inferring what mathematical concepts need to be used to solve a problem (Golbeck, Ahlers-Schmidt, Paschal, & Dismuke, 2005; Montori & Rothman, 2005). In other words, numeracy embodies one's ability to use and understand numbers in daily life, and so it may play an important role in reading and understanding nutrition labels (Rothman et al., 2006). This is because one must be able to make simple calculations with nutrition labels in order to understand key concepts such as the number of calories per serving or per amount consumed (Grunert & Wills, 2007).

Rothman et al. (2006) were among the first to show that one's understanding of nutrition labels is indeed highly correlated with numeracy. Of course, this may be confounded with the influence of educational level, as they report that those participants with lower numeracy scores were older, and had lower educational levels. In the sample of Rothman et al. (2006), the numeracy skills for 63% of their participants were very low: less than 9th-grade level.

In a study by Levy and Fein (1998) it was found that math complexity, little nutrition label use, age, and lower education levels all decreased the accuracy of calculations using nutrition labeling. In this study, participants accurately used nutrition labeling to perform simple calculations, but accuracy decreased as task complexity increased.

Three more recent studies also showed that numeracy facilitates label use. Firstly, Hess, Visschers, and Siegrist (2012) showed that numeracy is positively associated with label use, but this was only assessed with a self-report questionnaire. Secondly, Visschers and Siegrist (2010) showed that individuals with low numeracy skills make different food choices compared to those with high numeracy skills, depending on task complexity. However, these results are based on a choice task between equivalent products with different properties (e.g., non-fat vs. low fat yoghurt). This task does not involve comparing different products (e.g., bread vs. croissants), nor does it require calculations related to other food dimensions (e.g., sugar or calorie content). Finally, Miller, Applegate, Beckett, Wilson, and Gibson (2017) also found a correlation between numeracy and nutrition label use: Regardless of age, greater nutrition knowledge and higher numeracy skills were associated with more accuracy in using nutrition labels.

In their recent review, Malloy-Weir and Cooper (2017) concluded that empirical relationships between, amongst others, numeracy and nutrition label understanding and use have been understudied and are also often limited by the use of self-report data. We aim here to address the latter issue by examining the influence of numeracy on objective rather than self-reported performance in using nutrition labels. Consistent with prior work, we hypothesized that low numeracy individuals with low numeracy skills would perform more poorly on food label-related questions.

3. Involvement

Besides numeracy, a second factor of interest that may play a key role in performance on food label use is involvement. In the present research, the behavioral form of involvement was considered, using the definition proposed by Stone (1984): "Involvement shall be defined as time and/or intensity of effort expended in the undertaking of behaviors" (p. 210). Involvement is multidimensional and can be considered a type of motivation (Broderick & Meuller, 1999; Laurent & Kapferer, 1985; Marshall & Bell, 2004).

The elaboration likelihood model of persuasion (ELM) provides a framework for understanding the influence of involvement on food label processing (Cacioppo & Petty, 1984). According to the ELM, consumers who are highly involved and have the ability to process information base their product evaluations on intrinsic cues (i.e., the nutrition label). Conversely, when consumers have low involvement and/or their ability to process information is limited, their product evaluations are based on extrinsic cues (Walters & Long, 2012). This suggests that individuals who are highly involved in their food choices should base their product evaluation on intrinsic cues such as the nutrition table, resulting in increased use of nutrition information and increased performance when using nutrition information, which also requires more nutrition knowledge to interpret.

It is important, however, to clearly distinguish between nutritional knowledge and food-related involvement since their overlap is high and the distinction between them in the literature is occasionally ambiguous. Below we discuss the differences between these constructs. We first discuss nutrition knowledge and its relation to motivation. We then turn to two types of food-related involvement: food involvement and nutrition involvement.

4. Nutrition knowledge

In general, past research suggests that there is a positive correlation between nutrition knowledge and nutrition label use (for a review, see Miller & Cassady, 2015). However, Miller and Cassady (2015) also stated that nutrition knowledge measures vary widely in the scope of their assessment, as well as the dimensions included. Most research shows that nutrition knowledge has a large impact on how consumers use nutrition labels (e.g., Drichoutis, Lazaridis, & Nayga, 2005), and how consumers evaluate/choose food (Droms, 2006; Kozup, Burton, & Creyer, 2006).

Additionally, it has been shown that consumers with greater nutrition knowledge are more likely to use nutrition information than those low in nutrition knowledge (Barreiro-Hurlé et al., 2009; Drichoutis et al., 2005; Drichoutis, Lazaridis, & Nayga, 2006), and that nutritional knowledge interacts with motivation (i.e., the use of nutritional information is more effective when consumers had high motivation; Yoon & George, 2012). However, past research provides no conclusive answer yet concerning nutrition knowledge and *objective* performance with nutrition labels. Some studies (e.g., Levy & Fein, 1998; Norazmir, Norazlanshah, Naqieyah, & Anuar, 2012) found that increased nutrition knowledge is associated with increased nutrition label use and better performance, whereas other studies (e.g., Nayga, 2000) did not find an influence of nutrition knowledge on nutrition label use.

