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# Gag reflex and disgust sensitivity in selective eaters

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**Gag reflex and disgust sensitivity in selective eaters**

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**Master's Thesis**

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Hayley Nichols

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# Gag reflex and disgust sensitivity in selective eaters

A Thesis
Presented to
The Faculty of
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In Partial Fulfillment
Of the Requirements for the Degree
Master of Arts

by
Hayley Nichols
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# Abstract

The gag reflex evolved to protect individuals from choking, due to the unique overlap between the respiratory and gastrointestinal tracts in adult humans. A potentially related response is disgust, an emotion that influences avoidance of harmful foods. Both responses are protective, but the gag reflex is little studied outside the context of dental procedures. Selective eaters are known to reject foods, particularly vegetables, due to perceived disagreeable textures, tastes, and other sensory characteristics. This study explores two hypotheses to examine possible relationships of these three reactions: 1) stronger gagging will be accompanied by a more sensitive disgust response and 2) selective eaters will exhibit a more extreme response to gag and disgust triggers. Methods consisted of the Predictive Gagging Survey, the Disgust Scale-Revised (DS-R), and an itemized list of behaviors adapted from previous studies distributed to students at Western Washington University. SPSS Statistics 24.0 (2016) is used for statistical analyses. Results supported hypothesis one but rejected hypothesis two. Further tests showed significant correlations between selective eating behaviors and four variables determined through the following surveys: the Predictive Gagging Survey and the DS-R. More studies are needed to elucidate the relationship of the gag reflex and disgust sensitivity to food preferences and selective eating behaviors.

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# Introduction

The gag reflex protects humans from choking to death due to the unique-to-human aerodigestive adaptation that permitted the evolution of speech (Laitman & Reidenberg, 2013; Lieberman, 2012). Much of the research on the gag reflex is addressed in the dental or clinical fields, where a variety of procedures must overcome the reflex and disregard the evolutionary aspects of protection (Anand et al., 2015; Bignardi et al., 2018; Garg, Singhal, Agrawal, & Agrawal, 2014). Failure of the gag reflex can have serious consequences for those with neurological disorders or the elderly (Schindler & Kelly, 2002; Oliveira et al., 2015a). Further, extreme gag responses can negatively impact individuals and contribute to poor oral hygiene (Pradhan & Gryst, 2015; Almoznino et al., 2015). Studying non-extreme responses could give insight into adaptive purposes and connected responses.

The gag reflex is often affiliated with the disgust response ("that is so disgusting. I'm going to gag"). Both responses are thought to protect the gastrointestinal tract. The gag reflex protects through ejection of objects in the esophagus (Akarslan & Bicer, 2012), while the disgust response prevents the ingestion of harmful substances through intense emotional reactions and facial cues (Schienle, Arendasy, & Schwab, 2015; Feder, 2016). However, there are currently no studies testing the relationship between the gag reflex and disgust response. A connection between these two mechanisms could allude to further functional benefits of the gag reflex beyond protection from choking.

The gag reflex and disgust sensitivity may influence eating behaviors. Selective eating is the rejection of new and familiar foods due to sensory characteristics of the food items such as texture, smell, presentation, or taste (Toyama & Agras, 2016; Kauer, Pelchat, Rozin, & Zickgraf, 2015). Selective eating could be another protective mechanism against intaking harmful

substances as it tends to develop in early childhood and last a short period, though it can persist into adulthood (Toyama & Agras, 2016). Research on this topic often focuses on children. However, studies on adults are becoming more prominent, along with connections to psychological disorders (Kauer, et al., 2015; Zickgraf, Franklin, & Rozin, 2016). To date, two studies have connected selective eating to food disgust subscales (Kelly & Ogden, 2016; Hartmann & Siegrist, 2017). Only one study has linked selective eating to general disgust sensitivity (Kauer et al., 2015). Connecting the gag reflex to selective eating could show how the gag reflex affects an individual's eating behaviors and nutrition.

This study examines the relationship between the gag reflex, disgust sensitivity, and selective eating through two hypotheses: 1) stronger gagging will be accompanied by a more sensitive disgust response and 2) selective eaters will exhibit a more extreme response to gag and disgust triggers. Chapter one explores research on evolutionary changes to the throat, purpose of the gag reflex, and implications of the reflex. Chapter two discusses the biological and cultural influences on disgust sensitivity and details food related triggers. Chapter three explains the development and persistence of selective eating and associated behaviors.

To test this study's hypotheses, the Disgust Scale-Revised (DS-R) (Haidt, McCauley & Rozin, 1994, modified by Olatunji et al. 2007), the Predictive Gagging Survey (Hearing, Bind, Tabacco, & Hallock, 2014), and an itemized eating behavior survey adapted from Kauer et al. (2015) are utilized. To my knowledge, this is the first study that measures the gag reflex in combination with eating behaviors and disgust sensitivity.

# Chapter 1: Anatomy and physiology of the gag reflex

This chapter will describe the development of the human throat, adaptions for speech, and current gag reflex research. The gag reflex protects the upper Gastrointestinal tract (GI) by ejecting unpalatable foods or unexpected debris on route to the lungs (Akarslan & Bicer, 2012).

In most mammals and human infants, the larynx is positioned anteriorly such that the epiglottis connects to the soft palate locking the larynx with the nasopharynx, preventing the aspiration of food (Laitman & Reidenberg, 2013; Lieberman, 2002; Wind 1970). Food and liquid are forced around the larynx creating separate digestive and respiratory tracts. In adult humans, however, there is overlap creating a unique aerodigestive tract that is more vulnerable to blockage (Lieberman, 2012). Therefore, the gag reflex is a protective response for animals to dislodge substances caught in their digestive tracts or breathing tube, but it is a critical defense for humans.

## Evolution of the human throat

Speech provides many adaptive benefits, but there is a cost. The capacity for human speech involved many anatomical changes in the mouth and throat (Lieberman, 1994, 2000). Articulation of sounds requires rewiring of the brain to increase control of tongue, lips, and diaphragm and to interpret the sounds. To produce and articulate vowel sounds, the intersection of the respiratory and digestive tracts shifted more posteriorly (opening of the larynx), which increases the risk for choking (Lieberman, 2012). These anatomical changes increase the overlap between the esophagus and larynx, meaning there is a greater risk of substances entering the air pathway, leading to suffocation if the obstruction is not dislodged. Gagging can help displace the item.

In adult humans, as food travels through the oropharynx, the epiglottis collapses to cover the larynx so that the food can pass through the esophagus without entering the larynx (Sherwood, 2013, p.592). This process can be interrupted by the gag reflex if the soft palate or opening of the larynx are stimulated through muscle contractions at the back of the throat. This muscle contraction is activated through a series of cranial nerves. Messages from the stimulated area are carried from the pharynx, tonsils, epiglottis, and back of the tongue by the glossopharyngeal and vagus nerves to the medulla oblongata in the brain (Figure 1) (Muller et al., 2013).

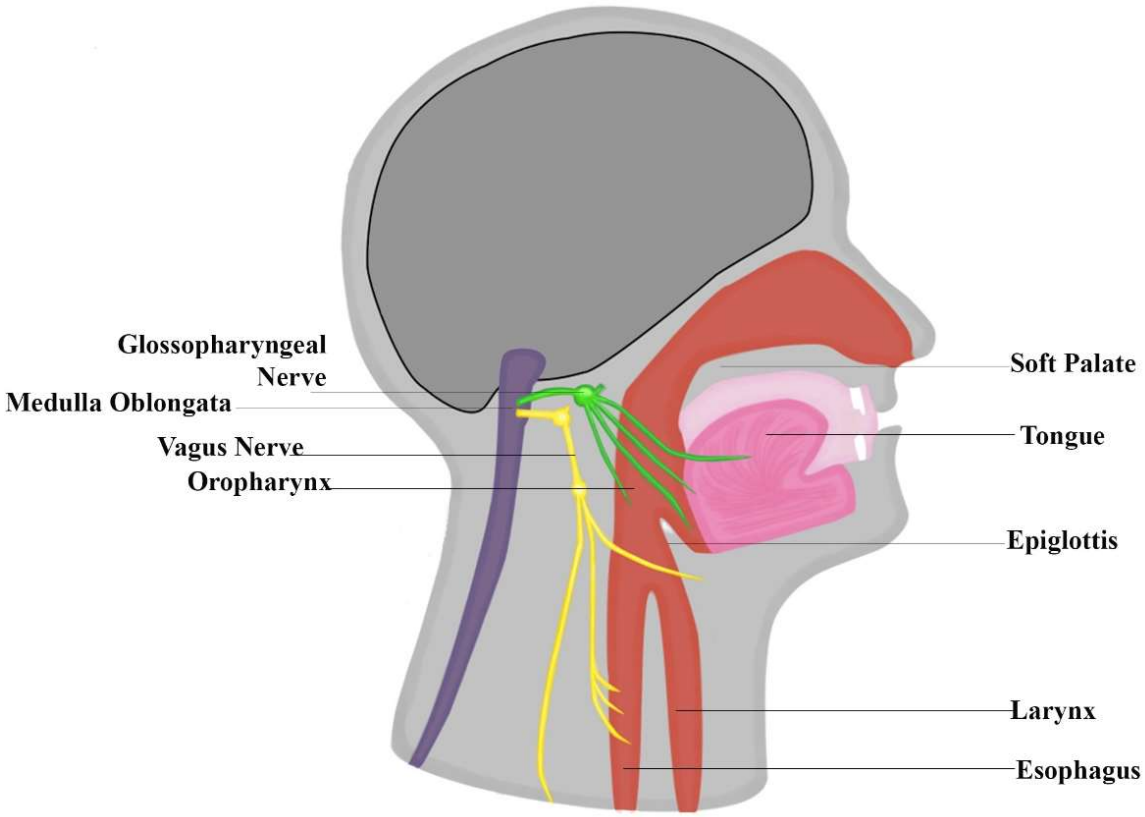


Figure 1. Anatomy of adult human throat with nerve innervations. Illustration by Bea Franke.

The vagus nerve then carries the signal back, resulting in constricting of the posterior oral and pharyngeal muscles, preventing foreign objects from entering the trachea. Both the glossopharyngeal and vagus nerves carry motor and sensory signals for the muscles of the

pharynx and taste buds. More specifically, the vagus nerve supplies the thoracic and abdominal organs, along with the taste buds on the tongue and pharynx. The glossopharyngeal nerve carries afferent sensory signals (from stimulus to brain) and efferent motor signals (towards the muscle). The gagging center in the medulla oblongata is close to the center for controlling vomiting, salivating, & cardiac responses, therefore, these may accompany a gagging episode (Almoznino et al., 2016).

There are two main types of gagging, somatic and psychogenic (Fiske & Dickinson, 2001). Somatic gagging typically occurs from tactile stimuli on five zones: anterior and posterior faucial pillars, the base of the tongue, soft palate, uvula, and posterior pharyngeal wall (see Figure 2) (Scarborough, Kuren, & Hughes, 2008).

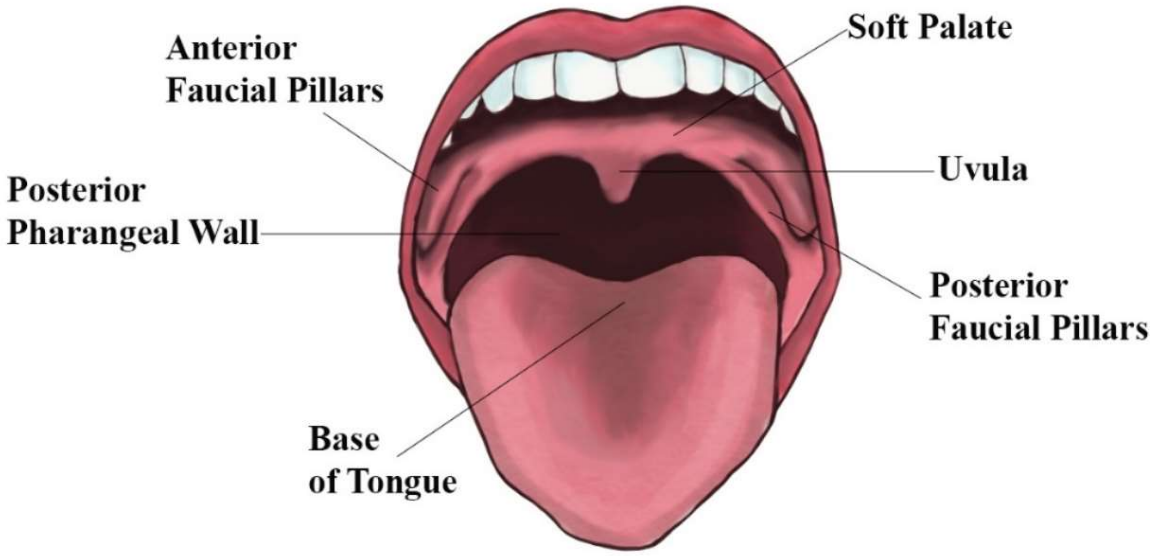


Figure 2. Anatomy of the mouth showing gag reflex stimuli zones. Illustration by Bea Franke.

The most studied gag reflex triggers are touch stimulus, dental anxiety, or Blood-Injection-Injury phobia (B-I-I) (Almoznino et al., 2016). Some studies briefly state psychogenic gagging, which has psychological triggers rather than physical ones (Singh, Ali, Nazirkar, Dole,

& Gaikwad, 2013; Dickinson & Fiske, 2005). However, only one article was found that directly asked patients about this type of gagging (Murphy, 1979).

