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# Disease-threat model explains acceptance of genetically modified products

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Natural selection favoured survival of individuals who were able to avoid disease. The behavioural immune system is activated especially when our sensory system comes into contact with disease-connoting cues and/or when these cues resemble disease threat. We investigated whether or not perception of modern risky technologies, risky behaviour, expected reproductive goals and food neophobia are associated with the behavioural immune system related to specific attitudes toward genetically modified (GM) products. We found that respondents who felt themselves more vulnerable to infectious diseases had significantly more negative attitudes toward GM products. Females had less positive attitudes toward GM products, but engaging in risky behaviours, the expected reproductive goals of females and food neophobia did not predict attitudes toward GM products. Our results suggest that evolved psychological mechanisms primarily designed to protect us against pathogen threat are activated by modern technologies possessing potential health risks.

Keywords: *behavioural immune system, disgust, gender, genetic modification, pathogens*

Natural selection has led to adaptations that influence survival of all living organisms including humans (Darwin, 1859). These adaptations influence the human brain and consequently human behaviour (for an overview see Liddle, Bush, & Shackelford, 2011). Evolutionary approach in studying behaviour is therefore focused on its adaptive value which means that we are asking why a particular behaviour has evolved and what benefits and costs it brings to living organisms. This approach can be applied to all areas of psychological research (Buss, 2011; Gaulin & McBurney, 2008).

One of the most striking weapons of natural selection is pathogen threat. Looking at historical data, in the 1300s, the plague was estimated to have killed between 25% and 50% of the populations of Europe, Asia, and Africa (Gottfried, 1983). Current estimates suggest that one to two million people

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die from malaria annually (Crompton, 1999; Sachs & Malaney, 2002) and the same number of people died in 2008 due to diseases associated with AIDS (World Health Organization (WHO), 2010). When the human sensory system is faced with disease-connoting cues, for example with people who are ill, two defensive systems are activated: the immune system (Schaller, Miller, Gervais, Yager, & Chen, 2010) and the behavioural immune system (Schaller, 2006). The mobilization of immunological defences is costly in terms of energy (Ilmonen, Taarna, & Hasselquist, 2000) and it is required only after pathogens are in physical contact with an individual's body. However, the behavioural immune system activates our basic emotions, like disgust and fear, and behaviours that prevent contact with subjects or objects that are potentially dangerous in terms of disease transmission (Schaller & Duncan, 2007)

A body of research has shown that the behavioural immune system does not need to respond specifically to disease-connoting stimuli, but instead it is also activated when the stimuli resemble cues of pathogens (reviewed by Schaller & Park, 2011). For example, people who think themselves vulnerable to disease transmission show a relatively greater level of averse response to physically disabled individuals (Park, Faulkner, & Schaller, 2003), towards older adults (Duncan & Schaller, 2009), towards immigrants (Faulkner, Schaller, Park, & Duncan, 2004), towards obese people (Park, Schaller, & Crandall, 2007) or towards some animals (Prokop, Fančovičová, & Fedor, 2010a; Prokop, Usak, & Fančovičová, 2010b; Prokop, Usak, & Fančovičová, 2010c).

Openness to experience and extraversion is associated with larger social networks, but also with higher risk of being infected by pathogens (Nettle, 2005; Mortensen, Vaughn Becker, Ackerman, Neuberg, & Kenrick, 2010). Similarly to the behavioural avoidance of disfigured people (Park et al., 2007) triggered by the smoke detector principle (Nesse 2005), modern technologies, albeit absent in our ancestral past, would activate specific kinds of cognitive structures that facilitate behavioural avoidance. In particular, modern technologies may pose potential threat, because they are novel, and, thus, people lack sufficient experiences with them.