Nutrition knowledge and food-related involvement are likely to be correlated: Individuals who are very involved in their nutrition are likely to also have better knowledge about nutrition. Consistent with this, research has shown that when motivation is high, knowledge is likely to be better than when motivation is low (Howlett, Burton, & Kozup, 2008; Moorman, 1990). The present research is not concerned with nutrition knowledge, though. Instead, it is interested in people's involvement in nutrition and how, together with numeric abilities, food-related involvement may influence nutrition label use. Accordingly, we now discuss food-related involvement as motivation, after which we will specify two types of food-related involvement: specific nutritional and general interest in food.

5. Food-related involvement as motivation

Food-related involvement is generally seen as a type of motivation, specifically for determining the importance of a food-purchase decision (Mittal & Lee, 1989). Several food researchers have used involvement as a measure of motivation (e.g., Van Loo, Hoefkens, & Verbeke, 2017; Vermeir & Verbeke, 2006). They argue that involvement is a specific kind of motivation that taps into perceived personal importance. Individuals with high levels of involvement are also more motivated to invest cognitive effort in the decision-making process (e.g., de Boer & Schösler, 2016; Van Loo et al., 2017). Past research also suggests that consumers' motivations influence how they respond to food and nutrition marketing (for a review, see Pechmann & Catlin, 2016) . For example, three studies by Grunert et al. (2012) suggest that the lack of attention to nutrition labels is the major bottleneck with regards to its effectiveness, and that the main factor influencing attention is motivation. If motivation is low, consumers are unlikely to invest time or effort in using nutrition information.

Past research clearly shows that motivation qualifies the impact of food labeling on a range of nutrition-related variables. For example, studies by Bialkova, Sasse, and Fenko (2016) suggest that the effectiveness of nutrition claims (e.g., a statement that the product contains 30% less sugar) depends on consumers' health motivation. Furthermore, three eye-tracking studies showed that people with high health-motivation spent more time looking at available nutrition information on food packages, whereas people with high taste-motivation spent less time looking at available nutrition information (Turner, Skubisz, Pandya, Silverman, & Austin, 2014; Visschers, Hess & Siegrist, 2010; Bialkova et al., 2014.)

It is also likely that food-related involvement, as a specific type of motivation, correlates positively with performance in nutrition label use. However, to the authors' knowledge, this relationship has not been studied directly. In general, little empirical attention has been paid to the role of food-related involvement on objective performance on a label task. Most studies that measured motivation within nutrition labelling research have focused either on a health motivation (e.g., a dieting or healthy eating goal) or a taste motivation (e.g., cooking a dish rich in flavor), rather than motivation for using and thinking about food or using nutrition information provided on foods in general (be it for a taste- or health goal).

To our knowledge, the study that comes closest to examining how food-related involvement influences objective performance was conducted by Gomez, Schneid, and Delaere (2015). These authors investigated the effect of food-related involvement (as well as nutrition knowledge) on estimates of appropriate consumption frequency (ACF) of several fresh dairy products. In their study, an interaction was found between food-related involvement and the perceived healthiness of the product. Specifically, higher food-related involvement was associated with better estimates of ACF, but only for judgments about the healthiest products. The present research aimed to directly examine the relationship between food-related involvement and objective performance in nutrition label use, using two different measures of food-related involvement. In line with de Boer and Schösler (2016), we believe that food-related decisions and behavior handling involve several features, and that addressing more than just one motivational strategy may be helpful in studying it.

6. Distinguishing two types of food-related involvement and their relation to label use performance

While food-related involvement relates to a general motivation in dealing with food, this research is more particularly interested in two specific types of food-related involvement. The first type, which we refer to as *food* involvement, is a general interest in the antecedents and consequences of food choice and intake (Bell & Marshall, 2003); it measures general interest in food and cooking. Marshall and Bell (2004) state that the scale (Food Involvement Scale, or FIS) they developed to assess this construct measures "general involvement with the food provisioning process rather than a measure of involvement with a specific food item or brand (p. 872)". The FIS is concerned with various stages in the food provisioning process: eating, making purchase decisions, preparing food and cooking, as well as disposing the food (Marshall & Bell, 2004). Given that people may use nutrition labels at several stages of the food provisioning process (e.g., during purchasing or preparation of the food), we found it important to have an involvement scale that addresses these various stages.

The second type of food-related involvement is referred to as *nutrition* involvement. It can be assessed using the Nutrition Involvement Scale (NIS; Chandon & Wansink, 2007), which is tailored towards the use of the nutrition information table. As the main task of this study is based on working with the nutrition information table, we thought it important to add a measure that taps into the subjective importance of having access to and using this type of information.

It is important to measure both food- and nutrition involvement, as people who have high food-related involvement may be interested in reading the nutrition information for, e.g., food allergy purposes, and may not score high on general food involvement. Conversely, some people may be very involved in their food and cooking, but may not have a specific interest in reading nutrition information tables. We predicted that individuals with higher levels of FIS and NIS would perform better on nutrition label tasks.

