The influence of disgust sensitivity on self-reported food hygiene behaviour

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Abstract

The present study aimed to investigate the relationship between people's food disgust sensitivity and their food hygiene behaviour. We asked 1066 participants in Switzerland to complete an online survey. They provided information on how often they performed certain hygiene behaviours, how likely they would be to eat different food items after they had passed their expiration dates, and, using a specific scenario, how they would decide whether milk was safe to drink after they forgot to put it in the refrigerator overnight. We found that food disgust sensitivity was a significant predictor of participants' edibility assessments and their reported frequencies of hygiene behaviour after controlling for age and sex. Our data suggested that food disgust was a strong predictor of food safety behaviour in the domestic kitchen. Learning more about people's behaviour is crucial for the successful design of interventions to improve hygiene behaviour and the prevention of foodborne diseases.

Keywords*: food disgust; food disgust scale; food safety; food hygiene; food safety behaviour.*

1 Introduction

Disgust, which is part of the behavioural immune system (Terrizzi, Shook, & McDaniel, 2013), is an adaptive mechanism that protects us from ingesting dangerous food items that may result in pathogen infections (Curtis, de Barra, & Aunger, 2011). Pathogen infection in the form of foodborne illnesses poses a substantial risk to humans (EFSA & ECDC, 2017; Scallan et al., 2011). In 2017, a total of 4,786 foodborne and waterborne outbreaks were reported across 37 European countries (EFSA & ECDC, 2017). To fight foodborne diseases, it is important to understand consumers' food safety behaviour and to identify its predictors.

So far, a major focus of research on food hygiene has suggested that consumers' knowledge is an important driver of food hygiene behaviour (for example, Al-Shabib, Husain, & Khan, 2017; Ruby, Ungku Zainal Abidin, Lihan, Jambari, & Radu, 2019; Tomaszewska, Trafialek, Suebpongsang, & Kolanowski, 2018). Previous research identified consumers' knowledge gaps in microwave oven safety (New et al., 2017), discrepancies between consumers' knowledge and behaviour (Ruby et al., 2019), and a need for food safety training in various fields of work (Abdelhakim, Jones, Redmond, Hewedi, & Seaman, 2019; Trafialek, Domanska, & Kolanowski, 2019). For instance, it has been reported that even though 86% of consumers indicated that they knew the implications of adequate hand-washing behaviour, only 66% reported actually following these behaviours (Redmond & Griffith, 2003). Similar findings have been reported for observed behaviour. Though participants might have intended to perform a certain hygiene behaviour, the majority was not observed to implement it (Redmond & Griffith, 2003). Therefore, to understand, predict, and train hygiene behaviour, it is necessary to identify factors that contribute to this behaviour that have not yet been recognised.

Another factor that plays an important role in participants' food safety behaviour is sex. Females have been reported to be more likely to follow cooking instructions on packaging (Murray et al., 2017), to be more concerned about food safety , to have more knowledge about correct food hygiene practices (Tomaszewska et al., 2018), and to wash their hands more frequently (Tan, Abu Bakar, Karim, Lee, & Mahyudin, 2013) than males. Males, on the other hand, have been found to take fewer steps to prevent cross-contamination (Murray et al., 2017) and to be at more risk of ingesting a risky meal (Christensen et al., 2005; Lange, Goranzon, & Marklinder, 2016) compared to females. Fischer and colleagues (2006) identified young, single, highly educated males as the group with the highest likelihood of showing incorrect food hygiene behaviour. Therefore, studies investigating food hygiene behaviour should take participants' sex into account.

At its core, disgust serves as a defence mechanism that promotes the behavioural avoidance of pathogens, preventing them from entering the body (Tybur, Lieberman, & Griskevicius, 2009). Food disgust sensitivity, which is an individual's tendency to react with disgust to certain food-specific cues (Hartmann & Siegrist, 2018), protects us from pathogen infection by promoting avoidance behaviour (Woody & Tolin, 2002). Based on the disease-avoidant nature of disgust, it is not surprising that various studies have demonstrated the suitability of disgust as a motivator for hand-washing (for example, Curtis, Danquah, & Aunger, 2009; Pellegrino, Crandall, & Seo, 2016; Porzig-Drummond, Stevenson, Case, & Oaten, 2009), which is of crucial importance in terms of hygiene behaviour. Studies have reported that an olfactory disgust cue significantly increased participants' likelihood of washing their hands (Pellegrino et al., 2016), that with increasing disgust during the preparation of food, the probability that participants would wash their hands also increased (Pellegrino, Crandall, & Seo, 2015), and that disgust was a key motivator of hand-washing behaviour across cultures (Curtis et al., 2009).