In this study, we used the disease-threat model to examine the role of psychological mechanisms protecting individuals from diseases in understanding the attitudes toward genetically modified (GM) products. Although the phenomenon of GM is very new and could not influence psychological pathogen avoidance mechanisms, GM products are ideal examples of risky technologies that influence decision making of modern humans (Kalaitzandonakes, Marks, & Vickner, 2005; Khishfe, 2012). Genetic engineering is a process that does not occur under natural conditions, thus its perception by people is controversial (Huotilainena, Pirttilä-backman, & Tuorila, 2006; Carlsson, Frykblom, & Lagerkvist, 2007; Knight, Mather, Holdsworth, & Ermen, 2007; Aerni, Scholderer, & Ermen, 2011), and consumers are generally less aware of possible benefits from GM products than of potential hazards (Einsele, 2007; Consumer Choice, 2008), particularly of risks to personal health (Miles, Ueland, & Frewer, 2005). Some people suggest that the production of GM products should be

prohibited due to the unknown impact of genetic engineering on human health and the environment (Bredahl, 1999) and prefer natural or alternative therapies over traditional medical treatments (Kaptein, Helder, Kleijn, Rief, Moss-Morris, & Petrie, 2005). These concerns are more pronounced in females (e.g., Siegrist, 2003, Magnusson & Hursti Koivisto, 2002; Moerbeek & Casimir, 2005; Prokop, Lešková, Kubiatko, & Diran, 2007). From an evolutionary perspective, higher concerns of risky technologies by females would reflect their greater investment in their offspring (Napolitano & Ogunseitan, 1999; Simon, 2009).

One would therefore expect that GM foods should be more acceptable to people who feel themselves less vulnerable to diseases, and who engage in more risky behaviours. Devcich, Pedersen, and Petrie (2007) found that consumers with a higher number of modern health worries, such as ‘‘depletion of the ozone layer’’, ‘‘drug-resistant bacteria’’, ‘‘pesticides in food’’ or ‘‘cell phones’’ showed a stronger preference for foods that had only natural ingredients (Devcich et al., 2007). A study conducted in Sweden showed that people who had health concerns had more negative attitudes toward the gene technology as compared with people without health concerns (Magnusson & Hursti Koivisto, 2002). Most recently, Prokop and Kubiatko (in press) found that school children who were more sensitive to cues of pathogen transmission showed greater environmental concerns. Collectively, evidence suggests that the perceived disease threat influences preferences for natural products and for a safe environment. However, it is not clear whether or not an individual’s vulnerability to infectious diseases predicts acceptance of GM foods.

An avoidance of novel foods (food neophobia) (Pliner, 1994) is also thought to be a mechanism that serves to protect the individual by making him or her avoid physical threat from consumption of potentially toxic or nutritionally inadequate foods (Martins & Pliner, 2005). Since food neophobia can influence preferences toward novel foods (Tuorila, Lähteenmäki, Pohjalainen, & Lotti, 2001; Choe & Cho, 2011), understanding its potential impact on consumers’ food selections is an important issue not only from the theoretical, but also from the practical perspective (especially for developers of food products, etc.). To date, however, little is known about relationships between food neophobia and the acceptance of GM products, and very little (based on only one study) is known about food neophobia in Asia (Choe & Cho, 2011). Some researchers have shown that food neophobia is associated with negative attitudes toward GMO (Bredahl, 2001; Tuorila et al., 2001), while some others have not found any similar associations (Lähteenmäki et al., 2002). In addition, these associations were found to vary from country to country (Bredahl, 2001).

## OBJECTIVES OF THE STUDY AND HYPOTHESES

Considering that GM products are often viewed as unnatural (Siegrist, 2008), we suggest that attitudes toward them would be influenced by some protective mechanisms, namely by the behavioural immune system (Schaller, 2006). The hypotheses that we have proposed for this study are as follows:

- Hypothesis `1: The vulnerability to diseases will correlate with negative attitudes toward GM products.
- Hypothesis `2: The negative attitudes toward GM products will correlate with the sensitivity to pathogen disgust because this emotion protects us against risky events in terms of disease transmission.
- Hypothesis `3: Females would have more negative attitudes toward GM products than males.
- Hypothesis `4: Respondents who engage in risky behaviours that correlate with extraversion (Schmidt, 2004; Zietsch, Verweij, Bailey, Wright, & Martin, 2010), would show lower concerns with GM products, thus their negative attitudes toward GM products would negatively correlate with risky behaviours.
- Hypothesis `5: Respondents with higher food neophobia would have more negative attitudes toward GM products.
- Hypothesis `6: Respondents with higher reproductive goals would have more negative attitudes toward GM products.