7. Interactive effects between numeracy, FIS and NIS

The final and perhaps most distinctive aim of this study is to examine whether numeracy moderates the relation between food-related involvement (as measured using FIS and NIS) and label reading. More specifically, we sought to investigate whether higher food-related involvement may compensate for lower numeracy skills. We hypothesized that individuals who have low numeracy skills but have high food-related involvement may be more motivated and should thus perform better on the task. Additionally, we hypothesized that for those individuals with low numeracy skills, both *food*- and *nutrition* involvement can preserve performance on the nutrition label task due to increased motivation. To the authors' knowledge, these hypotheses have never been examined before using a nutrition label task.

8. Pilot study

8.1. Methods

Participants. We recruited 75 students from a Belgian university as participants of the study (for demographic information, see Table 1), which was conducted online (i.e., the students were provided the link to an online questionnaire). Bachelor students in psychology had the opportunity to be involved in the study in exchange for course credits. First, written informed consent was obtained from all participants, who also provided demographic information, including age, sex, highest level of education, current height and weight (to calculate BMI) and how frequently they consult the nutrition information on packaging. Control questions (e.g., "this is a control question, please chose the answer 'disagree'") interspersed throughout the questionnaire were used to verify if participants paid sufficient attention to the task, and the answers of those who responded incorrectly to these questions were not retained for the analyses. After the consent and demographic questions, participants filled out the Nutrition Label Survey, as detailed below, and were thanked and dismissed. Recruitment took place in February 2015. Participants were excluded if they reported a current psychiatric illness, were non-native-French speakers or under 18 years of age. In the end, we recruited 70 students, of which a total of 20 participants did not fully complete the questionnaire, and thus their results could not be used for analysis. After further exclusions, due to the control questions, the results of 45 participants were retained for analysis in this pilot study.

Nutrition Label Survey (NLS). Rothman et al. (2006) designed a Nutrition Label Survey (NLS) with the help of registered dietitians, primary care providers, and experts in health literacy/numeracy. The NLS evaluates the understanding of nutrition labels and is based on different types of questions (e.g., asking participants to calculate the caloric content of one serving of the food or comparing two foods to see which contains more or less of a certain nutrient). In total the NLS contains 26 questions (see supplementary material).

In this study, the original NLS questionnaire was translated to French. Additionally, different products and labels were used in order to avoid using unknown food types as well as to ensure that the labels were in French. Four independent French-native researchers translated the NLS from English to French. The newly obtained French version was then back-translated to English by four different independent researchers to ensure that the meaning of the questions remained identical to the original English version. If differences occurred between the original NLS and back-translations, adaptations were made to the French version of the NLS by the first author of this paper. Lastly, two experts in the field of Psychology revised the French version and made final adaptations where needed. Finally, the reliability of the French version of the NLS was tested and the number of questions was revised, which will be explained in more detail later. Total NLS performance is calculated as the number of correctly answered questions, ranging from 0 to 26.

8.2. Results

When analyzing the data from the pilot study on the reliability of the NLS, the KR-20[1] was 0.64. However, it became apparent that the scale was very long (likely also causing the high rate of incomplete surveys) and removal of several questions would lead to a much shorter, yet more effective measure of one's nutrition label reading skills. Analysis of the correlations of the items of the scale revealed that several questions scored very low (i.e., one of the removed items had an item-total correlation of −0.17). After removal of these items, with the aim of reducing the questionnaire as much as possible without diminishing the validity of the scale, 15 of the 26 items were retained, with a final KR20 of 0.78 for the French version, whereas the original English scale scored 0.87. (For the final French questionnaire, see Supplementary Material). It is important to note that the pilot study relied on a convenience sample of college students. While we do not see why this may represent a significant issue for the pilot part of this research, we thought it was important to collect data for the main study on a more diverse and representative sample. This was achieved in the study proper.

Table 1
Participant characteristics.