Based on these findings, we hypothesized that disgust sensitivity could influence hygiene behaviour beyond hand-washing. With the present study, we aimed to investigate the nature of this influence. We have put the focus on the domestic environment, because the presence of pathogenic bacteria in the home has been demonstrated to be important (Azevedo, Albano, Silva, & Teixeira, 2014) and the majority of food we eat has been prepared at home (Byrd-Bredbenner, Berning, Martin-Biggers, & Quick, 2013). Therefore, a better understanding of the motivators of domestic food hygiene behaviour is important in successfully preventing foodborne diseases, such as campylobacteriosis from poultry (Bearth, Cousin, & Siegrist, 2014). The present study builds on previous research that investigated whether the emotion of disgust can be used to promote hand hygiene (Curtis et al., 2009; Porzig-Drummond et al., 2009) and aims to explore the role of food disgust in people's food safety behaviour. A better understanding of the drivers of consumers' food safety behaviour will allow for more successful and efficient interventions.

2 Methods

2.1 Participants

In July 2018, we conducted an online study with a total of 1122 participants from Switzerland. We recruited participants from an internet panel obtained from a commercial, ISO-certified panel provider (Respondi AG). To ensure an equal number of male and female participants, we applied quotas on sex. Completion of the online survey took around 15 minutes in total. We excluded 34 participants because the time they took to complete the survey was less than half the median of the survey duration calculated for the whole sample (for example, Hartmann, Keller, & Siegrist, 2016). Another 22 participants were excluded due to missing data

concerning their age. The final sample consisted of 1066 participants (50% females). Participants' age ranged from 18 to 88 years (M = 49, SD = 16).

2.2 Questionnaire

We developed the questionnaire both by designing new items and using items from previous studies (for example, Al-Shabib et al., 2017; Bearth et al., 2014; Fischer et al., 2006; Millman, Rigby, Edward-Jones, Lighton, & Jones, 2014; Turconi et al., 2003). The final questionnaire consisted of five sections. The first section included demographic and individual data, such as participants' age, sex, educational level, and dietary habits, for example, whether they were vegan or vegetarian. This section also included questions about who was mainly responsible for grocery shopping in the household.

Self-reported food hygiene behaviour was investigated in the second section. We asked participants to indicate how often they performed 24 behaviours. Responses were given on a six-point scale where higher scores meant that hygiene behaviour was performed more frequently, indicating a higher safety level. The scale also included a seventh option "*I do not know / someone else performs this task*", which was treated as missing data in the analyses. The 24 items were presented in German; their English translation, as well as their source, can be found in Appendix A.

In the third section, we asked participants to rate seven potentially disgusting situations that covered various disgust stimuli (for example, hygiene, interpersonal disgust, or cross-contamination). Some of them were shown alongside a picture. Results of this section have not been discussed further here, because the items concerning interpersonal disgust go beyond the scope of the present article.

In the fourth section, we presented participants with 12 different food items and asked them to indicate, on a scale from 1 (*very unlikely*) to 6 (*very likely*), how likely they would be to consume each item if it had passed its expiration date but still looked and smelled normal (we did not specify by how many days the product had passed its expiration date). After these twelve items, the section ended with a specific scenario, presenting participants with the following text: "*In the morning, you realise that you have left milk in the kitchen overnight."* Participants were asked to indicate how they would handle this situation and were given five possibilities to choose from which differed in their invasiveness: 1 = I discard the milk, 2 = I pour some milk in a glass and inspect it visually, 3 = I smell the milk, 4 = I taste the milk, and 5 = I put the milk back in the refrigerator. The last option was treated as a missing value, because it postponed the decision. If given the opportunity, many participants would probably have indicated multiple options, therefore, we allowed them to choose only one action to identify which was the most important for them.