Psychogenic is the term used for gagging that occurs without direct tactile contact; triggers can include smells, tastes, and textures of certain foods. Thinking about a trigger and gagging is also in this category (Murphy, 1979). The psychological mechanisms behind psychogenic gagging are not well researched. Most of these triggers are still sensory based, yet the term "psychogenic" groups them and remembrance of a trigger together.

Psychological factors contributing to gagging can be influenced by classic and operant learning history (Bassi, Humphris, & Longman, 2004). Classic learning history is when individuals associate a stimulus with a cause such as sounds in a dental office (drill) or the sight of a dentist coat to a previous negative gagging experience. Operant conditioning is positive or negative reinforcement, such as an incident where gagging stops a dental procedure, which could increase the likelihood of the patient gagging in the future.

**Dental research and implications**

The protective gag reflex occurs in a broader range of contexts and is documented during dental procedures when the soft palate is stimulated by touch or an instrument. Previous gag reflex research is mostly limited to dental or clinical fields as severe gagging can influence personal dental care (Rosted & Warnakulasuriya, 2005). Almoznino et al. (2016) even claims that gagging is limited to dental situations.

Almoznino et al.'s (2016) study states that gagging does not affect eating or daily activities. However, the study they cite only claims that individuals can still eat (Fiske & Dickinson, 2001). Neither study specifically addresses eating behaviors and food rejection or

how gagging may affect the quality of an individual's diet. This claim that gagging does not affect eating is too broad of a statement that needs to be further tested.

Approximately eighty-seven percent of dentists report that they deal with gagging problems at least once a month (Akarslan & Bicer, 2012), much of this research focuses on severe gagging in patients, since mild gagging is easy to overcome during dental procedures (Bassi et al., 2004). These studies examine patient comfort and the manner in which doctors may prepare for gagging situations during dental procedures such as behavioral, cognitive behavioral, sensory flooding, and pharmaceutical treatments.

A few neurological studies venture outside of the dental and clinical fields, testing for connections to age and loss of function due to neurological disorders. Findings indicate that the gag reflex is highly age-dependent; elderly populations can have much lower percentages of individuals with a gag reflex (Lim, Hew, Lau, Lim, & Tan, 2009). It is also a problem for the elderly and swallowing is difficult for many with pathological conditions. Lim et al. found that 90% of their younger group had an active gag response, but only a third of their elder group expressed a gag reflex (2009). In another study, Davies et al. (1995) found the gag reflex was present in 57% of their elderly group and 74% in their younger group. These findings indicate that the gag reflex could lose function later in life.

Too little is known about the gag reflex shared with all mammals. In humans, gagging is uniquely protective, but there is always the potential to choke if gagging becomes vomiting. The current research on the gag reflex fails to explore possible relationships to other sensory sensitivities or eating behaviors. There is currently no research on the relationship between the gag reflex and disgust (discussed in Chapter 2). However, like the gag reflex, disgust is shown to relate to tactile stimuli (Croy, Drechsler, Hamilton, Hummel, & Olausson, 2016). My research

will be the first to test the connections between the gag reflex and disgust and how they may be related to selective eating behaviors. Finding correlations to other protective mechanisms, especially one as highly studied as disgust, can help to more accurately identify individuals who are at risk of gagging during dental procedures.

# Chapter 2: Disgust sensitivity

This chapter introduces the disgust response, evolutionary theories on the development of disgust, and cultural influences on triggers. Emotions can affect how we process information and have many evolutionary advantages (Al-Shawaf, Conroy-Beam, Asao, & Buss, 2014). Disgust is considered one of six universal emotions, along with fear, surprise, happiness, anger, and sadness (Olatunji, Haidt, McKay, & David, 2008).

Disgust drives behavioral avoidance of triggers such as rotten foods, insects, or people with signs of illness (Feder, 2016). The gag reflex is the physical response to triggers (see previous chapter), while disgust is an emotional response. Only one study mentioned both terms, "I am going to gag: Disgust cognitions in spider and blood-injury-injection fears" indicates gagging but does not discuss it further in the article (Teachman & Saporito, 2009). This article does not mention the gag reflex throughout the body of the article, showing that disgust and gagging are assumed to be related or interchangeable.

## Introduction to the disgust response

The disgust response can be triggered by sensory cues such as smelling something rotten or eating bitter tasting substances (Rozin, Lowery, & Ebert, 1994). Many gag and disgust triggers overlap, such that if someone is exposed to a trigger, they may activate both the disgust response and gagging.

Each emotion has a distinct facial expression that is universally expressed and is controlled (Tettamanti, Rognoni, Cafiero, Galati, & Perani, 2012). The "disgust face" is typically characterized as a raising of the lips, wrinkling of the nose, and scrunching of the forehead (Herz, 2014). This facial reaction helps us to express our disgust towards triggers (Rozin, Lowery, & Ebert, 1994).

Disgust can be categorized into many domains, which are based on specific triggers; the boundaries and number of these domains are highly debated (Feder, 2016). Two of the larger domains are visceral and moral disgust. Both domains can be broken down and categorized further. Visceral triggers relate to pathogens, disease, and body products. This study focuses on three visceral disgust categories: core disgust, animal-reminder disgust, and contamination disgust. Core disgust triggers relate to disease and oral ingestion of dangerous substances. Animal-reminder disgust triggers involve mortality and reminders of our animalistic nature. Contamination disgust relates to dangers of contamination in food, poor hygiene, or body secretions (Berger & Anaki, 2014; Olatunji et al., 2008). Scales created to study disgust are designed to test disgust sensitivity, which is the degree an individual experiences disgust towards common triggers (Sherlock, Tybur, Zietsch, & Jern, 2016). Both biological and cultural factors influence disgust sensitivity.

**Evolutionary theories of disgust and "disgust face"**

The most popular hypothesis for how we developed disgust is that disgust evolved as an avoidance behavior to protect the gastrointestinal tract from the intake of poisonous or harmful foods (Schienle et al., 2015). This hypothesis can be supported by Vicario et al. (2017) who found that when a person is exposed to images of rotten foods or another individual showing distaste, they exhibit anticipatory inhibition mechanisms such as decreased tongue motor-evoked potentials (MEPs) and tongue representation motor cortex suppression. These decreased physiological responses would negatively affect swallowing of foods, signaling the body to slow the ingestion of the food. This could give the body time to reject ingested harmful substances, supporting that disgust evolved to inhibit oral ingestion of harmful substances. It is unknown why non-food triggers are so common (Hartmann & Siegrist, 2017; Vicario, et al., 2017).

The strongest connection of disgust to food consumption is the avoidance of bitter foods. The "disgust face" muscle movements are similar to facial responses to tasting bitter compounds (Rozin, Lowery, & Ebert, 1994). This is a further argument on how disgust evolved to protect the gastrointestinal tract.

Reactions to bitter taste can be a protective behavior as bitter can indicate harmful toxins or bacteria (Wardle & Cooke, 2010). To test bitterness, PTC and PROP (propylthiouracil) taste strips are most commonly used. Individuals report test strips containing the compound as 'little bitterness or no taste,' 'moderately bitter,' and 'highly bitter.' Those that state the PTC taste strip is moderately bitter are 'tasters,' while those that label them 'highly bitter' are supertasters. Disgust has shown significant relationships with increased intensity of bitterness tasting (tasters and supertasters) (Schienle et al., 2015). Herbert et al. (2014) illustrated that PROP tasters showed stronger and more frequent emotional responses such as fear, anger, disgust, and pleasure to visual stimuli.

There has been a recent trend towards how disgust can affect individual food preferences as well (Hamerman, 2016; Grabowski, Mengden, von Brethorst, & Kleint, 2018). Food and taste preferences are greatly affected by social experiences and cultural taboos (Shutts, Kinzler, & DeJesus, 2013). Children learn what foods to eat by observing their parents, siblings, friends, etc. They look for cues from them for what is ok to eat, and what is not. Aunger (2000) discusses how children go through phases of learning food taboos. In the first stage, children are innocent of cultural food taboos, meaning they tend to eat whatever they wish.

The second phase, starting at around 11, children are enculturated heavily by their parents and are eating diets similar to their parents. In the third phase, they are influenced by people outside of their families (such as peers and friends), altering their diets again. Based on this,

Askew et al.'s (2014) study on children rating animal photos as more disgusting after seeing an adult's reaction could be applied to food as well. Seeing the "disgust face" expressed from a parent or peer could be a cue for the child that the food is not good to eat. Therefore, if a child sees an adult making the "disgust" face while eating a particular food, they may not accept it.

Taste sensitivity to bitterness has a limited relationship with food preferences (Catanzaro, Chesbro, & Velkey, 2013). This indicates that cultural influences could be more influential on individual food preferences. This study methods focused on surveys and did not use PROP or PTC strips. However, it is important to mention that bitterness is found in both disgust and selective eating research.

An alternative hypothesis for the development of disgust includes behavioral avoidance of pathogen transmission through other humans as disgust can be elicited by individuals with illness cues such as mucus, coughing, and vomiting. Rottman (2014) argues that these triggers suggest that disgust could be more adaptive for living in close proximity. The evolution of disgust likely stems from a combination of both instead of having one specific function due to the range of triggers.

Genetic information on disgust is limited. Sherlock et al. (2016) examined the genetics of disgust sensitivity between female identical and non-identical twins and their other siblings to investigate how much variation in individual disgust sensitivity is due to genetic factors. Sherlock found that about fifty percent of the variation in disgust sensitivity to pathogens, sexual behaviors, and morals is due to genetic effects. Pathogen and sexual disgust sensitivity are shown to be influenced by unique sources of genetic variation on top of a common genetic influence across all disgust domains.

Expression of emotion, such as facial reactions, can be evolutionarily advantageous and even selected for in groups (Boone & Buck, 2003). Social animals commonly express facial reactions which are tied to group communication and cooperation (Schug, Matsumoto, Horita, Yamagishi, & Bonnet, 2010). Facial reactions are important for the identification of threats such as possible ingestion of harmful substances and threatening actions from other species or within the same species.

Apes tend to have more intricate facial muscle structures than other animals, which allows for more nuanced facial reactions (Kemp & Kaplan, 2013). These facial reactions are unique for each emotion. Having more intricate facial muscles allows for more obvious facial muscle movements to express emotions (Kemp & Kaplan, 2013). Apes are also known to interpret and understand directedness of facial reactions; they can understand where or who the facial expressions are directed towards (Buttelmann, Call, & Tomasello, 2009). These characteristics would make it easier for apes to communicate emotions using facial reactions.

Kawai et al. (2016) tested if facial reactions were easily identified as a threat, or if accompanying behavior or vocalization was needed to process. Japanese Macaques and humans were shown pictures of male monkey facial reactions. Both species responded more quickly to pictures of a threatening male monkey facial reaction in a group of neutral faces than a neutral face in many threatening faces. This shows that both the Macaques and humans could process a threat given only facial expressions. However, there has been little standardization in descriptions between species (Parr & Waller, 2006). Therefore, each species could have different ways in which they express facial reactions and how they are interpreted. Recognition of facial reactions has limitations. Thresholds of facial reactions need to be met for someone to recognize one of the six basic emotions (Calvo, Avero, Fernández-Martín, & Recio, 2016). For recognition

of disgust, about 40% of facial intensity (facial movements related to the disgust face) needs to be met. This is the same for sadness, surprise, and anger.

There are some genetic similarities found within families. Kendler et al. (2008) examined genetic influences on emotional facial expressions to films between identical and non-identical twins raised apart. They found that facial expressions were correlated between the twin pairs, suggesting that resemblances in emotional facial reactions are influenced by genetics, depending on the emotion. This study had a small sample size and did not look for specific genetic influences, only the facial reactions to the films presented. Further, individuals born blind still produce facial expressions for the six basic emotions, with more similarities in refined facial movement within families (Peleg et al., 2006).

There is still unexplained variation between individuals in the expression and intensity of reported disgust. Rodger et al. (2015) suggests that many demographic factors can affect disgust sensitivity such as sex, education, religion, and age. However, the current literature is inconclusive on which have a large effect and to what degree (Berger & Anaki, 2014). The specific triggers that activate the disgust response can be learned and influenced by culture.

**Learned and cultural influences on disgust**

The survey used in this study was the Disgust Scale-Revised (DS-R) (Appendix B), the newest version of the most widely used method to test disgust sensitivity. This scale, however, would only be useful in cultures with similar disgust triggers, specifically western, educated, industrialized, rich, and democratic (WEIRD) societies (Henrich, Heine, & Norenzayan, 2010). The DS-R is not useful in studying populations that are not WEIRD.

Culture is a shared set of concepts, images, and ideas which enable individuals within the same culture to interpret the world in roughly the same way (Hall, 1997). Disgust triggers can

vary based on differing environmental impacts and cultural influences, making it difficult to conduct cross-cultural comparisons. Learned behaviors and cultural influences can shape disgust triggers. This can be seen with the "germ theory" and aversions to the consumption of insects which are common in westernized societies (Feder, 2016; Hamerman, 2016).

The influence of learned responses to disgust triggers is seen in the behavior of young children. Askew et al. (2014) tested how the "disgust face" could affect interpretation of images in children. Children were shown animal photos, then animal photos paired with adults expressing the disgust facial reaction. The children from this study rated pictures as more disgusting after being exposed to the disgust facial reaction of an adult. Therefore, children can be taught to have higher disgust sensitivity towards different triggers at a young age (Askew, Cakır, Põldsam, & Reynolds, 2014). This shows that perspectives on contamination can be shaped through social transmissions of disgust and contamination beliefs (Siegal, Fadda, & Overton, 2011). This study gives an idea of how learned behaviors can shape culturally-specific disgust triggers.