	Pilot Study	Main Study
N (%males)	45 (24.4)	101 (45.5)
Age: Mean (SD; range)	19.89 (1.72; 18–26)	31.21 (12.85; 18–65)
BMI: Mean (SD; range)	21.91 (3.44; 18–36)	22.75 (4.36; 15–41)
Highest Obtained Grade: n (%)		
Primary school	0 (0)	1 (1)
Lower Secondary school	0 (0)	3 (3)
Upper Secondary school	49 (98)	24 (23.8)
Bachelor or equivalent	1 (2)	44 (43.6)
Master	0 (0)	27 (26.7)
Doctorate (or higher)	0 (0)	2 (2.0)
Current Marital Status: n (%)		
Single	33 (73.3)	44 (43.6)
Couple (not married)	12 (26.7)	28 (26.7)
Married	0 (0)	31 (29.7)
Widow (er)	0 (0)	0 (0)
Currently on a Diet: n (%)		
Yes	13 (28.9)	12 (11.9)
No	32 (71.1)	89 (88.1)
Correct answer on Nutrition Label Survey: n (%)		
Item 1	30 (66.7)	77 (74.8)
Item 2	27 (60)	50 (48.5)
Item 3	34 (75.6)	77 (74.8)
Item 4	39 (86.7)	81 (78.6)
Item 5	33 (73.3)	85 (82.5)
Item 6	22 (48.9)	55 (53.4)
Item 7	37 (82.2)	81 (78.6)
Item 8	37 (82.2)	70 (68.0)
Item 9	36 (80)	71 (68.9)
Item 10	41 (91.1)	88 (85.4)
Item 11	20 (44.4)	49 (47.6)
Item 12	18 (40)	51 (49.5)
Item 13	35 (77.8)	70 (68.0)
Item 14	41 (91.1)	91 (88.3)
Item 15	36 (80)	74 (71.8)
Total Score Mean (SD; Range)	10.80 (3.14; 4–15)	10.59 (2.91; 1–15)
Prior Label Reading n (%)		
Yes	33 (73.3%)	84 (83.2%)

9. Main study

9.1. Methods

Participants. For the main study, 131 native French-speaking participants were recruited online via Crowdflower and social media between March and October 2015, of which 101 were retained for analysis after a control question correction.[2] All participants signed an online consent form, after which they provided demographic information, including age, sex, highest level of education, height, weight, and how frequently they consult the nutrition information on packaging (see Table 1). For this study, the Short Numeracy Scale, Food Involvement Scale and Nutrition Involvement Scale were used in addition to the Nutrition Label Survey, and control questions were again added

[1] The KR-20 is alike the Cronbach's Alpha, but for dichotomous items.

[2] To ensure that the exclusion did not influence results, all analyses were also performed on the total sample of 131 participants, and all significance levels remained the same or approached significance more closely (e.g., the significance level of the NIS*contrast 1 is 0.067 in the full sample).

at several locations in the survey.

Short Numeracy Survey (SNS). The Short Numeracy Survey (SNS) was used to assess numeracy. The expanded 11-item version by Lipkus, Samsa, and Rimer (2001) was chosen for use, as it specifically assesses the understanding of chance, proportions, and percentages, which are frequently used when trying to interpret nutrition labels. The scale underwent the same back-translation processed as previously described for the NLS. An example question of the SNS is: "If the chance of getting a disease is 20 out of 100, this would be the same as having a … % chance of getting the disease".

Food Involvement Scale (FIS) – Preparation and Eating subscale. The original Food Involvement Scale is a 12-item scale that asks respondents to indicate their agreement on a 7-point scale (1 = strongly disagree, 7 = strongly agree, Bell & Marshall, 2003). The FIS was used in this questionnaire as it is a broader measure of food-related involvement, and focuses not only on nutrition information, but also on general food choice importance and enjoyment of eating or cooking. The FIS consists of two subscales, the Preparation and Eating (P&E, example question: "I enjoy cooking for others and myself") Subscale and the Set and Disposal (S&D, example question: "I do most or all of the clean up after eating") subscale. In order to reduce the question load for participants, only the P&E subscale was used in this questionnaire. Removing the S&D subscale also makes theoretical sense: The authors believe that involvement in the purchasing, preparation and actual eating of food has a much higher impact on the use and understanding of nutrition labels than setting the table or disposing of the food afterwards. Therefore, nine questions were retained for our questionnaire. The same back-translation principle as for the Nutrition Label Survey and Short Numeracy Survey was used.

Nutrition Involvement Scale (NIS). The original Nutrition Involvement Scale (NIS) was made by Chandon and Wansink (2007). It is a 5-item scale that asks respondents to indicate their agreement on a 9-point scale (1 = strongly disagree, 9 = strongly agree) on questions regarding nutrition information. The reliability of the original scale was good (Cronbach's alpha = .85) and many other authors have used the scale (e.g., Cadario, 2016; Chernev & Chandon, 2010; Gomez et al., 2015). The same back-translation process as for the Nutrition Label Survey and Short Numeracy Survey was used. An example question of the NIS is: "it is important for me that nutrition information is available".

9.2. Results

When analyzing the data from the main study on the reliability of our French version of the NLS, the KR-20 was found to be 0.71. For the French version of the SNS, in this study, the KR-20 of the SNS was found to be relatively low 0.59, compared to the KR-20 found in the pilot study, which was 0.86. When analyzing the data from the main study on the reliability of our French version of the FIS (P & E Subscales) the Cronbach's alpha was .64. Upon further analysis, removal of two questions of the FIS (questions 9 and 10) led to an improved alpha of .71, so all further analyses were performed with the remaining 7 questions of the FIS. For the French version of the NIS, the Cronbach's alpha was .85. All analyses were done with mean centered variables. For the effects of SNS, FIS and NIS on the NLS, hierarchical regressions were performed, with the main effects in the first step, and all (2-way) interactions in the second step.