The fifth and final section included a measure of disgust sensitivity. We used the 8-item short version of the Food Disgust Scale (FDS short, Hartmann & Siegrist, 2018) as a measure of food-specific disgust. The FDS short includes eight food-specific items from different domains of food disgust (meat, mould, fruit, fish, hygiene, vegetable, human contamination, and living contamination). Participants rated these eight situations or products on a scale from 1 (*not disgusting at all*) to 6 (*extremely disgusting*). Sample items were *"To eat with dirty silverware in a restaurant"* or *"To eat brown-coloured avocado pulp".* The scale had good reliability (8 items, $\alpha = .71$, $M = 3.6$, $SD = .9$).

2.3 Data analysis

Two exploratory factor analyses were conducted to identify the underlying factors of items that measured participants' self-reported food hygiene behaviour and their edibility assessments of different types of food items. Factor analytical methods are typically used in consumer studies (for instance, Pacheco et al., 2018) in order to reduce a dataset into a smaller set of factors that explain the maximum amount of variance using the smallest number of explanatory constructs (Field, 2009). To interpret the factor loadings, we used factor rotation (Field, 2009). We chose varimax rotation, which is an orthogonal rotation that maximizes the dispersion of loadings within factors. As a result, a smaller number of variables is loaded highly onto each factor, facilitating interpretation (Field, 2009). We considered factors with eigenvalues larger than one as relevant and made use of the interpretability criterion, that is, we made sure that factors were interpretable. We used the Kaiser-Meyer-Olkin measure (KMO $\geq .5$) and Bartlett's test of sphericity ($p < .05$) to determine the adequacy of the dataset for a factor analytical procedure (Yong & Pearce, 2013). We calculated Cronbach's alpha coefficients to check the reliability and internal consistencies of the new scales (values > .6 were considered adequate). In addition, we investigated the relationship between the retained factors and food disgust sensitivity using Pearson's correlations, and finally, we assessed the influence of food disgust sensitivity on food hygiene behaviour using multiple hierarchical regression models. We analysed all data with Statistical Package for the Social Sciences (SPSS) version 25 (IBM, New York, USA).

3 Results

3.1 Edibility assessment

To assess participants' food management and wastage behaviour, we asked them whether they would still eat 12 food items after they had passed their expiration dates. For meat and fish, participants indicated a lower willingness to consume items past their expiration dates compared to milk- and plant-based products (see Table 1). We conducted a factor analysis on the 12 food items. The overall KMO measure was .93, and Bartlett's test of sphericity was statistically significant ($p < .001$). The eigenvalue larger than one criterion indicated that two factors should be retained. The two-factors solution also met the interpretability criterion and explained 75% of the total variance. In Table 1, we have summarised the factor loadings of the items after varimax rotation. Based on these results, two averaged rating scales were computed. The meat and fish products scale comprised a total of four items that dealt with animal flesh. Specifically, the items described various meat and fish products, and the scale had very good reliability (four items, $\alpha = .92$). The remaining eight items were grouped into the plant and dairy products scale, which contained various plant-based products, such as rice, oil, and vegetables and dairy products, such as milk, yoghurt, and cheese. The plant and dairy products scale had a very good reliability (eight items, $\alpha = .94$).

3.2 Hygiene behaviour

We asked participants to indicate how often they performed 24 hygiene behaviours. We excluded seven items due to their skewed distribution (with mean values above 5), indicating that most participants gave similar responses. We also excluded an item asking participants whether they would eat unbaked dough due to its ambiguity, as we later realised that only dough containing

eggs was a hygienic concern. We then ran a PCA on the 16 remaining items. We excluded two more items due to low factor loadings (< .3). The analyses revealed that the two-factor solution for hygiene behaviour provided the best interpretability and explained 36% of the variance. The overall KMO measure was .81 and Bartlett's test of sphericity was statistically significant (p < .001). The final list of items, including mean values and factor loadings, can be found in Appendix B. Results indicated that participants rated food-related behaviour and cleaning behaviour differently. Therefore, we computed two averaged rating scales. The food-related behaviour scale comprised ten items that dealt with food-related hygiene behaviours, such as washing produce, buying products that are close to their sell-by dates, and personal hygiene during cooking. The scale had good reliability ($\alpha = .70$). The cleaning behaviour scale contained four items that dealt with cleaning behaviour in the kitchen, such as cleaning the kitchen or changing sponges or towels, and the scale had good reliability ($\alpha = .71$).