Culturally-bound triggers relate to Mary Douglas' work on pollution beliefs and food taboos. Pollution beliefs are culturally-specific explanations to why we avoid specific "triggers" or stimuli such as germ theory where illness is explained through microorganisms (Feder, 2016). The relationship between disgust and pollution beliefs can be seen in how this knowledge is transferred between people. According to Mary Douglas, pollution beliefs and food taboos are reflections of historical and social concerns with many boundaries and categories (Ellis, 2011). Similarly, disgust triggers are thought to reflect culturally-specific pollution beliefs and are divided into subcategories, which are the disgust domains.

The interaction between pollution beliefs and individual reactions can be thought of as feedback loops where disgust is the initial driving force. Without disgust, it would not be possible to learn new triggers. Feder describes contamination appraisals as the response to possible triggers, this could be using hand sanitizer after touching a grocery cart. Contamination appraisals can be thought of as the bridge between disgust and culturally-specific pollution beliefs.

In these feedback loops, individual experiences affect the collective pollution beliefs which, in turn, will affect an individual's disgust triggers. Even if an individual has never encountered a specific trigger, they may express disgust upon first seeing it due to transmitted pollution beliefs. For this information to be passed to others, disgust needs to be expressed in a way that others can interpret it, such as easily recognizable facial reactions, which, according to Feder (2016), would be a form of contamination appraisals. The disgust response, specifically the "disgust face" can contribute to group knowledge and avoidances through non-verbal cues.

The disgust facial reaction is thought to warn other group members of possible pathological threats and contribute to culture-specific pollution beliefs through interactions between individuals and learned avoidances (Feder, 2016). This can explain culturally-, family-, and individual-specific disgust triggers as people are exposed to many different groups and individuals throughout their lives who have different pollution beliefs that may be transferred through these feedback loops.

## Conclusions

Disgust is considered to be universally understood and expressed cross-culturally. However, specific triggers vary depending on cultural beliefs. The gag reflex and disgust response are both protective mechanisms for the gastrointestinal and respiratory tract, however,

in the literature search for this study no direct research was found connecting these protective responses. This study will compare the strength of the gag reflex and disgust sensitivity to see if these mechanisms are strongly related. This study will then explore connections to selective eating behaviors, which is further explored in the next chapter.

# Chapter 3: Selective eating

This chapter discusses the common eating behaviors and development of selective eating, along with connections to disgust in the literature. Extreme reactions to foods include gagging, facial displays of disgust, and food avoidance or selective eating. Cross cultural literature suggests that up to fifty percent of children will be selective eaters at some point in their lives (Thompson, Cummins, Brown, & Kyle, 2015). This percentage suggests that selective eating is a normal development and is usually short-lived; however, sometimes this behavior can persist for years (Cardona Cano et al. 2015). Selective eaters represent a subset of the population in which individuals reject many types of food as unpalatable, potentially leading to malnutrition (Maitre et al., 2014; Hegazi, Sehlo, Al-Jasir, & El-Deek, 2015).

There is no standardized definition of "selective eating," which is also known as "picky eating" or "fussy eating" (Toyama & Agras, 2016). Many studies have variations in identifying selective eaters such as asking if the individual is a selective eater or using previously utilized or new eating behavior surveys (Dovey, Staples, Gibson, & Halford, 2008). In this study, selective eaters are defined as individuals who eat a restricted variety of foods through the rejection both novel and familiar foods due to sensory characteristics (Toyama & Agras, 2016; Kauer et al., 2015).

Similar eating behavior questions to the ones used in this study were used by Kauer et al. (2015), Wildes et al. (2012), and Ellis et al. (2017) to evaluate selective eaters. The eating behavior questions for this study reflect eating behaviors that are commonly associated with selective eating as outlined by these studies. Many of the surveys try to determine which foods are avoided and if the individual expresses food neophobia.

This eating behavior is often viewed with negativity (Bisogni, Conners, Devine, & Sobal, 2002). Selective eating is thought to be a behavioral problem with children and not an eating disorder (Jacobi, Schmitz, & Agras, 2008). Selective eating behavior during childhood can be frustrating for parents (Horodynski & Arndt, 2005; Toyama & Agras, 2016). Therefore, it is commonly studied in children as parents worry if their children are getting the nutrients they need during development (Kauer et al., 2015). This has prompted a lot of behavioral and nutritional value studies for this topic. Recently there has been a rise in studies examining adult selective eating behaviors.

**Food avoidance and neophobia**

Food preferences vary cross-culturally relative to local ecologies, but within a culture, individuals differ in their responses to traditional foods (Feder, 2016; Tan, van den Berg, Stieger, 2016; Tan et al., 2015). Selective or "picky" eaters are often identified by the range and variety of foods they eat (Bisogni, et al., 2002). Therefore, any eating behaviors that restrict the consumption of foods can often be lumped under selective eating.

It is unclear if individuals with religious or ethical food aversions or health concerns restricting their diet will consider themselves as selective eaters. Also, children with food allergies that require them to have a strict diet (such as a cow's milk allergy) reported to higher rates of selective eating and feeding difficulties (Maslin, Dean, Arshad, & Venter, 2015).

Individual reasons for rejecting foods are many and can be triggered by responses to texture, taste, smell, degree of familiarity, how prepared, cultural and psychological associations, and with whom the foods are eaten (Kauer et al., 2015; Van Tine, McNicholas, Safer, & Agras, 2017). Kauer et al. (2015) found that self-identified adult selective eaters rejected food based on sensory characteristics such as texture, color, and taste were less likely to express enjoyment of

eating and were more likely to have unhealthy eating habits. Werthmann et al. (2015) also tested sensory rejection using yogurt for taste, sight, and texture. In this study, children were given a baseline yogurt and a variation of the yogurt. They changed the color using food coloring, changed the flavor, but kept the same color, and added lumps of fruits that correlated with the yogurt flavor to test texture sensitivity (Werthmann et al. 2015). They concluded that the number of bites a child took (food acceptance) did not correlate with parental reports of selective eating.

The 'textured' yogurt with fruit pieces did show a significant decrease in consumption. However, the children eating this yogurt could not like the specific fruit added, or not enjoy fruit in general. The children were also not asked why they disliked that particular yogurt; it was only assumed that it was due to the texture and not a general dislike of fruits. However, Werthmann et al.'s (2015) want to assess 'lumpiness' is validated by Kauer et al. (2015) who interviewed 489 self-identified adult selective eaters, many of whom described certain textures they disliked such as 'slimy or slippery' and 'lumps' or mixes.

Werthmann et al.'s measure of acceptance using the number of spoonfuls the children eat is further explained in Boquin et al.'s (2014) study. In their study, Boquin et al. found a correlation between the percentage of meal consumption and picky eating. Non-picky eaters were more likely to consume a higher percentage of their meals and have higher acceptance rates for foods such as hard-boiled eggs, peas, carrots, orange juice and several other food items on their surveys than picky eaters. His study also found that picky eating children and their parents had more differences in the foods they enjoyed than non-picky eating children and their parents (Boquin, Smith-Simpson, Donovan, et al. 2014).

Selective eaters are often shown to have strong likes and dislikes for foods, refusal of new foods, tantrums after food denial, special food preparation requests, and difficult meal time

behavior (Mascola, Bryson, Agras. 2010). Mascola et al's study followed 120 children from ages 2 to 11 years with 40% having a duration of selective eating behavior for more than 2 years. Children who showed food refusal, poor eating, and difficulties in having a daily eating routine at early ages (tested at 4-6, 12-15, 24, and 48-54 months) exhibited less fruit and vegetable intake at ages 4-5 years which can be correlated to selective eating (Oliveira, et al., 2015b). This indicates that selective eating behaviors can have lasting effects on food preferences.

Another reason for the rejection of foods is how familiar it is to the individual. For example, vegetable exposure at a young age is significantly correlated with preference for and quantity of vegetable intake in adulthood (Haire-Joshu, Kreuter, Holt, et al., 2004). Vegetable avoidance is a large part of selective eating research. Many believe that the more bitter taste of vegetables contributes to higher avoidances. However, it is unclear if any food groups are consistently missing from selective eaters' diets (Loomis et al., 2017).

Food neophobia is defined as avoidance of or unwillingness to try new foods and is common amongst selective eaters (Wildes, Zucker, & Marcus, 2012; Dovey et al., 2008). Food neophobia is distinct from selective eating. Selective eaters tend to reject new and familiar foods and are often categorized as having lower variety in their diets (Dovey et al., 2008). Food neophobia is only relating to the rejection of un-familiar foods. Children are typically not labeled food neophobic until they still reject foods after 15 exposures as it can take 8-15 exposures to new foods for children to accept them (Lam, 2015). Like selective eating, this behavior typically develops in early childhood, peaking between 2 and 6 years old and decreases with age, it is debated at what age this behavior typically stabilizes (Dovey et al., 2008).

There is some disagreement on factors contributing to food neophobia, such as if the foods look similar to past disliked foods (or amount of isolation from culturally diverse foods

(Dovey et al., 2008). Individuals who grow up with access to higher varieties of foods (typically urban areas) are less like to develop food neophobia (Dovey & Shuttleworth, 2006).

**Development of selective eating**

Selective eating often occurs in early childhood and is typically a short-lived developmental phase (Thompson et al., 2015). It is highly reported in children under the age of 7 years old. However, estimations are variable between studies (Jacobi et al., 2008). Selective eating can persist into adulthood, causing concern on long-term undernourishment and obesity (Loomis et al., 2017). However, it is unclear if selective eating has significant negative nutritional impacts. Research on selective eating is still emerging and is not standardized.

Individuals can develop selective eating behaviors later in life, though adult selective eaters often exhibit selective eating behaviors since childhood (Van Tine et al., 2017). Studies on adult selective eaters tend to focus on other psychological associations that may contribute to this continued behavior (Zickgraf et al., 2016). Selective eating in adulthood can be confused with eating disorders. Wildes et al. (2012) proposed that there were two distinct groups of adult selective eaters. One group included adults that had never modified their selective eating behaviors since childhood. The other group included selective eaters with additional disordered eating issues (Wildes et al., 2012). Thus, selective eating in adults is not considered an eating behavior on its own; however, it can coincide with eating disorders, amplifying the negative health repercussions of selective eating.

Kauer et al. (2015) completed two studies to find out how selective eating affected dietary habits and its associations to mental health (obsessive-compulsive disorder (OCD), depression, neophobia and disgust sensitivity levels). Kauer et al. (2015) found that selective eaters had significantly higher rates of OCD symptoms, food neophobia, disgust sensitivity, and

were more likely to be diagnosed with clinical depression. However, general neophobia and disordered eating (less severe eating disorders) did not seem to be affected by selective eating. Similarly, ADHD is found to be associated with selective eating, possibly due to higher oral sensitivity (Ghanizadeh, 2013; Zucker et al., 2015).

Family and social interactions play a large role in the development of healthy eating habits, along with personal preferences and development. Thompson et al. (2015) found that self-identified selective eaters in the United Kingdom tended to have strong physical and emotional reactions toward certain foods and distressing and alienating social food experiences. Children exposed to healthier family mealtimes in toddler years are more likely to continue healthy eating habits into adulthood (Cathey, & Gaylord, 2004). Toddlers in Horodynski et al.'s (2010) study were less likely to consume fruits and vegetables if their mothers labeled them as "picky eaters" and if the mothers themselves consumed fruits and vegetables less than 4 times a week. This shows how social interactions involving food as a child can contribute to the persistence of selective eating into adulthood. Similarly, children surrounded by many adults eating novel foods were more likely to eat them as well (Dovey et al., 2008).

Prolonged picky eating can result in many issues outside of meal time including social avoidance, anxiety, and conflict (Nicholls, Christie, Randall, et al. 2001). This could be due to possible eating situations in which a picky eater may have to try new foods in restaurants or houses and do not feel comfortable (don't want to be seen as rude for rejecting foods).

**Disgust and selective eating**

Food can cause sickness, and thus, one would anticipate that it is important to signal others of danger if food elicits a negative response (Feder, 2016; Burrows, Li, Waller, et al.,

2016). This relates to the "disgust face" mentioned in the previous chapter. This facial reaction would help others determine if the food was unsafe for consumption.

Throughout the literature search for this study, only one article could be found that directly tests the relationship between overall disgust sensitivity and selective eating. Kauer et al. (2015) uses the Disgust Scale (Haidt, McCauley & Rozin, 1994) and eating behavior questions to determine correlations between selective eating and disgust sensitivity. They found that selective eaters scored higher on the Disgust Scale (were more disgust-sensitive) than non-selective eaters. Selective eating was a predictor of higher disgust sensitivity, and they found significant differences between the selective and non-selective groups.

Kauer et al may be the only ones to directly test the relationship between disgust and selective eating, some have overlapping ideas. For example, Hamerman (2016) and Grabowski et al. (2018) explore different preparatory ways that could reduce disgust towards the consumption of insects. This theme of preparing foods differently and encouraging children to be a part of the cooking process to encourage consumption is also seen in the selective eating literature (Matheson, Spranger, & Saxe, 2002; Maslin et al., 2015).

Selective eating can be related to higher emotionality and behavioral problems in children (Machado, Dias, Lima, Campos, & Gonçalves, 2016). Higher emotionality in selective eaters could relate to increased expression of disgust as these tests tend to use negative emotions. However, Machado et al. does not detail specific emotions, instead using the Child Behavior Checklist (Achenbach & Rescorla, 2000) which details emotionality, anxiety and depression, attention problems, and aggression, among others.