Nutrition Label Survey. The mean score on the label reading survey was 10.57 (SD = 2.88), where the minimum score was 1 and the maximum 15. This means that the participants were able to answer correctly in only two out of three assignments. In Table 1 the number of correct or incorrect answers per question is displayed. Sex, age, prior label reading (self-reported: "Do you ever read the labels describing the composition of the food?", either yes or no), and current dietary status did not influence the label reading survey results.

Numeracy. We hypothesized that if one's numeracy skills are very low, then scores on the nutrition label task may be lower too. The mean score on the SNS was 9.42 (SD = 1.59), which is high (i.e., the range is between 5 and 11). In order to investigate the relationship between numeracy and the label-reading task, a Spearman's rank-order correlation was run due to the skewedness of the results of the scale. There was a moderately strong, positive correlation that was statistically significant, indicating that as expected, a higher SNS score is correlated with a higher NLS score (see Table 2). As in the study by Rothman et al. (2006) there was a negative correlation between numeracy scores and age, but not with educational level (see Table 2)).

Table 2
Bivariate correlations between the Three Dependent Variables, other variables of interest and Nutrition Label Survey Score (N = 101).

Dependent variable	NLS	SNS	FIS	NIS	Age	BMI	Degree	Sex	Diet
1. NLS									
2. SNS[a]	.40**								
3. FIS	.25*	.04							
4. NIS	.16	.04	.18†						
Other correlations									
5. Age	.03	−.20*	.03	.06					
6. BMI	−.08	−.04	−.03	.15	.19†				
7. Degree	.16	.07	.02	.03	.14	.09			
8. Sex	.02	−.20*	.18†	.05	.13	−.02	−.29**		
9. Diet Status	.07	−.02	.19†	.05	.06	.34**	.04	.09	
10. Prior Label Reading	.07	.12	.17	.54**	.10	.062	−.01	.23*	.00

Note. [a] SNS correlations reported are Spearman rho due to non-normal distribution; †p < .08, *p < .05, **p < .01; Abbreviations: NLS = nutrition label survey, SNS = short numeracy survey, FIS = Food Involvement Scale, NIS = Nutrition involvement Scale, BMI = Body Mass Index.

Food-related Involvement. It was hypothesized that if one has high food-related involvement, one will perform better on the label reading task. The mean score on the FIS (7 item version) was 34.01 (6.89), where the minimum score was 15, and the maximum 49. Scores on the FIS significantly predicted scores on the NLS, see Table 3. The mean score on the NIS was 21.44 (SD = 7.25), where the minimum score was 5, and the maximum 35. Contrary to our hypothesis and unlike the FIS, the NIS did not significantly predict scores on the NLS, see Table 3.

Interactive effects. Food-related involvement was also examined as a moderator of the relationship between numeracy and label reading score. It was hypothesized that food-related involvement may

Table 3
Summary of regression analysis for nutrition label survey score (N = 101).

	B	$SE(B)$	β	t	Sig. (p)
Main Effects (first step)					
Food Involvement Scale (FIS)	.095	.038	.225	2.475	.015
Nutrition Involvement Scale (NIS)	.051	.037	.126	1.373	.173
Low vs. High & Medium Numeracy (contrast 1)	.808	.176	.410	5.596	.000
High vs. Medium Numeracy (contrast 2)	.037	.339	.010	.110	.913
				R^2	.24
Interactions (second step)					
FIS*NIS	-.002	.006	-.028	-.315	.753
FIS*contrast 1	-.085	.026	-.296	−3.286	.001
FIS*contrast 2	-.060	.047	-.111	−1.271	.207
NIS*contrast 1	.043	.024	.165	1.783	.078
NIS*contrast 2	.015	.048	.028	.316	.753
				R^2	.33