In Figure 1, we have shown the frequencies participants reported for the 14 hygiene behaviour items. The average group values were higher for food-related behaviour than for cleaning behaviours. The lowest frequencies were reported for using a cutting board for meat only and for changing the dish sponge. High frequencies of behaviour were reported for washing fruit prior to consumption, checking the inside of meat to make sure it is done, and cleaning the kitchen.

3.3 Food assessment

Finally, we included a specific example of food safety behaviour by asking participants what they would do if they realised, in the morning, that they had left milk in the kitchen overnight. A small group of participants (5%) would have postponed the decision by putting the milk back in the refrigerator or would have discarded the milk (11%). Slightly more participants would have

judged from what the milk looked like (15%), and most would have smelled the milk before deciding (43%). About a fourth (27%) would have tasted the milk to make a decision.

3.4 Relationship between food disgust and self-reported food and hygiene practices

The relationships between age, sex, disgust sensitivity, and hygiene behaviour are reported in Table 2. Sex was significantly associated with the FDS short score. That is, males tended to be less food disgust sensitive than females. Furthermore, disgust sensitivity was strongly associated with the edibility of meat and fish products past their expiration dates (the meat and fish products scale; $r = -.43$, $p < .001$). This was also the case with the plant and dairy products scale ($r = -.45$, $p < .001$). Food disgust sensitivity was statistically significantly associated with hygiene behaviour, with a stronger positive correlation for food-related hygiene behaviour ($r = .33$, $p < .001$) than for cleaning hygiene behaviour ($r = .14$, $p < .001$). Results indicated that with increasing disgust sensitivity, the frequency of showing hygiene behaviour also increases.

In the next step, we conducted a series of hierarchical regression analyses to assess the influence of food disgust sensitivity on various hygiene behaviours while controlling for the effects of age and sex. Table 3 shows the hierarchical regression analysis used to predict participants' edibility ratings for meat and fish items from age, sex, and FDS short score. The final model was statistically significant and explained 18% of the variance. After controlling for age and sex, the FDS short was a significant predictor of participants' edibility assessments. That is, participants with higher food disgust sensitivity were less likely than those with lower food disgust sensitivity to rate as edible meat and fish products that have passed their expiration dates. Table 3 further shows the results of a hierarchical regression analysis to predict participants' edibility rating for milk- and plant-based products from their age, sex, and FDS short score. The final model was

statistically significant and explained 21% of the variance. Sex and FDS short score were significant predictors. That is, females and participants with higher food disgust sensitivity were less likely to rate as edible plant- and milk-based products that have passed their expiration dates than males and participants with lower disgust sensitivity.

Next, we conducted a hierarchical regression analysis to predict participants' food-related hygiene behaviour from age, sex, and FDS short score (see Table 4). The final model was statistically significant and explained 14% of the variance. Age and FDS short score were significant predictors. The FDS short was a strong predictor of participants' behaviour frequencies, suggesting that people with high food disgust sensitivity reported higher frequencies of hygienic cleaning behaviour. The hierarchical regression analysis that predicted participants' hygienic cleaning behaviour from their age, sex, and FDS short score has also been shown in Table 4. The final model was significant and explained 7% of the variance. Age, sex, and FDS short score were significant predictors of participants' hygiene behaviour. Females and people with high food disgust sensitivity reported higher frequencies of hygienic cleaning behaviour than males and people with low food disgust sensitivity.

For the milk item, which asked participants what they would do if they realised, in the morning, that they had left milk in the kitchen overnight, there was a significant negative association between the invasiveness of the method used to judge the milk and participants' food disgust sensitivity ($r_s = -.24$, $p < .001$). That is, disgust sensitive participants were more likely to discard the milk, whereas less disgust sensitive participants were more likely to taste it first.