## Conclusions

The foods that give individuals the most difficulty, such as vegetables, have implications for nutritional balance. There is little agreement on whether nutritional balance is affected by selective eating, but sensitive eaters often avoid vegetables and fruits, and thus have a lower quality of diet (Zickgraf & Schepps, 2016).

This study focuses on adult selective eaters to test prevalence and possible relationships to disgust sensitivity and gag reflex as the participants continue selective eating habits past the developmental phase. Using procedures adapted from Kauer et al. (2015), selective eaters will be self-reported and asked about common eating behaviors to show consistency with the current literature.

# Chapter 4: Methods

This chapter outlines the methods used to test the following hypotheses: 1) Stronger gagging will be accompanied by a more sensitive disgust response, and 2) Selective eaters will exhibit a greater response to disgust and gag triggers, which includes survey selection and statistical analysis. Study methods were approved prior to data collection by the Western Washington University IRB (EX18-019). Participants were students recruited through Western Washington University Anthropology classes and fliers posted in the Anthropology department. Students were encouraged to invite their peers, thus increasing the sample size, through respondent driven sampling. All students were encouraged to participate.

## Surveys

The online questionnaire, estimated to take 30-45 minutes, was implemented through Qualtrics, web-based survey software (2017). The survey opened on October 25, 2017, and closed November 17, 2017. As compensation, participants who provided their email at the end of the survey were entered into a raffle for four $25 e-gift cards. This study used a combination of several questionnaires including the Predictive Gagging Survey (Appendix A) (Hearing et al., 2014), the Disgust Scale-Revised (DS-R) (Appendix B) (Olatunji et al., 2007), an itemized questionnaire to assess food selection and eating behaviors adapted from Kauer et al. (2015) (Appendix C), and demographic questions (Appendix D).

The Disgust Scale is previously used in multiple studies and shows consistency in the measure of disgust sensitivity in western societies (see Chapter 2) (Schienle et al. 2010, 2015; Kauer et al., 2015); the DS-R is the most recently revised version of this scale. Surveys measuring the gag reflex are variable. The most consistently used is the Gagging Problem Assessment Questionnaire, used in dental offices and clinical studies (Akarslan & Bicer, 2012).

For this study, however, I found that the Predictive Gagging Survey, developed in 2014, would be more beneficial in a general population study as it contained more daily gag triggers rather than focusing on dental procedures.

Participants first completed the Disgust Scale-Revised (Appendix A) which consists of twenty-seven questions that ask participants to indicate how disgusted they would be by specific stimuli (Olatunji et al., 2007). Secondly, participants reported the strength of their gag reflex, along with common triggers through the Predictive Gagging Survey (Appendix B) (Hearing et al., 2014). Thirdly, participants completed forty-five questions about eating behaviors and other factors that are commonly associated with selective eating (Appendix C) (Kauer et al. 2015; Ghanizadeh, 2013). Lastly, six demographic questions were presented, along with email information for the raffle (Appendix D). Participants were able to opt out of taking the survey at any time or leave questions unanswered. Those who started the survey but did not answer at least half of the first set of questions were excluded from this study.

**Analysis**

All statistical analyses were completed on SPSS Statistics 24.0 (2016). No attempt was made to statistically account for missing data. Both the Disgust Scale-Revised (DS-R) and the Predictive Gagging Survey were coded and scored based on guidelines provided by Olatunji et al. (2007) and Hearing et al. (2014), respectively. For statistical tests, the P-value used for significance was 0.05.

Mean DS-R scores and subscales: core, animal-reminder, and contamination domains (explained in Disgust Sensitivity chapter) were calculated to compare to previous disgust research. Scores for the DS-R range from 0 to 4. Incomplete responses can result in lower total values because averages are not damaged by unanswered questions (Haidt, McCauley, & Rozin,

2012). Incomplete surveys were used; however, individuals were excluded who consented to participating in the study, but did not answer any specific survey questions. Individuals who failed to answer the attention check questions correctly were also excluded from this study. One-sample t-tests were used to test these averages against the YourMorals means using data from 2007-2010 of 34,442 individuals in the USA, in order to assess how the participants in this study compared to those in more extensive studies (Haidt, McCauley, & Rozin, 2012). The total score for the Predictive Gagging Survey was used for statistical analysis (ranging from 0 to 18).

To address the first hypothesis of this study, that stronger gagging will be accompanied by a more sensitive disgust response, Pearson correlations were calculated between the Predictive Gagging Survey scores and DS-R scores. The Predictive Gagging Survey scores were then grouped into low, medium, and high tertiles. Tertiles allows comparisons of group means rather than each individual. Spearmen's rho correlation, one-way ANOVA, and post-hoc tests were completed between total Predictive Gagging Survey score tertiles, and average DS-R, core, animal-reminder, and contamination disgust scores to see if the high Predictive Gagging Survey score tertile group was significantly different from the low group.

For the second hypothesis: selective eaters will exhibit a more extreme response to gag and disgust triggers, participants were grouped into self-reported selective and non-selective eating groups. Consistency between this study and past selective eating studies is assessed through comparing frequencies of the onset of selective eating and types of foods avoided (adapted from Kauer et al., 2015). The emergence of selective eating was coded into Always, Early childhood, Childhood, Adolescence, and Adulthood based on participant responses. Eight food groups were used for this study based on participants' written responses. Frequencies were recorded for all self-reported selective eaters and those without religious food avoidances and food allergies.

Further tests for selective eaters included all self-reported selective eaters, despite food choices influenced by allergies, religion, ethics, or health concerns.

Questions addressing eating behavior were entered into a Likert 5-point scale to allow for more fine-grained answers. The data was then aggregated into three categories based on Bernard's (2011) recommendations. The first category consisted of 'probably yes' or 'definitely yes' answers, the second of 'probably not' or 'definitely not,' and the third contained 'might or might not' answers. Questions asking for the frequency of selective behaviors or intensity of such were coded similarly. Unlike the Disgust Scale-Revised and Predictive Gagging Survey, no totals were calculated for eating behavior questions; instead statistical analysis was conducted for each question.

Significant differences between self-reported selective and non-selective eaters were determined through chi-squared tests and compared to Kauer et al.'s results (2015). Chi-squared tests were also conducted excluding the 'unsure' or 'maybe' selective eaters to further test significant differences between selective and non-selective eaters.

Spearman's rho correlations, ANOVA, and post-hoc tests were then used to determine significant relationships in eating behaviors between gagging tertiles, disgust sensitivity tertiles, and selective eating. Further, ANOVA tests were run to find statistical differences between self-reported selective and non-selective eaters DS-R and Predictive Gagging Survey tertile scores. Common eating behaviors discussed in previous selective eating research were then tested against selective eating, DS-R, and Predictive Gagging Survey scores to determine overlaps in behavior and establish consistency between self-reported selective eaters in this study compared to others.

# Chapter 5: Results

This chapter will present sample characteristics and the results from testing both hypotheses in this study: 1) Stronger gagging will be accompanied by a more sensitive disgust response, and 2) Selective eaters will exhibit a greater response to disgust and gag triggers, which includes survey selection and statistical analysis. Methods are outlined in the previous chapter.

**Sample characteristics**

Of the original 131 participant responses, 108 were used for this study. Three of these individuals did not complete the Predictive Gagging Survey, therefore, in tests using these scores, 105 participants are used. Ten participants were excluded from statistical analysis due to inconsistent answers on Disgust Scale-Revised (DS-R) attention check questions. Others that were excluded began the survey but did not answer any of the specific survey questions. One participant's height and weight were removed as they were place-holder numbers rather than real values. Reported ethnicity for this study was 74.6%(n=85) White, 8.8%(n=10) Asian, 2.6%(n=3) Native American/Alaskan, 1.8%(n=2) African American, and 11.8%(n=14) other. Some individuals selected more than one ethnicity, the above percentages and counts are for total reported ethnicities (n=114). The age range for this study was 18 to 34 years.

A clear majority of the participants in this study were female (83.33%, n=90). There were no significant differences between males, females, and unspecified sex relating to BMI, age, or any of the survey scores (Table 1). Table 1 shows more information on traits between the sexes, however, this study did not further compare differences between sexes due to the relatively small number male participants. Further results in this study do not report sex differences between the variables.

Table 1. ANOVA results showing non-significant differences when comparing sexes. Mean(s.d.).

| Traits | Total | Males | Females | Unspecified | df | F | p-value |
|---|---|---|---|---|---|---|---|
| **Age** | 19.9(2.6) | 20(2) | 19.9(2.7) | 20(2.8) | 2, 98 | 0.003 | 0.997 |
| **BMI** | 25.5(5.7) | 22.3(3.9) | 25.8(5.8) | 32.32 | 2,96 | 2.619 | 0.078 |
| **Total DS-R** | 33.32(11.91) | 26.36(11.06) | 33.97(12.08) | 36(7.42) | 2,105 | 2.238 | 0.112 |
| **Average DS-R** | 1.33(0.47) | 1.05(0.44) | 1.36(0.48) | 1.44(0.3) | 2,105 | 2.245 | 0.111 |
| **Average Core Disgust** | 1.36(0.52) | 1.01(0.54) | 1.4(0.52) | 1.4(0.36) | 2,105 | 2.725 | 0.07 |
| **Average Animal Disgust** | 1.48(0.72) | 1.32(0.66) | 1.48(0.74) | 1.77(0.45) | 2,105 | 0.832 | 0.438 |
| **Average Contamination Disgust** | 1.02(0.66) | 0.73(0.5) | 1.06(0.69) | 1.0(0.52) | 2,105 | 1.277 | 0.283 |
| **Average Gag Score** | 5.56(2.63) | 4.73(2.1) | 5.72(2.7) | 4.25(1.89) | 2,102 | 1.22 | 0.3 |
| **n** | 108 | 11 | 90 | 7 | | | |

The total DS-R scores had similar ANOVA and correlation results as average DS-R in all the tests for this study, meaning that average DS-R scores can be used as a representative of the total score. Mean scores and standard deviations of the total DS-R are represented in Table 1, but only average DS-R results are reported for further analysis in this study.

The average DS-R, Core disgust subscale, and Animal-Reminder disgust subscale scores found in this study were significantly lower than the YourMorals dataset from 2007-2010 of 34,442 individuals in the USA ($p<0.001$, $p<0.001$, $p=0.043$, respectively) (Haidt et al., 2012) (Figures 3-5). The Contamination subscale was not significantly different, but the mean was slightly lower for Western students when compared to the YourMorals dataset.

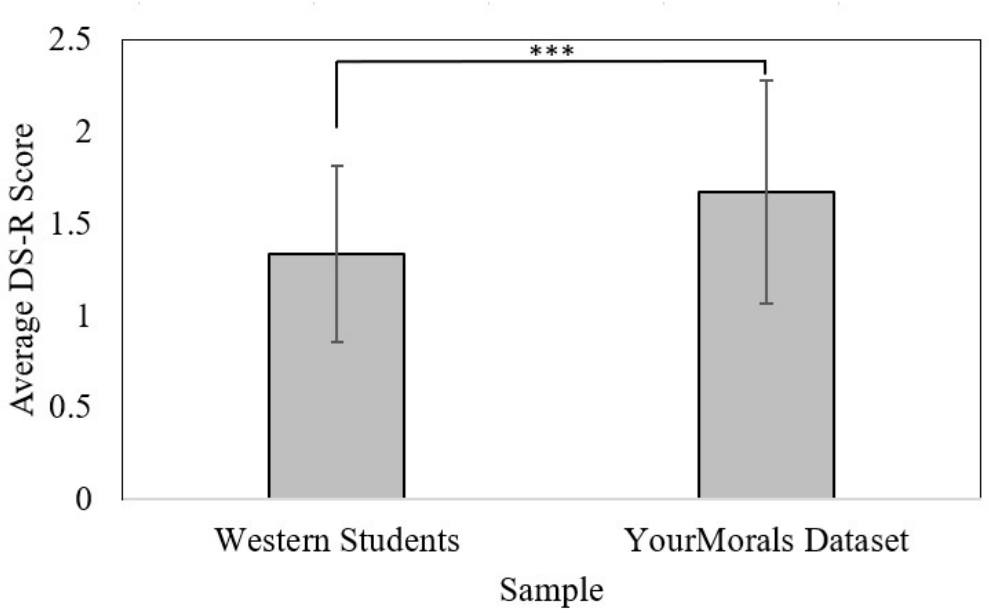


Figure 3. Boxplot showing differences between mean for average DS-R scores between Western Students and YourMorals dataset. $p<0.001$ is denoted as ***.