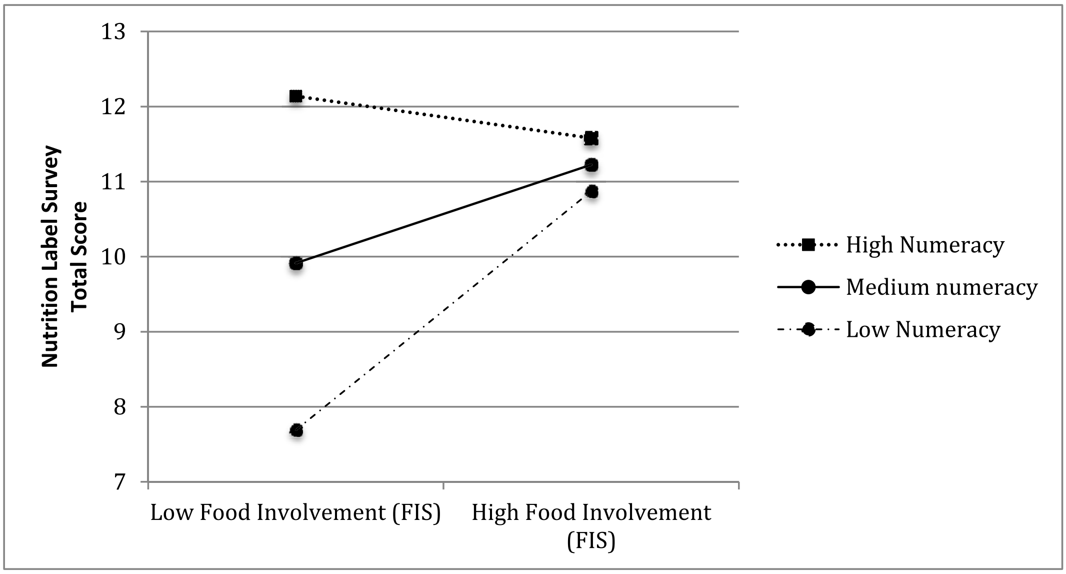

Fig. 1. The interaction effect between FIS and contrast 1 ($p = .001$).

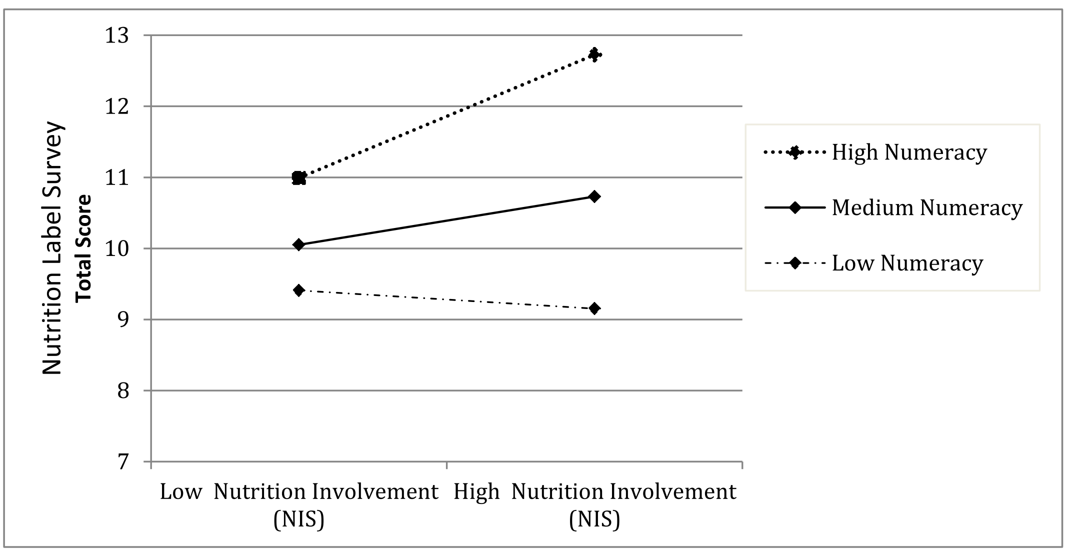

Fig. 2. The interaction effect between NIS and contrast 1 ($p = .78$).

compensate for a lower numeracy score. Due to the skewedness of the SNS data, we decided not to treat this variable as continuous and performed two contrasts corresponding to a tertile split of the sample, splitting them into a low (mean = 7.85, $SD = 1.41$) a medium (mean = 10, $SD = 0$) and a high (mean = 11, $SD = 0$) score group of total SNS score. This is preferable to a median-split: Indeed, if split in two, the lower group would include both people with medium and low numeracy, which is of little theoretical interest. The first contrast compared the low scores vs. high and medium scores (i.e., −2, 1, 1). The second contrast compared high vs. medium scores (i.e., 0, −1, +1). Both measures of food-related involvement and these contrasts were added to the model. See Table 3 for the regression summary. The overall model was significant ($R^2 = 0.34$ F (9,91) = 5.08, $p < .001$). The first contrast between low numeracy vs. high and medium was significant ($p < .001$), yet the second contrast between high vs. medium numeracy was not ($p = .91$). To test whether food-related involvement moderated the effect of numeracy on label reading, we examined the interaction between FIS and this first contrast ($p = .001$), and the interaction between NIS and this first contrast ($p = .08$). In Fig. 1 (FIS) and, Fig. 2 (NIS) these interaction effects were plotted.

When controlling for the NIS score, FIS has a positive effect for participants with low numeracy skills ($B = 0.25$, $\beta = 0.59$, $p < .001$). In the two other groups (medium and high numeracy, respectively), FIS exerted no significant effect (medium numeracy: $B = 0.06$, $\beta = 0.14$, $p = .34$; high numeracy: $B = -0.6$, β = -0.14, $p = .40$). So, for those individuals with low numeracy skills, FIS contributes more to the label reading score, than it does for those with high numeracy skills. This suggests that a higher food-related motivation may compensate for weaker numeracy skills.

Conversely, when controlling for the FIS score, the impact of NIS on performance tends to be lower in the low numeracy group than in the two other groups (low numeracy: $B = -0.03$, $\beta = 0.07$, $p = .60$, medium numeracy: $B = 0.08$, $\beta = 0.21$, $p = .17$, high numeracy: $B = 0.11$, $\beta = 0.28$, $p = .13$), but this interaction did not reach significance (see Table 3).