## Method

***Respondents.*** Respondents were 252 volunteers (168 females and 84 males) recruited from three universities in Turkey. The mean age of respondents was 21.7 years (SE = 0.19, range 18 – 37). The respondents were enrolled in various fields including both humanities and natural sciences. All the respondents participated in this study were full-time students. Six questionnaires were administered by the researchers, two of whom visited the students in their classes and invited them to this study. The questionnaires were administered to students who agreed to participate voluntarily. The students completed the questionnaires in 25–30 minutes. Respondents were also asked to provide their age, sex, field of study, number of illnesses within the last year (How many times were you ill during the last 365 days?) and their desired number of children (How many children would you like to have in future?). The later variable was used to measure the expected reproductive goals (ERG) similarly as in Wang, Kruger and Wilke (2009). All respondents reported that they were childless.

***Research Instruments***

*Attitudes toward genetically modified products***:** Attitudes toward GM products (GMO) were measured by 14 items (Cronbach's alpha = 0.81) developed and previously validated by Erdogan, Özel, Uşak, and Prokop (2009). Most items were adopted from the "shopping of GM products", "consumption of GMO products", "ethics of genetic modifications", and "use of genetic engineering in human medicine" subscales of the original questionnaire. The selection of these items reflects the (1) willingness to consume, (2) willingness to buy GM products, and (3) moral acceptance of GM products. Summed scores of questionnaire indicated whether or not the respondent was willing to purchase and/or eat GM products and whether or not he/she supports the genetic modification of food products in general. Examples of items included: "I would eat GM tomatoes"; "I would not give GM food to children"; "Eating GM foods regularly could result in health problems in a few years". Items were rated on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). We calculated individual scores for this dimension by summing the responses to the constituent item and controlling for the effect of age, using SPSS software. Negatively worded items were scored in reverse order.

*Knowledge of genetically modified products questionnaire**:*** Knowledge of GM products (KGMO) was measured by using a combination of questions related to modern biotechnology.

The questions were taken from the Eurobarometer 52.1 (Melich, 2006). Respondents were asked whether twelve statements regarding concepts and facts about biotechnology were true or false. The following questions are some examples: "Ordinary tomatoes do not contain genes while genetically modified tomatoes do"; "Genetically modified animals are always bigger than ordinary ones"; "It is impossible to transfer animal genes into plants"; "By eating a genetically modified fruit, a person's genes could also become modified". We calculated individual scores for this dimension by summing the responses to the constituent item and controlled for the effect of age. Since the acceptance of GMO could be influenced by study combination, age or knowledge (Bal, Keskin-Samanci, & Bozkurt, 2007; Chen & Raffan, 1999; Chen & Li, 2007; Dawson, 2007; Erdogan, Özel, BouJaoude, Lamanauskas, Uşak, & Prokop, 2012; Prokop, Leškova, Kubiatko, & Diran, 2007; Šorgo, Ambrožič-Dolinšek, Usak, & Özel, 2011; Turkmen & Darçın, 2007; Usak, Erdogan, Prokop, & Ozel, 2009), the mean score of the acceptance of GMO dimension was regressed against these variables and the residuals of regression (one variable) were defined as the dependent variable.