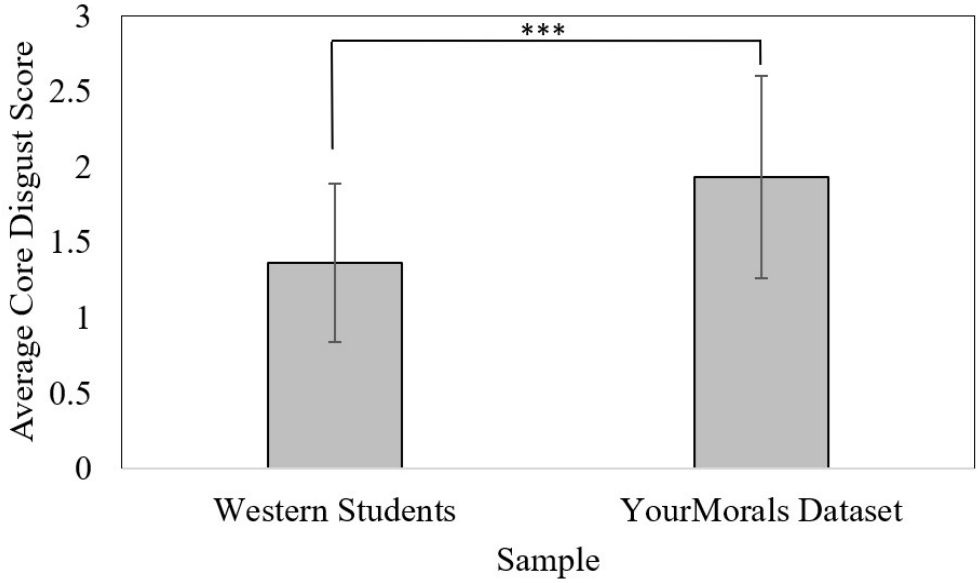


Figure 5. Boxplot showing differences between means for average Core Disgust subscale scores for Western Students and YourMorals dataset. $p<0.001$ is denoted as ***.

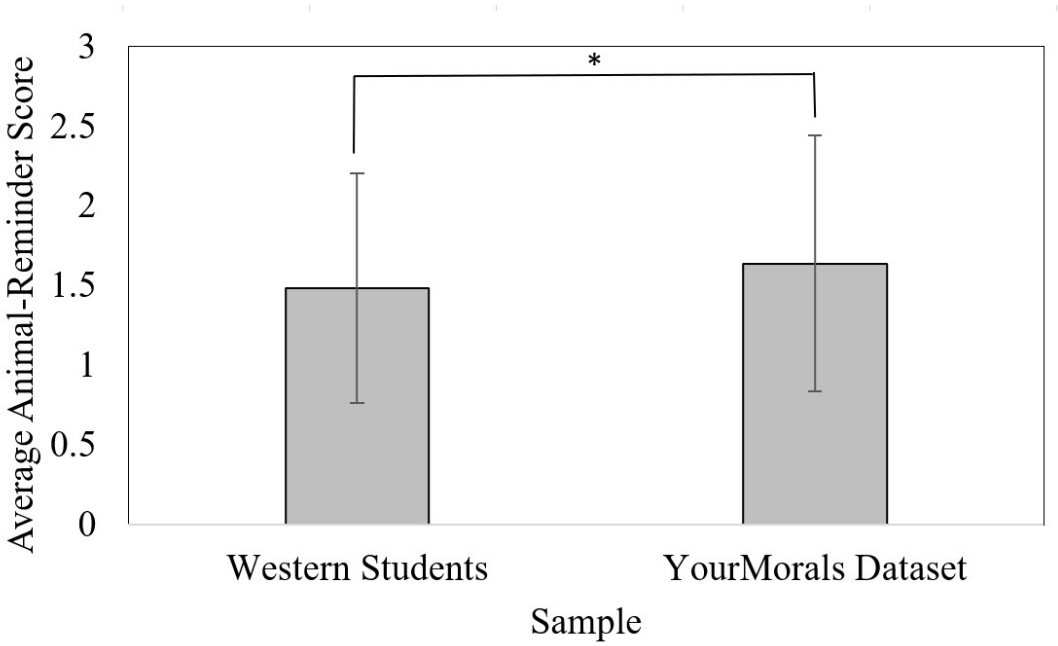


Figure 4. Boxplot showing differences between means for average Animal-Reminder scores between Western Students and YourMorals dataset. $p<0.05$ is denoted as *.

Overall, Western students had lower reported disgust sensitivity than the larger population sample. These results indicate that this subset of the population does not accurately represent the larger population disgust sensitivity from the YourMorals dataset.

## Tests for Hypothesis One

### Stronger gagging will be accompanied by a more sensitive disgust response

Pearson's correlation tests showed significant positive correlations between the Predictive Gagging Survey scores, average DS-R r (105)=0.294, $p$=0.002, and core disgust sub scale scores r (105)=0.357, $p<0.001$. This explains around 30% of the variance in the strength of the gag reflex. This indicates that the gag reflex and disgust sensitivity are related but other unknown variables are affecting the variance.

For further comparisons, participants were sorted into gag reflex tertile groups 1, 2, and 3, with one being the lowest and three being the highest (Table 2). These groups were generated

by SPSS (Version 24.0; IBM, 2016). Table 2 shows the mean scores for each tertile groups: 3.19 (low), 5.53 (medium), and 8.78 (high) and differences between the groups.

Table 2. Sample descriptors separated into tertile groups based on their scores for the Predictive Gagging Survey. One-way ANOVA results between gag reflex tertile groups and variables. Significant p-values are marked with '*.'

| Gag Reflex Tertiles | 1 | 2 | 3 | df | F | p-value |
|---|---|---|---|---|---|---|
| Score mean | 3.19(0.88) | 5.53(0.51) | 8.78(1.86) | | | |
| **Age** | 19.4(1.6) | 20.2(3.9) | 20.5(1.9) | 2, 95 | 1.31 | 0.274 |
| **BMI** | 24.3(4.6) | 25.5(6.2) | 27.2(6.4) | 2, 95 | 2.41 | 0.095 |
| **Average DS-R** | 1.17(0.43) | 1.31(0.51) | 1.54(0.45) | 2, 95 | 6.24 | 0.003* |
| **Average Core Disgust** | 1.13(0.49) | 1.36(0.55) | 1.63(0.43) | 2, 95 | 10.55 | <0.001* |
| **Average Animal-Reminder Disgust** | 1.38(0.64) | 1.41(0.79) | 1.67(0.75) | 2, 95 | 1.49 | 0.231 |
| **Average Contamination Disgust** | 0.94(0.56) | 1.0(0.7) | 1.14(0.77) | 2, 95 | 0.878 | 0.419 |
| **n** | 40 | 30 | 31 | | | |

The gag reflex tertiles positively correlated with Average DS-R scores r(108)= 0.315, $p$=0.001, and Average Core Disgust r(108)= 0.399, $p$<0.001 (Table 2). Animal-reminder and contamination disgust domains were not significantly different between gag reflex tertile groups. Levene's test showed that the data followed the rules of homogeneity. The low and high gag reflex tertile groups differed significantly in average DS-R and core disgust scores, with high gagging groups having higher disgust sensitivity ($p$=0.003 and $p$<0.001). The difference was only significant between high and low groups. Figures 6 and 7 show that the high gag reflex tertile group has higher average DS-R and core disgust scores than the low gag reflex group.

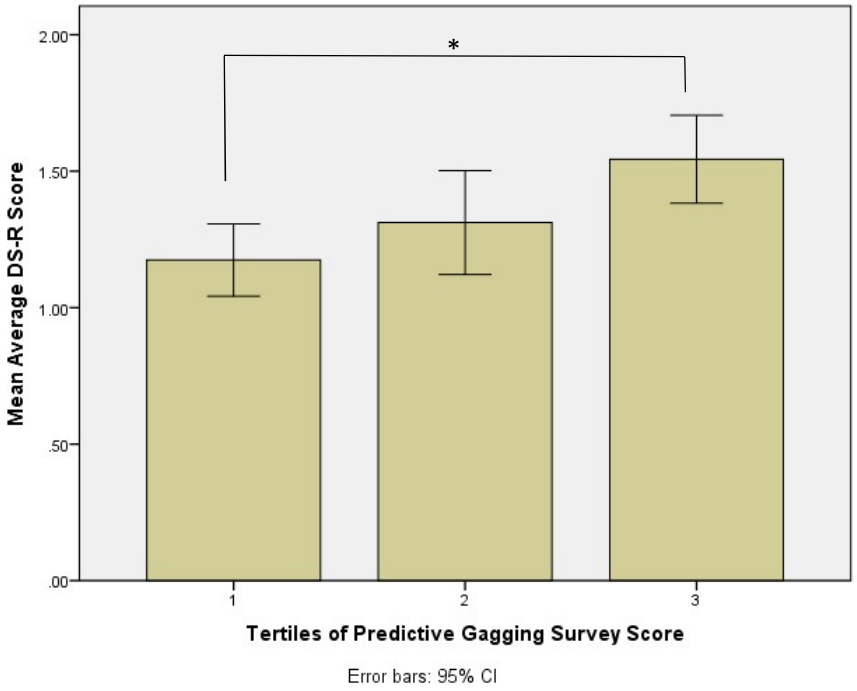


Figure 6. Mean average DS-R versus tertile groups of Predictive Gagging Survey. Differences are significant between tertile groups 1 and 3 (low and high). $p<0.05$ is denoted as *.

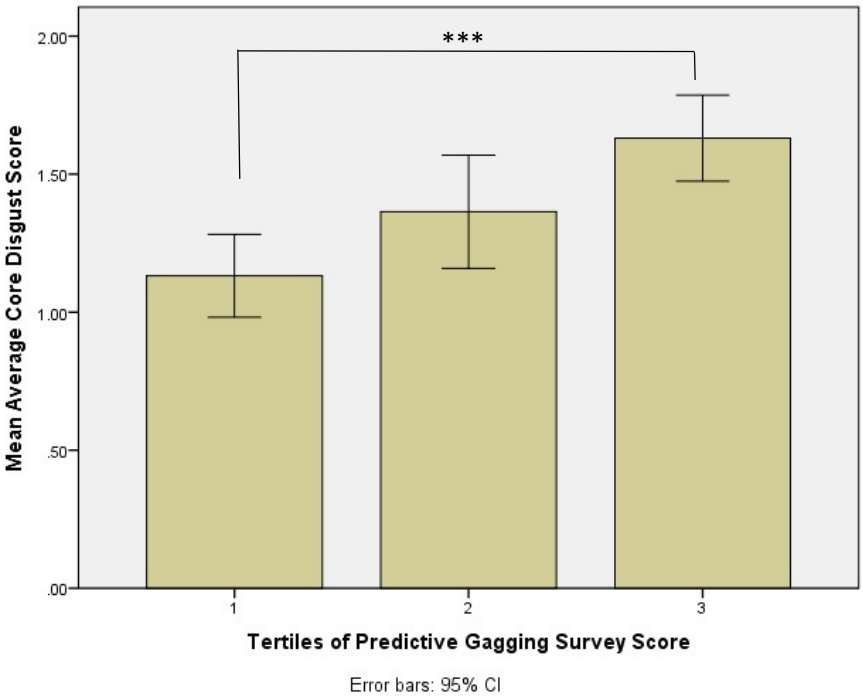


Figure 7. Mean average DS-R and core disgust scores separated by tertile groups of Predictive Gagging Survey. Differences are significant between tertile groups 1 and 3. $p<0.001$ is denoted as ***.

These findings support the first hypothesis. The more reactive gag reflex is accompanied by higher disgust sensitivity.

## Tests for Hypothesis Two

**Selective eaters will exhibit a more extreme response to gag and disgust triggers.**

### Consistency in selective eating behaviors

To show consistency between this study's selective eaters (n=36) and previous studies, self-reported selective eaters were asked to state when their selective eating behavior began, types of foods they avoided, and frequency of common selective eating behaviors. The frequencies of reported age of onset are listed in Table 3 and are broken down into total self-reported selective eaters, excluding individuals with food allergies, and then excluding both food allergies and religious, ethical, or health concern reasons for food aversions.

Table 3. Frequencies of onset of selective eating for total responses, adjusted for allergies, and adjusted for allergies and religious reasons.

| | Total | | Adjusted for allergies | | Adjusted for allergies and religion | |
|---|---|---|---|---|---|---|
| **Onset** | **Frequency** | **Percent** | **Frequency** | **Percent** | **Frequency** | **Percent** |
| **Always** | 11 | 30.6 | 8 | 22.2 | 7 | 19.4 |
| **Early childhood** | 4 | 11.1 | 2 | 5.6 | 1 | 2.8 |
| **Childhood** | 11 | 30.6 | 8 | 22.2 | 4 | 11.1 |
| **Adolescence** | 2 | 5.6 | 1 | 2.8 | 0 | 0 |
| **Adulthood** | 8 | 22.2 | 2 | 5.6 | 0 | 0 |
| **n** | 36 | | 21 | | 12 | |

Self-reported selective eating reported more religious, ethical, or health concern reasons for food avoidances than non-selective eaters ($p$=0.049). The amount of reported allergy food aversions did not significantly differ between selective and non-selective eaters. In total selective eaters, reports of "always" and "childhood" were most frequent. After excluding allergies and

religious reasons, “always” was the most reported, with none indicating “adolescences” or “adulthood.” However, the total amount of reports drops from 36 to 12 after excluding these individuals.

Before excluding allergies and religious, ethical, or health concerns food avoidances, the most commonly reported food avoidances amongst self-reported selective eaters were meat (31.4%, n=16) and dairy (25.5%, n=13) (Table 4). These numbers indicate the number of cases, as selective eaters could write in multiple responses. After excluding cases of allergies and religious reasons, vegetables (36.4%, n=4) and meat (27.3%, n=3) were the most common food aversions.