10. Discussion

Several interesting results were found in this study, with regards to objective label-readings scores, numeracy and two types of food-related involvement. Each will be highlighted in their own sections below.

Objective label-reading score. In this sample, individuals answered label calculations correctly in 2/3 of the cases. This is a reasonable performance, but also worrisome as it is likely that many individuals do not take the time to properly read the nutrition labels and may make more mistakes than in a specific task-based setting. Moreover, previous research has shown that people overestimate their nutrition label use (Grunert & Wills, 2007). If, in addition to this overestimation, the label task is allocated less attention, it is highly probable that performance on comparable label calculations is even worse in everyday life.

Also of importance is that our sample scored relatively high on numeracy, suggesting that it is not representative of the general population, so for those with lower numeracy scores the correct use of nutrition labels may be even lower. Moreover, our sample was relatively highly educated: Only 4% of our sample had below upper secondary education as compared to 22% in the normal population (OECD, 2016), and 44% had at least some form of tertiary education as compared to 35% in the normal population (OECD, 2016).

It is interesting to note that questions 2, 6, 11 and 12 were answered incorrectly most often in the nutrition label task. These questions involve different types of tasks: question 2 is a very basic 'read-off' question, requiring only doubling a value that can be found directly in the nutrition information (much alike question 1, 3, 4 and 8), whereas question 6 requires a more difficult calculation (much like question 5 and 9). Question 11 and 12 are both comparisons of products, and thus involve different numeracy skills. These results suggest that people make mistakes across a range of numeracy skills, which may be an indication that correctly reading food labels involves multiple types of skills, as several errors can be made even amongst the simpler tasks.

Numeracy and its effect on label reading scores. In general, people scored high on the SNS, indicating that the general numeracy task involving basic mathematic skills such as subtraction, addition and calculating percentage were relatively easy to solve for the participants in our sample. There was a moderately strong, positive correlation indicating that a higher SNS score is correlated with a higher NLS score (see Fig. 2). This means that those participants who are good at numeracy also performed well on the NLS. This is to be expected, since many of the NLS questions involve basic mathematical skills, and if those skills were to be lacking, then logically one cannot perform the tasks on the NLS either. The reliability of the numeracy scale in the study was rather low, therefore results should be interpreted with some caution. Note, however, that Rothman et al. (2006) found similar results for this variable.

One could argue that the SNS was skewed due to the relatively high level of education of the participants of the study. However, the 11-item SNS was first developed and tested to see how "highly educated participants performed on a general and an expanded numeracy scale designed within the context of health risks (p. 1)" (Lipkus et al., 2001). The present findings indicate that even highly educated participants have difficulties answering relatively simple numeracy questions, and that the measure was adequate for use with participants who took part in this study.

Food-related Involvement. Contrary to our prediction, the NIS did not significantly predict scores on the NLS, but scores on the FIS did significantly predict scores on the NLS. This could mean that a more general food involvement is a better predictor of label task performance than specific nutrition involvement.

That the effect of the NIS did not reach statistical significance came as a surprise, as one would assume that a scale that directly measures interest in nutrition information predicts performance in a task tailored to such information. One possible explanation for this finding is that a more general interest in food and cooking (as measured by the FIS) is already sufficient to help in the label-reading task, since people who have a greater interest in food and cooking may also look at food labels and nutrition information more regularly than average consumers do, even though they may not report researching this nutrition information specifically (as is, e.g., the case for the NIS). This could reflect the difference between a conscious search for nutrition information and a more general interest in food information, or perhaps a more implicit use of nutrition labels. Barreiro-Hurlé et al. (2009) came to a similar conclusion in their study, in which not only consumers who valued the nutrition characteristics of a product, but also those who enjoy ease of preparation, were more likely to use the nutrition information table. This could be an indication that consumers who shop for convenience foods still pay some attention to the nutrition information table in order to consolidate their need for convenience with, for example, a healthy eating goal (Barreiro-Hurlé et al., 2009). Following this line of argument may partly explain why scores on the NIS did not significantly impact on the performance on the nutrition label task: even though nutrition information may not be of high importance for some consumers, they might still use nutrition labels when making food choices, therefore counteracting the expected effect for those scoring low on the NIS.

Another possibility is that some of the individuals who score high on the NIS do not read labels because of their interest for the nutrition information itself in general, but rather to check for allergies, as the questions of the NIS (e.g., "I pay close attention to nutrition information," or "It is important to me that nutrition information is available") do not specify the reason behind this perceived importance. Moreover, NIS and NLS scores may not have been significantly correlated, as motivation is necessary but may not be a sufficient condition to cause certain food-related behavior (Chernev, 2011) such as nutrition label use.

A final possibility is that individuals who score high on the NIS read labels because they want to track their intake of specific food properties (e.g., sugar or calories), for dieting purposes, rather than due to general food-related involvement.