*Perceived vulnerability to disease questionnaire***.** This questionnaire (PVD) (Duncan, Schaller, & Park, 2009) was used to assess the respondents' self-perceived vulnerability to disease. This scale consisted of 15 items (Cronbach's alpha = 0.75); one subscale assessed beliefs about one's own susceptibility to infectious diseases (Perceived Infectability [PI] with 7 items); the second subscale assessed emotional discomfort in contexts that suggest an especially high potential for pathogen transmission (Germ Aversion [GA] with 8 items). Items were rated on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). We calculated individual scores for these dimensions by summing the responses to the constituent items. Negatively-worded items were scored in reverse order.

We used the PI subscale to assess inter-personal differences in perceived vulnerability to infectious diseases (item example: "In general, I am very susceptible to colds, flu and other infectious diseases"). The GA subscale assessed some behaviours and emotional avoidance of some pathogen-relevant stimuli (item example: "I prefer to wash my hands soon after shaking someone's hand"). Thus, the GA subscale reports pathogen avoidance behaviours rather than perceived vulnerability to diseases. High mean scores in these dimensions indicate high vulnerability to diseases. Summed scores of both dimensions were controlled for the effect of age. To support the reliability of the two subscales, the total number of illnesses significantly correlated only with the PI subscale, but not with the GA subscale ($r = 0.40$ and 0.07, $p < .0001$ and 0.25, respectively) similarly as in Prokop, Uşak, and Fančovičová (2010c).

*The pathogen disgust questionnaire:* The Pathogen Disgust (PD) questionnaire was adopted from the Disgust Sensitivity Scale developed and validated by Tybur, Lieberman, and Griskevicius (2009). We used 7 items from the original questionnaire (Cronbach's alpha = 0.78) that were rated from 1 (not at all disgusting) to 5 (extremely disgusting) following the recommendation of Tybur et al. (2009). The PD questionnaire was designed specifically to measure disgust elicitors caused by sources of various pathogens (e.g., stepping on dog poo). High mean scores in this dimension indicated high disgust sensitivity. We calculated individual scores for this dimension by summing the responses to the constituent items and controlled for the effect of age because disgust sensitivity was found to vary with age (Curtis, Aunger, & Rabie, 2004).

*The risky behaviours questionnaire***:** *The risky behaviours questionnaire* (RB) was used to examine the degree to which respondents engaged in various risky behaviours. The seven items in this questionnaire (with Cronbach's alpha = 0.70) were developed based on the Youth Risk Behavior Survey Questionnaire (Brener et al., 2002). This questionnaire investigated a range set of risky behaviours like taking drugs ("I used marijuana/cocaine/heroine during the last 30 days"; "I was drunk at least once in past 30 days"; "I smoke cigarettes regularly"), suicidal thoughts ("I was thinking about suicide during the past 12 months") and physical aggression ("I was in a physical fight during the past 12 months"; "I was physically hurt by

boyfriend/girlfriend during the past 12 months"). These items were rated from 1 (absolutely disagree) to 5 (totally agree). High mean scores in this questionnaire indicated engaging in risky behaviours. We calculated individual scores for this dimension by summing the responses to the constituent items after controlling for the effect of age.

*The food neophobia questionnaire: The food neophobia questionnaire* (FN) was adopted from Pliner (1994). This questionnaire investigated behavioural reluctance to feed and/or reject novel foods. It contained 10 items (Cronbach's alpha = 0.73) that were rated from 1 (absolutely disagree) to 5 (totally agree). Examples of items included: "I am afraid to eat things I have never had before"; "I am very particular about the foods I will eat"; "I will eat almost anything". High mean scores in this dimension indicated high food neophobia. We calculated individual scores for this questionnaire by summing the responses to the constituent items after controlling for the effect of age because food neophobia was found to vary with age (Dovey, Staples, Gibson, & Halford, 2008). Negatively-worded items were scored in reverse order.

## Results

Descriptive analysis of measured variables is summarised in Table 1. Overall, respondents showed relatively higher PVD scores, relatively lower FN and KGMO scores, relatively supportive attitudes toward GMO and moderate means in other domains.