Table 4. Reported food avoidances by selective eaters. n= total number of cases.

| | **Total selective eaters** | | **Adjusted for allergies and religion** | |
|---|---|---|---|---|
| **Foods avoided** | **Frequency** | **Percent** | **Frequency** | **Percent** |
| **Vegetables** | 6 | 11.8 | 4 | 36.4 |
| **Fruits** | 2 | 3.9 | 0 | 0 |
| **Dairy** | 13 | 25.5 | 2 | 18.2 |
| **Meat** | 16 | 31.4 | 3 | 27.3 |
| **Sweets** | 6 | 11.8 | 1 | 9.1 |
| **Gluten** | 3 | 5.9 | 0 | 0 |
| **Starches/grains** | 5 | 9.8 | 1 | 9.1 |
| **n (total reports)** | 51 | | 11 | |

Findings from this study show significance between self-reported selective eating and many common selective eating behaviors. Table 5 shows whether selective (n=36) and non-selective eaters (n=49) differ between reports of eating behaviors. Kauer et al. (2015) significant results are indicated by “#”. Effect sizes were categorized as 0.1 is small effect, 0.3 is medium, and 0.5 is large.

Table 5a. Chi-squared results with selective eating behaviors. "*" indicates variables that did not meet the assumptions, so Fisher's exact tests were used.
P-value significance was set to p=0.05.

| | Affirmative answers | | | | | |
|---|---|---|---|---|---|---|
| **Eating behaviors** | **Selective** | **Non-selective** | **$X^2$** | **df** | **sig** | **phi** |
| Do others label you as a selective or "picky" eater?* | 69.20% (n=25) | 0% (n=0) | 58.15 | | **<0.001** | 0.776 |
| Are your choice of foods influenced by religious practices, ethical, nutritional or health concerns? | 58.33% (n=21) | 36.73% (n=18) | 3.9 | 1 | **0.048** | 0.214 |
| Do you have any food allergies or medically imposed dietary restrictions?# | 36.11% (n=13) | 28.57% (n=14) | 0.544 | 1 | 0.461 | 0.08 |
| Are you often on a diet to lose weight?# | 22.22% (n=8) | 18.37% (n=9) | 0.193 | 1 | 0.661 | 0.048 |

In Table 5a, both others labeling individuals as selective eaters and religious, ethical, or health related food choices were significant with selective eaters ($p$<0.001 and $p$=0.048, respectively). Self-reported selective eaters are more often identified by others as such. The phi value for this relationship indicates a large effect size (over 0.5). Selective eaters in this study are also more likely to report religious practices or health concerns. The effect size is small (under 0.3), indicating a weak relationship. Being on a diet to lose weight and having food allergies were not significant with selective eaters in this study but were reported by Kauer et al. (2015).

Table 5b. Eating behaviors associated with narrow consumption of foods.

| | Affirmative answers | | | | | |
|---|---|---|---|---|---|---|
| **Narrow range of foods** | **Selective** | **Non-selective** | **$X^2$** | **df** | **sig** | **phi** |
| Do you eat from a very narrow range of foods?# | 33.33% (n=12) | 4.08% (n=2) | 25.03 | 2 | **<0.001** | 0.543 |
| Do you avoid one or more major food group(s)?*# | 63.89% (n=23) | 24.49% (n=12) | 15.76 | 2 | **<0.001** | 0.428 |

Table 5b illustrates that both eating from a narrow range of foods and avoiding major food groups are statistically related to selective eating ($p$<0.001 for both). Selective eaters are more likely to report both behaviors. Eating from a narrow range of foods has a large effect size

(phi over 0.5), while avoiding major food groups has a medium effect size (phi over 0.3). These were also significant in Kauer et al. (2015).

Table 5c. Reported cases of food neophobia.

| | Affirmative answers | | | | | |
|---|---|---|---|---|---|---|
| **Food Neophobia** | **Selective** | **Non-selective** | **$X^2$** | **df** | **sig** | **phi** |
| Are you willing to try foods that you have never eaten before?#* | 47.22% (n=17) | 97.96% (n=48) | 31.32 | 2 | **<0.001** | 0.594 |

Selective eaters in this study reported being less willing to try new foods ($p$<0.001) (Table 5c). The strength of this relationship is strong (over 0.5). This relationship was also reported by Kauer et al. (2015).

Table 5d. Rejection based on taste.

| | Affirmative answers | | | | | |
|---|---|---|---|---|---|---|
| **Sensory rejection: taste** | **Selective** | **Non-selective** | **$X^2$** | **df** | **sig** | **phi** |
| I reject bitter foods# | 27.78% (n=10) | 14.28% (n=7) | 2.38 | 2 | 0.304 | 0.167 |
| I reject sour foods*# | 19.44% (n=7) | 6.12% (n=3) | 4.79 | 2 | 0.094 | 0.24 |
| I reject salty foods*# | 5.55% (n=2) | 2.04% (n=1) | 1.73 | 2 | 0.546 | 0.136 |
| I reject sweet foods* | 2.78% (n=3) | 6.12% (n=1) | 1.23 | 2 | 0.583 | 0.125 |

Self-reported selective eaters in this study were not significantly more likely to reject foods based on any of the taste rejection questions (Table 5d). This is counter to Kauer et al.'s (2015) findings that selective eaters reported rejecting foods that were bitter, sour, and salty.

Table 5e. Rejection based on texture.

| | Affirmative answers | | | | | |
|---|---|---|---|---|---|---|
| **Sensory rejection: texture** | **Selective** | **Non-selective** | **$X^2$** | **df** | **sig** | **phi** |
| I avoid foods with a particular consistency (texture)*# | 25.00% (n=9) | 12.24% (n=6) | 7.03 | 2 | **0.032** | 0.292 |
| I reject foods that are slippery or "slimy"# | 38.89% (n=14) | 12% (n=6) | 8.22 | 2 | **0.016** | 0.311 |

Selective eaters were more likely to report rejection of foods based on texture characteristics (Table 5e). Both rejecting foods based on texture and rejecting foods that were "slimy" were significant with selective eating ($p$=0.032 and $p$=0.016, respectively). The relationship between selective eating and texture was weak (below 0.3) while selective eating with rejection of "slimy" foods was medium (above 0.3). This association is consistent with Kauer et al.'s findings.

Table 5f. Rejection based on appearance.

| | **Affirmative answers** | | | | | |
|---|---|---|---|---|---|---|
| **Sensory rejection: appearance** | **Selective** | **Non-selective** | **$X^2$** | **df** | **sig** | **phi** |
| I reject foods that are a particular color*# | 0.00% (n=0) | 0.00% (n=0) | | 1 | 1.00 | 0.024 |
| I prefer to eat only foods that are a particular color*# | 0.00% (n=0) | 0.00% (n=0) | | 1 | 1.00 | 0.026 |

Responses to rejection of foods based on appearance questions were significant with selective eating (Table 5f). No selective or non-selective eaters reported this behavior. This is inconsistent with Kauer et al.'s (2015) findings where selective eaters were more likely to report food rejection based on appearance.

Table 5g. Rejection based on contact or mixing.

| | Affirmative answers | | | | | |
|---|---|---|---|---|---|---|
| **Contact or mixing** | **Selective** | **Non-selective** | **$X^2$** | **df** | **sig** | **phi** |
| Do you reject foods that are mixed or combined?# | 33.33% (n=12) | 6.12% (n=3) | 10.65 | 2 | **0.005** | 0.354 |
| Do you reject foods that have "lumps" in them?*# | 11.11% (n=4) | 2.04% (n=1) | 3.87 | 2 | 0.154 | 0.217 |
| Do you refuse foods that have "things" in them?*# | 13.89% (n=5) | 8.16% (n=4) | 8.17 | 2 | **0.015** | 0.314 |
| Do you refuse foods with sauces on them?*# | 11.11% (n=4) | 0% (n=0) | 6.33 | 2 | **0.016** | 0.28 |
| Do you reject foods if there is something you can't see in them?*# | 11.11% (n=4) | 0% (n=0) | 9.51 | 2 | **0.002** | 0.35 |
| Do you try not to let different foods touch on the plate?*# | 27.78% (n=10) | 18.37% (n=9) | 4.25 | 2 | 0.122 | 0.226 |
| Do you reject foods that have touched on the plate?*# | 5.55% (n=2) | 2.04% (n=1) | 1.18 | 2 | 0.677 | 0.109 |

More selective eaters reported contact or mixing food rejections (Table 5g). These food rejections included mixed or combined foods ($p$=0.005), foods with “things” in them ($p$=0.015), sauces ($p$=0.036), and foods with something you can’t see in them ($p$=0.006). The strength of these relationships varied. Rejection of mixed or combined, foods with “things” in them, and foods with something you cannot see in them had medium strength relationships (phi value over 0.3). Rejecting foods with sauces on them had a weak relationship (phi value under 0.3). All of the eating behaviors in this category were significant in Kauer er al.’s study (2015), showing some variation in the selective eaters from this study.

Table 5h. Rejection based in ritualization or repetition.

| | Affirmative answers | | | | | |
|---|---|---|---|---|---|---|
| **Ritualization/Repetition** | **Selective** | **Non-selective** | **$X^2$** | **df** | **sig** | **phi** |
| Do you prefer to eat with a special person(s), in a special place, or with special utensils/dishes?*# | 5.55% (n=2) | 8.16% (n=4) | 1.40 | 2 | 0.599 | 0.144 |
| Do you usually eat foods in a sequence in the main course? | 25.00% (n=9) | 16.33% (n=8) | 1.43 | 2 | 0.49 | 0.13 |
| Do you eat foods in an unusual order?*# | 2.78% (n=1) | 0.00% (n=0) | 3.13 | 2 | 0.204 | 0.197 |
| I eat the same meal for breakfast every day or most days | 41.67% (n=15) | 42.86% (n=21) | 0.141 | 2 | 0.932 | 0.041 |
| I eat the same meal for lunch every day or most days* | 11.11% (n=4) | 6.12% (n=3) | 6.91 | 2 | **0.026** | 0.287 |
| I eat the same meal for dinner every day or most days*# | 22.22% (n=8) | 2.04% (n=1) | 9.04 | 2 | **0.009** | 0.328 |
| I will not eat food if I saw someone else touch it*# | 19.44% (n=7) | 8.16% (n=4) | 2.47 | 2 | 0.29 | 0.17 |

Only two behaviors were significant in the ritualization/repetition category for this study (Table 5h). Selective eaters were more likely to report eating the same meal for lunch and dinner ($p$=0.03, $p$=0.01, respectively). Eating the same meal for dinner had a medium strength relationship, while lunch had a weak relationship. Selective eaters from Kauer et al.'s (2015) study not only reported these same behaviors, but were also more likely to prefer eating with a special person(s), place, or with special utensils, eat foods in an usual order, and eat the same dinner every day.

Table 5i. Social eating and interest influences.

| | Affirmative answers | | | | | |
|---|---|---|---|---|---|---|
| **Interest in food/social eating** | **Selective** | **Non-selective** | **$X^2$** | **df** | **sig** | **phi** |
| I look forward a lot to eating# | 52.78% (n=19) | 61.22% (n=30) | 0.697 | 2 | 0.706 | 0.091 |
| Do you miss meals because you are preoccupied or busy and forget to eat?# | 27.78% (n=10) | 12.24% (n=6) | 3.29 | 2 | 0.193 | 0.197 |
| When you go out, do you activities often include food as a central focus?# | 36.11% (n=13) | 26.53% (n=13) | 0.9 | 2 | 0.638 | 0.103 |
| Enjoying food is one of the most important pleasures in my life# | 44.44% (n=16) | 51.02% (n=25) | 0.47 | 2 | 0.79 | 0.074 |
| Do you prefer to leave a clean plate?# | 44.44% (n=16) | 67.35% (n=33) | 5.19 | 2 | 0.074 | 0.247 |
| When you are invited to dinner, do you worry that there may be nothing that you can eat?# | 61% (n=22) | 2.04% (n=1) | 46.91 | 2 | **<0.001** | 0.743 |
| Do you have fond memories of family food occasions? | 50.00% (n=18) | 65.31% (n=32) | 2.87 | 2 | 0.238 | 0.184 |
| My memories of meals with my family when I was a child include a lot of tension about what or how much I was eating. | 33.33% (n=12) | 12% (n=6) | 11.66 | 2 | **0.003** | 0.37 |

In the "Interest in food/social eating" category, only worrying about having nothing to eat when invited out and childhood memories of tension about what or how much they were eating were significant with selective eating ($p$<0.001 and $p$=0.003, respectively) (Table 5i). Worrying when invited out to eat has a strong relationship to selective eating (phi over 0.5), while childhood memories of tension has a medium strength (phi over 0.3). This differs from Kauer et al.'s (2015) finds as selective eaters were less likely to report looking forward to eating, activities with food as the central focus, food being one of the most important pleasures of their lives, and leaving a clean plate. Selective eaters were also more likely to miss meals and worry about having nothing to eat when invited out.

Table 5j. Healthy eating behaviors.

| | Affirmative answers | | | | | |
|---|---|---|---|---|---|---|
| **Healthy eating** | **Selective** | **Non-selective** | **$X^2$** | **df** | **sig** | **phi** |
| I am a healthy eater# | 61.11% (n=22) | 69.39% (n=34) | 0.958 | 2 | 0.619 | 0.106 |
| I prefer to eat "health food" | 55.55% (n=20) | 53.06% (n=26) | 0.134 | 2 | 0.935 | 0.04 |
| I usually choose low- to no-fat foods over the full fat version | 27.78% (n=10) | 30.61% (n=15) | 0.082 | 2 | 0.96 | 0.031 |

Healthy eating behavior questions were not significant with selective eating in this study (Table 5j). Kauer et al. (2015) reported significantly more non-selective eaters indicating that they were healthy eaters. This was not replicated in this study.