Interactive effects. The more general FIS measure played a role in one's performance on the NLS, but only in those individuals who had lower numeracy skills. Specifically, for such individuals, a higher FIS score was associated with a higher label reading score. It could thus be argued that motivation may compensate for lower numeracy skills.

Limitations and Perspectives. The overconsumption of (unhealthy) food has become an important issue amongst nutrition experts as well as policy makers, and a range of innovations have been implemented over the past decade to improve people's dietary choices. Amongst these is the availability of nutrition labeling (for more information, see the State-of-the-Art articles by Guthrie, Mancino, & Lin, 2015; and Scrinis & Parker, 2016). It has to be mentioned that, in theory, using nutrition labels as the only strategy for improving nutritional health is insufficient due to their limited distribution (i.e., they often only appear on pre-packaged foods but not on fresh fruits or vegetables). Additionally, limited nutritional knowledge may reduce the consumer's ability to understand the nutrition information provided in the first place. However, in practice, nutrition information often is the only source of objective information about the food available to the consumer (Cowburn & Stockley, 2005), which highlights why it is so important to understand how the average consumer uses this information. Admittedly, however, the present study did not measure how performance on the task impacts subsequent food choice or eating behavior.

While nutrition labeling is primarily aimed at influencing consumers' food-related behavior, it could also be used to encourage the food industry to improve the quality of foods, which can then be represented favorably on the nutrition label (Scrinis & Parker, 2016). This could be done not only on the nutrition label of the 'back-of-package' (BOP) labels (as investigated in this study), but also with 'front-of-package' (FOP) labels. These FOP labels make parts of the (numeric) information listed on the BOP more prominent but are also used to highlight certain components in the products (e.g "traffic-light"-labelling). However, the FOP labels still rely on consumers having sufficient understanding to evaluate the numeric information, and they have been criticized for ineffectively helping or even misleading consumers, due to the limited information reported (Lobstein, Landon, & Lincoln, 2007; Scrinis & Parker, 2016). The most complete image of a product can be formed when also integrating information available on the BOP, which is an important reason why FOP cannot simply replace BOP information. Moreover, labeling diversity likely increases confusion: A study by Bialkova, Grunert, and van Trijp (2013) suggests that having several types of information on food packages reduces the attention-grabbing properties of any single one. Therefore, the answer to adequately labeling products for the consumers to use may ultimately reside in education practices that increase label understanding and correct use, rather than merely relying on labeling policies such as FOP and BOP (Scrinis & Parker, 2016).

In future studies, it would be interesting to investigate if differences occur in processing nutrition information for healthy and unhealthy products (i.e., response time and/or accuracy) and to examine whether the results for numeracy found here are replicated with a different (i.e., more sensitive) measure. Additionally, more research needs to be done regarding the differences between the two types of food-related involvement, and the interaction effect needs to be replicated.

In previous research, many contradicting results have been found. This study shows that this may be due to the different measures of food-related involvement used, and thus highlights the importance of specifying the measure and specific type of involvement. It could be the case that food-related involvement is a multidimensional construct, and that different measures tap into the different dimensions of this construct: e.g. very general food involvement or more specific interest for nutritional details. This should be explored in future research. Furthermore, the finding that NLS scores and NIS scores were not significantly correlated in this study is quite surprising and should be investigated further in the future.

A few limitations of this study have to be considered. Firstly, a university sample was used for the pilot but a more diverse sample for the main study. Ideally, a representative sample may be considered in future studies, as well as some specific sub-samples (e.g., samples of different weights, dieting status or even eating disorders), in order to examine effects in more diverse populations. Furthermore, both studies were run online, which has some limitations like variations in the time taken to complete the task, how much concentration people have while answering the survey. Moreover, a selection bias may have occurred during the data collection phase, as individuals who are interested in food may have been more likely to participate in the survey than those who are not. Additionally, the study does not reflect true purchasing and consumption behavior, which would be an interesting addition for a future study. A last limitation of this study is the limited sample size with relatively highly educated respondents.

From a public health perspective, it seems that major improvement could be achieved by developing consumers' competency in handling nutrition labeling in general. This could be done, for example, through education with regards to using food labels and the nutrition information provided on the package. Increasing consumers' competency in handling nutrition labeling may favor healthy eating behavior, particularly for consumers with lower levels of numeracy and motivation. However, interventions should not only tackle the competency to adequately use food labels, increasing the average motivation to use these labels may have a major effect on food behavior too. Knowledge on nutrition labeling, and how to apply it, may increase individuals' motivation to read nutrition labels.

Ethical standards disclosure

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the ethical committee of the Université Libre de Bruxelles (*comite d'éthique de la faculte des sciences psychologiques et de l'éducation*).

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Authorship

Mulders, MDGH (PhD Candidate): designed and carried out the study, analyzed all data and wrote the article. Klein, O (Professor): aided in study design and data analysis, revised article. Corneille, O (Professor): aided in study design, revised article.

Conflicts of interest

None.

Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.appet.2018.06.003.

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