Table 1. *Descriptive Data for Attitudes toward GM Products and Their Possible Predictors (N = 252)*

| Variable | Mean | Minimum | Maximum | SE |
|---|---|---|---|---|
| Attitudes toward GM products | 56.87 | 32.00 | 70.00 | 0.48 |
| Knowledge of GM products | 4.95 | 0.00 | 9.00 | 0.11 |
| Perceived infectability | 22.42 | 8.00 | 34.00 | 0.32 |
| Germ aversion | 29.02 | 15.00 | 40.00 | 0.31 |
| Pathogen disgust | 22.65 | 9.00 | 35.00 | 0.38 |
| Risky behaviours | 11.87 | 7.00 | 34.00 | 0.27 |
| Food neophobia | 29.25 | 15.00 | 45.00 | 0.36 |
| Illnesses in last year | 2.40 | 0.00 | 12.00 | 0.11 |
| Expected reproductive goals | 2.15 | 0.00 | 6.00 | 0.06 |

The residual acceptance of GMO score correlated significantly and positively with GA and disgust subscales (Pearson r = 0.48 and 0.23, both p <.0001, n = 252, respectively) in support of Hypotheses 1 and 2. The PI subscale also significantly correlated with GMO attitudes (Pearson r = 0.15, $p$ = 0.02). Females had more negative attitudes toward GMO than males (mean residual score ± SE, 1.69 ± 0.55 vs. –3.37 ± 0.78, t = 5.28, df = 250, $p$ <.0001) in support of Hypothesis 3. In accordance with our expectations, attitudes toward GMO correlated negatively with RB (Pearson r = – 0.18, $p$ = .005), providing support for Hypothesis 4. The FN scale did not correlate with the

GMO scale (Pearson r = 0.10, $p$ = 0.13) providing no support for Hypothesis 5. ERG correlated weakly with the GMO scale (Pearson r = –0.13, $p$ = 0.04) providing no support for Hypothesis 6.

We then conducted multiple regression analysis (forward stepwise method) to investigate whether or not any of the individual difference variables uniquely predicted attitudes toward GMO. The list of independent variables in all regression analyses is shown in Table 2. The multiple regression model was significant ($R^2$ = 0.25, F(2,249) = 41.74, $p$ <0.0001). Two variables were entered into the model: the GA subscale and gender (β = 0.42 and – 0.16, t(248) = 7.08 and –2.61, $p$ <.0001 and 0.009, respectively; see Table 2). This suggests that respondents with high aversion against disease-connoting cues had more negative attitudes toward GMO and that males had more positive attitudes toward GMO than females. Other predictors were removed from the model.

Table 2. *Final model of the hierarchical multiple regression analysis on the GMO scale controlled for the effect of age, knowledge of GMP and study course. The PI and PD subscales were excluded from the model (N = 252)*

| Predictors | Unstandardized coefficients | | Standardized coefficients | | |
|---|---|---|---|---|---|
| | B | SE | Beta | t | *p* |
| Constant | –21.93 | 4.06 | | –5.4 | <0.0001 |
| Risky behaviour | –0.08 | 0.1 | –0.04 | –0.73 | 0.45 |
| Food neophobia | 0.04 | 0.07 | 0.03 | 0.5 | 0.62 |
| Expected reproductive goals | –0.13 | 0.44 | –0.02 | –0.3 | 0.77 |
| Germ aversion | 0.63 | 0.09 | 0.04 | 6.8 | <0.0001 |
| Gender | 2.2 | 1.02 | 0.14 | 2.2 | 0.03 |

Hierarchical multiple regression (stepwise method) was used to test the mediation. The mediations tested the relationship between attitudes toward GMO (dependent variable) and predictors listed in Table 2. We defined gender, PD, GA and PI subscales as predictors of attitudes toward GMO and RB, FN and ERG as mediators of these relationships. Out of three models derived by hierarchical multiple regression, we present the strongest model that explains the largest variability of results ($R^2$ = 0.25, F(5,246) = 16.7, $p$ <.0001). As shown in Table 2, the GA subscale and gender differences significantly contributed to the model. The RB, FN and ERG scales showed a non-significant contribution and other predictors were excluded. This model fully corroborated results of multiple regression analysis presented above.