**Testing gag reflex and disgust sensitivity in selective eaters**

There were no significant differences between selective and non-selective eaters DS-R or Predictive Gagging Survey scores (Table 6). Selective eaters were not more likely to have higher scores on either survey. Therefore, the second hypothesis, that selective eaters would be more responsive to disgust or gag triggers was rejected.

Table 6. Mean(sd) trait descriptors for Selective Eating groups. ANOVA results for selective eating versus each variable. There is no significant difference between selective and non-selective eaters for any variable. There were no significant sex differences between the selective eating groups.

| Selective Eaters | Yes | Unsure | No | df | F | p-value |
|---|---|---|---|---|---|---|
| **Age** | 19.9(1.7) | 20.3(3.8) | 19.9(2.6) | 2, 98 | 0.172 | 0.842 |
| **BMI** | 26.5(6.5) | 23.7(4.9) | 25.5(5.3) | 2, 96 | 1.4 | 0.252 |
| **Average DS-R** | 1.39(0.51) | 1.26(0.33) | 1.31(0.51) | 2, 100 | 0.48 | 0.62 |
| **Average Core Disgust** | 1.37(0.55) | 1.27(0.43) | 1.38(0.56) | 2, 100 | 0.268 | 0.765 |
| **Average Animal-Reminder Disgust** | 1.57(0.81) | 1.46(0.61) | 1.41(0.72) | 2, 100 | 0.506 | 0.604 |
| **Average Contamination Disgust** | 1.14(0.66) | 0.92(0.49) | 0.99(0.73) | 2, 100 | 0.814 | 0.446 |
| **Average Gag Score** | 5.97(3.17) | 4.33(1.49) | 5.79(2.45) | 2, 100 | 2.64 | 0.076 |
| **Females** | 33 | 14 | 43 | 2, 100 | 0.4 | 0.671 |
| **Males** | 1 | 4 | 6 | | | |
| **Unspecified sex** | 2 | 0 | 0 | | | |
| **n** | 36 | 18 | 49 | | | |

**Selective eating behaviors and the gag reflex**

An overlap between selective eating behaviors and DS-R and Predictive Gagging Survey scores could show a less direct relationships between these variables and how the strength of the gag reflex could affect eating behaviors. Therefore, to further test possible connections between selective eating and the gag reflex, common selective eating behaviors and Predictive Gagging Survey scores were tested together. Statistically significant differences were found between tertile groups of Predictive Gagging Survey scores and several selective eating behaviors (Table 7).

Table 7. Significant ANOVA scores for tertile gagging scores and eating behaviors.
"*" indicates variables that had unequal variance.

| Eating behaviors | df | F | p-value |
|---|---|---|---|
| **Sensory rejection: texture** | | | |
| I avoid foods with a particular consistency (texture)* | 2, 100 | 3.5 | 0.034 |
| **Contact or mixing** | | | |
| Do you reject foods that have touched on the plate?* | 2, 100 | 3.75 | 0.027 |
| **Ritualization/Repetition** | | | |
| Do you usually eat foods in sequence in the main course?* | 2, 100 | 3.48 | 0.035 |

Differences were significant between high and low gag reflex tertiles for texture rejection ($p$=0.038), low and medium groups for rejection of foods that have touched on the plate ($p$=0.043), and eating food in a sequence did not show significant post-hoc results. These findings indicate that individuals with more reactive gag reflexes reject foods based on texture and contact and mixing more frequently than those with less reactive gag reflexes. Rejecting foods based on their texture was significant with Predictive Gagging Survey tertiles and selective eaters, showing overlap between these variables. This could indicate that the strength of the gag reflex can affect eating behaviors.

**Selective eating behaviors and disgust sensitivity**

Selective eating behaviors and average DS-R scores show positive correlations with rejecting foods that had touched on the plate, r(103)=0.233, p=0.018, rejecting foods if someone else touched them, r(103)=0.327, p=0.001, and childhood memories of tension about eating, r(103)= 0.197, p=0.046. Core disgust was correlated with all three of the same behaviors: r(103)=0.26, $p$=0.008, r(103)=0.371, $p$<0.001, and r(103)= 0.195, $p$=0.049, respectively. Contamination disgust scores were correlated with rejecting food that had touched on the plate, r(103)=0.213, $p$=0.031, and rejecting food that was touched by someone else r(103)=0.308, $p$=0.002. Selective eating, average DS-R, and core disgust are positively correlated with

childhood tension about eating ($p$=0.001, $p$=0.046, $p$=0.049). Selective eaters and those with higher average DS-R and core disgust subscale scores were more likely to report tension around what they ate as children.

Three DS-R tertile groups were created for further testing. Similar to the gag reflex tertile groups, these groups were generated by SPSS (Version 24.0; IBM, 2016) and ranked low to high. Each group average is listed in Table 8.

Table 8. Breakdown of tertile group means and (s.d.) for all DS-R scores used for ANOVA testing.

| **Tertile group** | **1** | **2** | **3** |
|---|---|---|---|
| Ave. DS-R | 0.8(0.21) | 1.35(0.13) | 1.85(0.22) |
| Core | 0.73(0.25) | 1.34(0.14) | 1.91(0.24) |
| Animal-reminder | 0.7(0.35) | 1.49(0.17) | 2.31(0.33) |
| Contamination | 0.34(0.22) | 0.99(0.17) | 1..82(0.45) |

Tertile groups of Average DS-R, Core disgust, and Contamination disgust were significant with several selective eating behaviors (Table 9). Individuals in the high Average DS-R tertile groups reported more rejection of foods that have touched on the plate than those in the medium tertile group ($p$=0.046). Individuals in the high Average DS-R scores also rejected food if someone else touched it more frequently than those in the low tertile group ($p$=0.014).

Table 9. Significant ANOVA results between eating behaviors and DS-R tertile groups.
"*" indicate unequal variances.

| | Average DS-R | | | Core disgust | | | Contamination disgust | | |
|---|---|---|---|---|---|---|---|---|---|
| **Eating Behavior** | **df** | **F** | **p-value** | **df** | **F** | **p-value** | **df** | **F** | **p-value** |
| Do you usually eat foods in sequence in the main course? | | | | | | | 2, 100 | 3.37 | 0.038 |
| Do you refuse foods with "things" in them? | | | | 2, 100 | 3.42 | 0.037 | | | |
| **Contact or mixing** | | | | | | | | | |
| Do you reject foods that have touched on the plate?* | 2, 100 | 3.41 | 0.037 | | | | | | |
| Do you try not to let different foods touch on the plate?* | | | | 2, 100 | 3.01 | 0.049 | | | |
| **Ritualization/Repetition** | | | | | | | | | |
| I will not eat food is I saw someone else touch it* | 2, 100 | 5.95 | 0.004 | 2, 100 | 8.15 | 0.001 | 2, 100 | 8.33 | <0.001 |

Individuals in the high Average Core DS-R tertile group reported rejecting food if another person has touched it more often than those in the low tertile group ($p$=0.004). Core disgust tertile groups also showed significant results with refusing foods with "things" in them. However, these results did not appear on post-hoc tests. The high Contamination tertile group reported eating the main course in the same sequence and rejecting foods that someone else touched more often than the low group ($p$=0.034, $p$=0.006).

**Summary**

In this study, hypothesis one was supported, while hypothesis two was rejected. Reported Predictive Gagging Survey scores positively correlated with higher DS-R scores. Though the second hypothesis that selective eaters would be more responsive to gag and disgust triggers was rejected, there is evidence that common selective eating behaviors are related to higher Predictive Gagging Survey and DS-R scores. Only texture aversion overlapped with this study's self-reported selective eaters and gag reflex scores. Increased reports of childhood tension surrounding eating behaviors overlapped between average DS-R, core disgust, and selective

eaters. This study found limited relationships between selective eating behavior, the strength of the gag reflex, and disgust sensitivity.

# Chapter 6: Discussion/Conclusions

The findings of this study supported Hypothesis one: a more responsive gag reflex will be accompanied by higher disgust sensitivity. Hypothesis two: Selective eaters will exhibit a more extreme response to gag and disgust triggers was rejected.

This study had many more female participants (83.33%, n=90) than male even though Western Washington University's demographics record 43.0% (n=6850) males and 56.9% (n=9058) during survey distribution (Student, 2017). Having more female participants is consistent with current research suggesting that women are more willing to participate in research (Smith, 2008; Yetter & Capaccioli, 2010; Slauson-Blevins & Johnson, 2016). Smith (2008) argues that women are more likely to participate in information-exchange online while men participate in information-seeking behaviors. This idea is one possible explain the divide between male and female participants are female in this study.

Further, as stated in Chapter 2, the Disgust Scale-Revised (DS-R) is only applicable in western societies. The DS-R was used in this study as participants were from a WEIRD population. However, research using this scale tends to make broad judgements on the evolution of disgust sensitivity and universality of the emotion while confining research to western, educated, industrialized, rich, and democratic (WEIRD) societies (Henrich, Heine, & Norenzayan, 2010).

**Gag reflex and disgust sensitivity**

The results of this study illustrate a significant positive relationship between the strength of the gag reflex and higher disgust sensitivity, supporting the first hypothesis. Findings in this study suggest the gag reflex is related to overall disgust sensitivity, but only one specific domain, core disgust. As core disgust contains of disease and oral ingestion triggers, this is consistent

with the gag reflex and disgust sensitivity being protective of the gastrointestinal tract (Berger & Anaki, 2014; Olatunji et al., 2008). The Predictive Gagging Survey does not have any direct food or disease-related triggers listed and instead focuses on general experiences and tactile gag triggers (Appendix A). Core disgust questions on the DS-R consisted of rotting foods, insects, and signs of illness. The connection between these two variables with different test triggers shows the versatility of the two and how they can protect from multiple threats to the gastrointestinal tract. To my knowledge, this is the first study that explores connections between the gag reflex and disgust sensitivity.

**Selective eating relationships with disgust sensitivity and gag reflex**

There were no significant relationships between self-reported selective eating and the strength of the gag reflex or disgust sensitivity. This differs from Kauer et al. (2015), who found that selective eaters in their study had statistically higher Disgust Scale scores. Self-reported selective eaters showed consistency with previous studies, reporting eating behaviors commonly associated with selective eating.

This difference in results between this study and Kauer et al. could be due to age differences, sex ratios, sample size, or population demographics. Their population varied more widely between age (36.56±13.77) and sex (62.5% female and 32.2% male), while the students in this study were in their 20's with very few male participants. More research is needed to verify if higher disgust sensitivity and more reactive gag reflexes could be found in adult selective eaters.

Another factor that could contribute to this difference in results is the significant amount of self-reported selective eaters indicating food aversions due to religious, ethical (vegetarian or vegan), or health reasons, selective eaters in Kauer et al.'s (2015) study did not report

significantly more cases of these reasons for food aversions. It is unknown how this might affect the results of this study.

**Eating behaviors, gag reflex, and disgust sensitivity**

Though selective eating and the gag reflex did not directly relate, both selective eaters and individuals with higher Predictive Gagging Survey scores reported more texture-based food avoidances. This overlap in eating behavior could show how the strength of the gag reflex can affect eating behaviors. Many gag reflex triggers are tactile triggers and texture of a food is about how food feels and touches aspects of the oropharynx (Almoznino et al., 2016). Therefore, finding that a stronger gag reflex relates to this type of sensory food aversion is understandable. Texture rejection is a large component of selective eating and is often cited as a reason for rejection of the food (Toyama & Agras, 2016). Therefore, it makes sense to see overlap in this form of sensory rejection eating behaviors.

The other two eating behaviors that were significant with the gag reflex are rejecting foods that touched on the plate and eating foods in a sequence in the main course (see Results). These eating behaviors were not significant with self-reported selective eaters in this study. However, average DS-R scores were also significant with rejection of foods that touched on the plate.

Individuals with higher average DS-R, core disgust, and contamination disgust subscales scores reported rejection of foods that someone else touched more than those with lower scores. Average DS-R scores were positively correlated with tension around childhood eating behaviors which further ties into selective eating behaviors as frustration or tension during mealtimes is commonly reported in selective eaters (Horodynski & Arndt, 2005).

Contamination disgust triggers mostly consist of contamination risks, bodily fluids, and poor hygiene (Berger & Anaki, 2014; Olatunji et al., 2008). Contamination disgust was significant with eating foods in sequence during the main course. Little is known about why this ritualization/repetition eating behavior would be influenced by contamination disgust. Surprisingly, contamination disgust did not overlap more with selective eating behaviors in the "contact or mixing" category.

Core disgust (disease or ingestion triggers) was significant with refusing foods with "things" in them, trying not to let different foods touch on the plate, and not eating food if someone else touched it. Rejection of foods with "things" in them overlapped with selective eating, while the other eating behaviors did not. Finding that core disgust relates to a selective eating behavior that is consistent with the function of the core disgust function and trigger categories as it protects from ingestion of harmful substances (Berger & Anaki, 2014; Olatunji et al., 2008). Similarly, selective eaters are known to reject foods with other "things" in them both in the literature and in this study (Werthmann et al., 2015).

**Conclusions**

This study shows that there may be some connection between specific selective eating behaviors and the gag reflex and disgust sensitivity. However, there is very little overlap in reported behaviors by selective eaters and individuals with more reactive gag reflexes or higher disgust sensitivity. This could indicate that all of these variables play a role in shaping an individual's eating behaviors. More research on how particular selective eating behaviors relate to disgust domains and the gag reflex could help to find stronger connections between them.

This study disputes Almoznino et al.'s (2016) claim that gagging does not affect eating or daily activities outside of dental situations. Examining triggers and connected evolutionary

mechanisms could better explain individual gag reflex variations and any population differences in strength. Further research outside of the dental field could highlight how the strength of the gag reflex can affect food avoidances. Minimally, it could provide information on the best predictors of which individuals are most sensitive.