4 Discussion

It has been argued that without disgust and the hygiene behaviours it elicits, infectious diseases would cause far more morbidity and mortality (Curtis, 2011). In the present study, we investigated the role of food disgust sensitivity in people's food hygiene behaviour. We assessed consumers' food management and wastage behaviour, the criteria they used to decide whether a food item was still edible, and their self-reported food hygiene behaviour. Supporting our hypothesis, we found that food disgust sensitivity was a strong predictor of food safety behaviour in the domestic environment. Our study also showed that a product's expiration date is a cue people use to assess edibility or pathogen presence.

4.1 Food management and wastage behaviour

Our results indicated that with increasing food disgust sensitivity, consumers were less likely to consume food products that have passed their expiration dates. Egolf and colleagues (2018) found a positive relationship between the amount of food waste produced by individuals and their food disgust sensitivity. They reasoned that food disgust sensitive people produce more food waste than less food disgust sensitive people, because they are oversensitive to certain cues. Together with evidence from the present study, we argue that one of the cues to which food disgust sensitive participants are more receptive, is a product's expiration date.

The consumption of dry rice that has passed its expiration date is less risky than the consumption of smoked salmon that has passed its expiration date. Therefore, we expected to find differences between participants' edibility assessments across various food groups. Indeed, riskier food items, such as meat and fish products, received lower mean values for their edibility after having passed their expiration dates than plant and dairy products. The finding that various groups

of food products were perceived differently is in line with previous research that identified different degrees of concern for protein foods (fish, meat, eggs, and milk) compared to fruits and vegetables (Ha, Shakur, & Do, 2019). Still, our results indicated that expiration date, in general, is an easy heuristic that disgust sensitive people use to assess food, independent of the food category to which the item belongs, because disgust sensitivity was a significant negative predictor in the regression models for fish and meat products as well as for dairy and plant products. In contrast to more invasive ways of assessing the edibility of a food item, such as smelling or tasting the item, through which people might inhale mould spores or ingest pathogens, assessments based on expiration dates require no direct interaction with the food item itself. It should be noted that we did not specify by how many days the product had passed its expiration date. To build on our results, first, it would be worth investigating whether the number of days by which respective products have passed their expiration dates influences consumers' perceptions. Second, researchers could look at whether products with long shelf lives are perceived differently by consumers than products with short shelf lives.

Finally, we found that, depending on their individual disgust sensitivity, consumers used different strategies to decide whether a food item was edible. Based on the notion that disgust helps us to avoid pathogen infection (Tybur et al., 2009), the finding that disgust sensitive consumers were more conservative in their methods for evaluating the edibility of food items was in accordance with our expectations. In line with Parizeau and colleagues' (2015) findings, we found a connection between the choice of methods used by consumers to assess the edibility of food items and the amount of food waste they produced. Therefore, our results may contribute to the understanding and prevention of consumers' food wastage behaviour.

4.2 Consumers' food hygiene behaviour

Importantly, we found that with increasing food disgust sensitivity, participants reported higher frequencies of hygiene behaviour, in both food and cleaning domains. Food disgust sensitivity explained a substantial amount of variance in food hygiene behaviour. Previous research has identified disgust as a key motivator for hand washing-behaviour (Curtis et al., 2009). Our results indicated that disgust is a motivator not only for hand-washing but also for a whole range of hygiene behaviours.

The frequencies participants reported for taking off rings, watches, and jewellery before cooking were similar to those reported by university students in Saudi Arabia (Al-Shabib et al., 2017). For other behaviours, the reported frequencies in the present study were surprisingly high. For instance, a total of 70% of participants reported that they always or almost always washed fresh fruit prior to consumption. Byrd-Bredbenner and colleagues (2007a), however, found that when they observed young adults preparing a recipe, the percentage of participants who washed produce before cutting was much lower. With this in mind, it is surprising that only 50% of consumers reported that they did not use or rarely used a designated cutting board for the preparation of raw meat. This finding is of concern, as cutting boards have been identified as a key route for cross-contamination (Byrd-Bredbenner et al., 2013). De Jong and colleagues (2008) concluded that separate cutting boards should be used for vegetables and raw meat, because dish-washing was identified as insufficient for the prevention of cross-contamination. Another surprising result was that only 53% of participants reported that they always or almost always used soap when washing their hands during cooking. This is concerning, because hand hygiene is of great importance in the prevention of contamination (de Jong et al., 2008). Furthermore, it has been shown that reported hand-washing behaviour tends to be higher than actual behaviour (Byrd-