Finally, we performed a path analysis for testing different models of how variables were related to each other. First, we tested a model in which only the GA subscale and gender were the significant predictors of GMO against the saturated model in which every variable was a significant predictor of GMO (Fig. 1). In this

model we also allowed for a covariation among any two variables. The results showed that our restricted model fitted the data equally well as the full model (it did not significantly differ from the saturated model) ($\chi_{(5)} = 2.078$, $p = 0.838$). The fit parameters had the values of 1, 0.992, 0.001 for NFI, CFI and RMSEA indices, respectively. Thus, this model had a good fit. Restricting this model further by removing the GA subscale variable from it, did not produce a good fit ($\chi_{(6)} = 48.127$, $p < 0.0001$). The resulting model with gender as the only predictor significantly deviated from the saturated model. NFI, CFI and RMSEA indices of this latter model had the respective values of 0.821, 0.825 and 0.167, suggesting a poor fit. In a third alternative model, we included GA as the only predictor. This third model also fitted the data well ($\chi_{(6)} = 8.861$, $p = 0.182$). NFI, CFI and RMSEA indices of this last model suggested a good fit with the respective values of 0.967, 0.988 and 0.044. In summary, GA seems to be the single most important factor in determining the attitudes toward GMO.

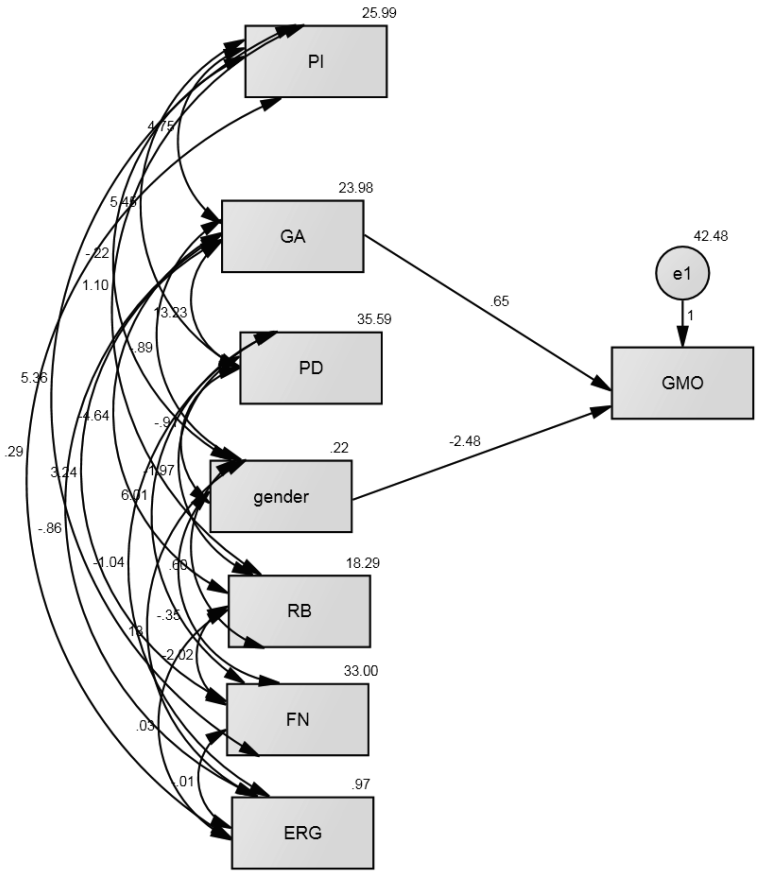


Figure 1. *Path model with the GA and gender as significant predictors of attitudes to GMO*

## DISCUSSION

This study shows that the behavioural avoidance of disease-connoting cues is associated with negative attitudes toward GM products. These results add to findings in the research literature focusing on how the evolved psychological mechanisms protect us against risky events, especially how the vulnerability to infectious diseases influences the acceptance of GM products. Six hypotheses were explicitly tested: Perceived vulnerability to diseases (Hypothesis 1) and sensitivity to pathogen disgust (Hypothesis 2) have been considered to predict negative attitudes toward GM products. Both hypotheses were statistically supported, but the GA subscale derived from the perceived vulnerability to diseases scale (Duncan et al., 2009) showed strongest associations with the attitudes toward GMO. Both aversive affective responses to situations that connote a relatively high likelihood of pathogen transmission and sensitivity to pathogen disgust were activated when respondents expressed their attitudes toward GM products. From a broader evolutionary perspective, the activation of disease-protecting mechanisms is adaptive because controversial products like GM foods (Magnusson & Hursti Koivisto, 2002; Huotilainena, Pirttilä-backman, & Tuorila, 2006; Carlsson, Frykblom, & Lagerkvist, 2007; Knight, Mather, Holdsworth, & Ermen, 2007; Siegrist, 2008; Aerni, Scholderer, & Ermen, 2011) are perceived to be risky for personal health (e.g., Miles et al., 2005; Einsele, 2007; ConsumerChoice, 2008). One would argue, however, that GM products have nothing to do with infectious diseases, thus correlations are haphazard and have nothing to do with disease protection. In agreement with Nesse (2005), Schaller and Duncan (2007) and Schaller and Park (2011), we suggest that the behavioural immune system is activated when respondents are asked to rate GM products, because these products are novel and differ from traditional products. The same mechanism, basically influenced by smoke detector principle, accounts for the aversion toward disfigured people (Park et al., 2003, 2007) or toward harmless animals that resemble insect larvae on corpses (Prokop & Fančovičová, 2010d; Prokop, Fančovičová, & Fedor, 2010a; Prokop, Uşak, & Fančovičová, 2010b; Prokop, Uşak, & Fančovičová, 2010c).

Females and respondents with greater reproductive goals were expected to have more negative attitudes toward GM products (Hypothesis 3 and 6). Hypothesis 3 was supported because females had significantly more negative attitudes toward GM products than males. This is in agreement with previous research in this field suggesting that females are more concerned with gene technologies than males (Christoph, Bruhn, & Roosen, 2007; Magnusson & Hursti Koivisto, 2002; Moerbeek & Casimir, 2005; Prokop et al., 2007; Siegrist, 2003; Simon, 2009). However, there were only very weak correlations between expected reproductive goals and attitudes toward GM products suggesting that reproductive goals themselves are not responsible for more conservative attitudes toward GM products in females while providing no support for Hypothesis 6. This result seems incompatible with previous research which suggested that women were significantly less supportive of reproductive biotechnologies than

men in six out of seven related items relating to reproductive biotechnologies (Napolitano & Ogunseitan, 1999). In their study, Napolitano and Ogunseitan (1999) pointed out that "it is important to recognize that many of the applications [of biotechnology] towards human health issues will likely affect foetuses, mothers, and young children more than adult males and non-childbearing female members of society" (p. 202). However, it must be noted that measures of expected reproductive goals in this study could not reflect the real reproductive goals. Unfortunately, the respondents of this study were childless, thus real reproductive goals could not be investigated properly in this study. Further research should therefore involve women with dependent children and/or pregnant women in analyses and compare their attitudes toward GM products with single women.