Bredbenner, Maurer, Wheatley, Cottone, & Clancy, 2007b), indicating that the actual rate of hand-washing would be even lower than reported.

Regarding cleaning behaviour, most consumers reported that they cleaned their kitchen either every day or every other day. In line with previous research, which has argued that habits are a determinant for the preparation of food and hygiene behaviour in the kitchen (Byrd-Bredbenner et al., 2013; Young et al., 2017), we reason that cleaning the home kitchen is a habitual behaviour consumers perform after the preparation of a meal. Furthermore, the visibility of dirt and existing habits promote the urge to clean (Curtis et al., 2003) and visible cues have been identified as an important driver for consumer confidence in food safety (Lagerkvist, Amuakwa-Mensah, & Mensah, 2018). Indeed, the removal of visible dirt has been identified as a motivation for home hygiene practices (Curtis et al., 2003). A total of 52% of participants reported that they changed their dish sponge less than once a week. Dish sponges can quickly become contaminated with microbes (Byrd-Bredbenner et al., 2013) but this contamination is not visible to the naked eye and is difficult to detect. Therefore, we reason that when participants decide whether to keep or discard a dish sponge, they rely on cues that are easy to detect, such as visible dirt or decay of the sponge.

4.3 Implications and outlook

Young and colleagues (2017) found that for most safe food handling constructs, there were no consistent relationships between knowledge and behaviour. An exception were behaviours related to the prevention of cross-contamination and the practice of personal hygiene. They concluded that interventions focusing on knowledge provision alone may not achieve the best possible results. We argue that, unlike knowledge, disgust can trigger an automatic response, as it

346 is part of the behavioural immune system promoting disease avoidant behaviour. Therefore,
347 consideration of disgust in the design of food safety interventions could significantly contribute to
348 successful outcomes.

349 Porzig-Drummond and colleagues (2009) demonstrated that a disgust intervention were
350 more effective in promoting soap and water usage in restrooms than social norms or knowledge
351 (Judah et al., 2009). The results of the present study add to the evidence that disgust plays an
352 important role in hygiene behaviour, including hand-washing. Therefore, we argue that instead of
353 or in addition to providing people with knowledge, interventions should aim to trigger a disgust
354 response, for instance, by visualizing disgust cues (Porzig-Drummond et al., 2009). Virtual reality
355 is a promising tool in this regard, as it enables researchers to augment the virtual environment with
356 disgust cues that are invisible in the real world. At the same time, the virtual environment remains
357 safe for participants (Botella, Fernandez-Alvarez, Guillen, Garcia-Palacios, & Banos, 2017).
358 Previous research has demonstrated that making contamination visible through microbiological
359 analyses can cause a change in behaviour (Gomes, Lemos, Silva, Hora, & Cruz, 2014). Therefore,
360 we reason that making visible the presence of microbes or the extent of cross-contamination using
361 a virtual environment could trigger hygiene behaviour. With this, virtual reality could also be a
362 promising tool for training purposes.

363 Our findings are also of relevance to the food industry. For instance, a recent study found
364 that the level of compliance with good manufacturing practices (GMP) and hazard analysis and
365 critical control point (HACCP) standards was high in respect of documentation but low in the case
366 of practice (Trafialek et al., 2019). Personnel hygiene documentation and practice were of
367 particular concern. With training programs contributing significantly to the total costs involved in
368 the implementation of GMP and HACCP (Cusato et al., 2014), it is important to identify the most

effective training approach. Based on our results, we suggest that in employee training programs, food industries could make use of disgust to trigger hygiene behaviour and to achieve higher hand-washing compliance rates.

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