Engaging in risky behaviours was expected to correlate with lower concerns for GM products (Hypothesis 4). We suggested that risky behaviours that generally correlate with extraversion (Schmidt, 2004; Zietsch et al., 2010) – a personality trait associated with the risk of being infected (Mortensen et al., 2010; Nettle, 2005; Schaller & Murray, 2008) – would correlate with acceptance of GM products. We found some support for this hypothesis, because there was a negative correlation (albeit small) between the ERG and attitudes toward GMO. Importantly, however, the multiple regression and path analysis showed that this association is weaker than associations between the GA subscale and GMO attitudes. It is possible that this result is influenced by limited types of risky behaviours in the RB scale. For example, engaging in risky sports (Røskaft, Hagen, Hagen, & Moksnes, 2004) and risky sexual behaviours (Schmidt, 2004; Wang et al., 2009; Zietsch et al., 2010) have not been included in our analyses. Further research examining a wide range of risky behaviours is needed to confirm relationships between risky behaviours and the acceptance of controversial technologies.

Respondents with higher food neophobia were expected to show more negative attitudes toward GM products (Hypothesis 5). In our view, GM products represent novel, potentially risky sources of food for the respondents. Thus, we expected that food neophobia, characterized as the unwillingness to consume novel, and thus potentially toxic or nutritionally inadequate foods (Martins & Pliner, 2005; Pliner, 1994) would correlate with the rejection of GM foods (Bredahl, 2001; Tuorila et al., 2001). Correlation between these variables indicated the positive direction that was expected, but the correlation coefficient was very small. These results are close to the findings of Lähteenmäki et al. (2002), who showed a low and non-significant correlation between the attitudes toward GMO and food neophobia. We suggest that at least two reasons could account for the missing correlation between these variables. First, the age group of our respondents is known to have lowest degree of neophobia that peaks in childhood and decreases with age (Dovey et al., 2008). Indeed, the mean score of the FN scale was lower than those reported for Asia in a recent research (29.3 [this study] vs. 33.5 [Choe & Cho 2011]) which was carried out in a sample of older (20 – 40 years) respondents (Choe & Cho, 2011). However, Bredahl (2001) in his cross-cultural study reported relatively low scores in the FN scale

(17 – 21) in a large sample of people with the mean age of about 37 – 45 years which suggests that the age of participants probably did not play a role in low correlations between attitudes toward GM products and the FN scale. Second, visual stimuli evoking disgust or acceptance of potential foods are primarily associated with food neophobia (Dovey et al., 2008), but these stimuli have not been investigated in our research. In the future, one might, for example, test how combining visual stimuli with different types of additives (natural vs. GM) influences the acceptance of these foods in younger respondents.

**Limitations of the study**

This study suffers from several limitations that do not allow for a definite generalization of the results obtained. First, our sample consisted exclusively of university students who are not considered representative of Turkish people. Second, the sample was female-biased, which is a typical problem in data collected from prospective teachers (e.g. Prokop et al., 2007). Third, the age range of selected participants was limited to 18 – 37 years old, childless students. This suggests that the demographic group of customers that buy food for their families, and therefore is crucial for further recommendations for food policy, was not involved in this study. Fourth, the research was carried out in a country where purchasing GM products is still banned by law and, therefore, responses of people who have real experiences with GM products were not obtained. In summary, future research should involve more diverse, unbiased samples of participants from various age groups and/or from countries that differ in GM policy and the availability of GM products. Still, however, the scores of research scales showed considerable variation in our study sample and provide some preliminary and meaningful results, suggesting that this study has merits.

## CONCLUSION

To conclude, our study shows that psychological mechanisms that evolved under natural selection to minimize the risk of being infected by pathogens play an important role in the modern world. Technologically novel GM products that are associated with some health risks activate the behavioural immune system and, as a result, people and especially females who feel themselves more vulnerable to disease transmission reject GM foods more than their less vulnerable counterparts. We found however no strong support for the association between the food neophobia, risky behaviours, the expected reproductive goals, on one hand, and the acceptance of GM products on the other. Future research should consider the role of evolved psychological mechanisms primarily designed to protect us against pathogen threat in the acceptance of risky technologies.

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