**Limitations and future studies**

Future studies could test more eating behaviors and detail reasons and causations of them. Studies could also aim for a larger sample size of selective eaters without allergies or religious/ethical aversions which could show stronger relationships between disgust sensitivity and selective eating. Detailing more social and cultural influences on childhood meal time and contributors to food choices could highlight more learned behaviors and possibly show connections to disgust sensitivity and strength of the gag reflex. These social and cultural influences could include parental eating patterns, involvement in meal prep, and more on the meal-time atmosphere/existence.

Testing more disgust domains may help to find connections not observed in this study. Future studies could also focus on common triggers that relate to both disgust and gagging. This study identified potential new directions for the future study of the gag reflex and the ramifications of those potentials studies outside of dental fields.

# Works Cited


Achenbach, T.M., & Rescorla, L.A. (2001). Manual for the ASEBA School-Age Forms & Profiles. Burlington, VT: University of Vermont, Research Center for Children, Youth, & Families.

Akarslan, Z. Z., & Biçer, A. Z. Y. (2012). Utility of the gagging problem assessment questionnaire in assessing patient sensitivity to dental treatments. *Journal of Oral Rehabilitation*. https://doi.org/10.1111/j.1365-2842.2012.02321.x

Almoznino, G., Zini, A., Aframian, D. J., Kaufman, E., Lvovsky, A., Hadad, A., & Levin, L. (2015). Oral Health Related Quality of Life in Young Individuals with Dental Anxiety and Exaggerated Gag Reflex. *Oral Health & Preventive Dentistry*. https://doi.org/10.3290/j.ohpd.a33921

Almoznino, G., Zini, A., Sharav, Y., Yanko, R., Lvovsky, A., & Aframian, D. J. (2016). Overlap between dental anxiety, gagging and Blood-Injection-Injury related fears — A spectrum of one multidimensional phenomenon. *Physiology and Behavior*. https://doi.org/10.1016/j.physbeh.2016.07.021

Al-Shawaf, L., Conroy-Beam, D., Asao, K., & Buss, D. M. (2014). Human emotions: An evolutionary psychological perspective. *Emotion Review*. https://doi.org/10.1177/1754073914565518

Anand, Mv., Rai, R., Bettie, N., Ramachandiran, H., Solomon, & Praveena, S. (2015). Acupuncture - An effective tool in the management of gag reflex. *Journal of Pharmacy and Bioallied Sciences*, *7*(6), 677. https://doi.org/10.4103/0975-7406.163601

Askew, C., Çakir, K., Põldsam, L., & Reynolds, G. (2014). The effect of disgust and fear modeling on children's disgust and fear for animals. *Journal of Abnormal Psychology*. https://doi.org/10.1037/a0037228

Aunger, R. (2000). The life history of culture learning in a face-to-face society. *Ethos*. https://doi.org/10.1525/eth.2000.28.3.445

Bassi, G. S., Humphris, G. M., & Longman, L. P. (2004). The etiology and management of gagging: A review of the literature. *Journal of Prosthetic Dentistry*. https://doi.org/10.1016/j.prosdent.2004.02.018

Berger, U., & Anaki, D. (2014). Demographic influences on disgust: Evidence from a heterogeneous sample. *Personality and Individual Differences*, *64*, 67–71. https://doi.org/10.1016/j.paid.2014.02.016

Bernard, H. (2011). Research methods in anthropology qualitative and quantitative approaches (5th ed.). Lanham, MD: AltaMira.

Bignardi, L., Prates, T., De Rossi, A., Nelson-Filho, P., de Carvalho, F. K., de Siqueira Mellara, T., & de Queiroz, A. M. (2018). Strategies and dental care in the treatment of patients with myelomeningocele. *Special Care in Dentistry*, *38*(2), 89–94. https://doi.org/10.1111/scd.12276

Bisogni, C. A., Connors, M., Devine, C. M., & Sobal, J. (2002). Who We Are and How We Eat: A Qualitative Study of Identities in Food Choice. *Journal of Nutrition Education and Behavior*, *34*(3), 128–139. https://doi.org/10.1016/S1499-4046(06)60082-1

Boone, R., & Buck, T. (2003). Emotional expressivity and trustworthiness: The role of nonverbal behavior in the evolution of cooperation. *Journal of Nonverbal Behavior*, *27*(3), 163–182.

Boquin, M., Smith-Simpson, S., Donovan, S. M., & Lee, S. (2014). Mealtime Behaviors and Food Consumption of Perceived Picky and Nonpicky Eaters through Home Use Test. Journal Of Food Science, 79(12), S2523-S2532.

Burrows, A. M., Li, L., Waller, B. M., & Micheletta, J. (2016). Social variables exert selective pressures in the evolution and form of primate mimetic musculature. *Journal of Anatomy*. https://doi.org/10.1111/joa.12440

Buttelmann, D., Call, J., & Tomasello, M. (2009). Do great apes use emotional expressions to infer desires? *Developmental Science*. https://doi.org/10.1111/j.1467-7687.2008.00802.x

Calvo, M. G., Avero, P., Fernández-Martín, A., & Recio, G. (2016). Recognition thresholds for static and dynamic emotional faces. *Emotion*. https://doi.org/10.1037/emo0000192

Cardona Cano, S., Tiemeier, H., Van Hoeken, D., Tharner, A., Jaddoe, V. W., Hofman, A., Verhulst, FC., & Hoek, H. W. (2015). Trajectories of picky eating during childhood: A general population study. International Journal Of Eating Disorders, 48(6), 570-579.

Catanzaro, D., Chesbro, E. C., & Velkey, A. J. (2013). Relationship between food preferences and PROP taster status of college students. *Appetite*, *68*, 124–131. https://doi.org/10.1016/j.appet.2013.04.025

Cathey, M., & Gaylord, N. (2004). Picky Eating: A Toddler's Approach to Mealtime. Pediatric Nursing, 30(2), 101-109.

Croy, I., Drechsler, E., Hamilton, P., Hummel, T., & Olausson, H. (2016). Olfactory modulation of affective touch processing - A neurophysiological investigation. *NeuroImage*. https://doi.org/10.1016/j.neuroimage.2016.04.046

Davies, A. E., Stone, S. P., Kidd, D., & MacMahon, J. (1995). Pharyngeal sensation and gag reflex in healthy subjects. *The Lancet*, *345*(8948), 487–488. https://doi.org/10.1016/S0140-6736(95)90584-7

Dickinson, C., & Fiske, J. (2005). A review of gagging problems in dentistry: I. Aetiology and classification. Dental Update, 32(1), 26-8, 31-2.

Dovey, T. M., & Shuttleworth, M. (2006). Food neophobia and willingness to eat vegetables in British rural and urban children. *Appetite*, *47*(2), 263. https://doi.org/10.1016/j.appet.2006.07.021

Dovey, T. M., Staples, P. A., Gibson, E. L., & Halford, J. C. G. (2008). Food neophobia and "picky/fussy" eating in children: A review. *Appetite*, *50*(2–3), 181–193. https://doi.org/10.1016/j.appet.2007.09.009

Ellis, J. M., Galloway, A. T., Mary Webb, R., & Martz, D. M. (2017). Measuring adult picky eating: The development of a multidimensional self-report instrument. *Psychological Assessment*. https://doi.org/10.1037/pas0000387

Ellis, T. B. (2011). Disgusting bodies, disgusting religion: The biology of Tantra. *Journal of the American Academy of Religion*. https://doi.org/10.1093/jaarel/lfr077

Feder, Y. (2016). Contamination Appraisals, Pollution Beliefs, and the Role of Cultural Inheritance in Shaping Disease Avoidance Behavior. *Cognitive Science*. https://doi.org/10.1111/cogs.12293

Fiske, J., & Dickinson, C. (2001). The Role of Acupuncture in Controlling The Gagging Reflex using a Review of Ten Cases. *British Dental Journal*. https://doi.org/10.1038/sj.bdj.4801053a

Garg, R., Singhal, A., Agrawal, K., & Agrawal, N. (2014). Managing Endodontic Patients with Severe Gag Reflex by Glossopharyngeal Nerve Block Technique. *Journal of Endodontics*, *40*(9), 1498–1500. https://doi.org/10.1016/j.joen.2014.01.028

Ghanizadeh, A. (2013). Parents reported oral sensory sensitivity processing and food preference in ADHD. *Journal of Psychiatric and Mental Health Nursing*. https://doi.org/10.1111/j.1365-2850.2011.01830.x

Grabowski, N., Mengden, R., von Brethorst, S., & Kleint, G. (2013). Edible Insects in a Food Safety and Nutritional Perspective: A Critical Review. *Comprehensive Reviews in Food Science and Food Safety*, *12*(3), 296–313. https://doi.org/10.1111/1541-4337.12014

Haidt, J., McCauley, C., & Rozin, P. (1994). Individual differences in sensitivity to disgust: A scale sampling seven domains of disgust elicitors. *Personality and Individual Differences*. https://doi.org/10.1016/0191-8869(94)90212-7

Haidt, J., McCauley, C., & Rozin, P. (2012). The Disgust Scale Home Page. Retrieved from http://people.stern.nyu.edu/jhaidt/disgustscale.html

Haire-Joshu, D., Kreuter, M. K., Holt, C., & Steger-May, K. (2004). Estimates of fruit and vegetable intake in childhood and adult dietary behaviors of African American women. *Journal of Nutrition Education and Behavior*. https://doi.org/10.1016/S1499-4046(06)60400-4

Hall, S. (1997). Representation: Cultural representations and signifying practices (Culture, media, and identities). London; Thousand Oaks, Calif.: Sage in association with the Open University.

Hamerman, E. J. (2016). Cooking and disgust sensitivity influence preference for attending insect-based food events. *Appetite*, *96*, 319–326. https://doi.org/10.1016/j.appet.2015.09.029

Hartmann, C., & Siegrist, M. (2017). Development and validation of the Food Disgust Scale. *Food Quality and Preference*, *63*. https://doi.org/10.1016/j.foodqual.2017.07.013

Hearing, C. M., Bind, R. H., Tabacco, M. J., & Hallock, R. M. (2014). A Reliable and Valid Survey to Predict a Patient's Gagging Intensity. *Journal of Oral & Maxillofacial Research*. https://doi.org/10.5037/jomr.20014.5203

Hegazi, M. A., Sehlo, M. G., Al-Jasir, A., & El-Deek, B. S. (2015). Development and cognitive functions in Saudi pre-school children with feeding problems without underlying medical disorders. *Journal of Paediatrics and Child Health*, *51*(9), 906–912. https://doi.org/10.1111/jpc.12880

Henrich, J., Heine, S., & Norenzayan, A. (2010). The weirdest people in the world? Behavioral and Brain Sciences, 33(2-3), 61-83.

Herbert, C., Platte, P., Wiemer, J., Macht, M., & Blumenthal, T. D. (2014). Supertaster, super reactive: Oral sensitivity for bitter taste modulates emotional approach and avoidance behavior in the affective startle paradigm. *Physiology and Behavior*. https://doi.org/10.1016/j.physbeh.2014.06.002

Herz, R. S. (2014). Verbal priming and taste sensitivity make moral transgressions gross. *Behavioral Neuroscience*. https://doi.org/10.1037/a0035468

Horodynski, M. & Arndt, MJ (2005). "Eating-together" mealtimes with African-American fathers and their toddlers. Applied Nursing Research., 18(2), 106-109.

Horodynski, M. A., Stommel, M., Brophy-Herb, H., Yan, X., & Weatherspoon, L. (2010). Low-Income African American and Non-Hispanic White Mothers' Self-Efficacy, "Picky Eater" Perception, and Toddler Fruit and Vegetable Consumption. Public Health Nursing, 27(5), 408-417.

IBM Corp. Released 2016. IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp.

Jacobi, C., Schmitz, G., & Agras, W. S. (2008). Is picky eating an eating disorder? *International Journal of Eating Disorders*, *41*(7), 626–634. https://doi.org/10.1002/eat.20545

Kauer, J., Pelchat, M. L., Rozin, P., & Zickgraf, H. F. (2015). Adult picky eating. Phenomenology, taste sensitivity, and psychological correlates. *Appetite*, *90*, 219–228. https://doi.org/10.1016/j.appet.2015.03.001

Kawai, N., Kubo, K., Masataka, N., & Hayakawa, S. (2016). Conserved evolutionary history for quick detection of threatening faces. *Animal Cognition*. https://doi.org/10.1007/s10071-015-0949-y

Kelly, Á. R., & Ogden, J. (2016). The effects of perceived early childhood attachment and care status on young people's eating behaviour. *Adoption & Fostering*, *40*(3), 234–246. https://doi.org/10.1177/0308575916663561

Kemp, C., & Kaplan, G. (2013). Facial expressions in common marmosets (Callithrix jacchus) and their use by conspecifics. *Animal Cognition*. https://doi.org/10.1007/s10071-013-0611-5

Kendler, K. S., Halberstadt, L. J., Butera, F., Myers, J., Bouchard, T., & Ekman, P. (2008). The similiarity of facial expressions in response to emotion-inducing films in reared-apart twins. *Psychological Medicine*. https://doi.org/10.1017/S0033291707001535

Laitman, J. T., & Reidenberg, J. S. (2013). The evolution and development of human swallowing: The most important function we least appreciate. *Otolaryngologic Clinics of North America*. https://doi.org/10.1016/j.otc.2013.09.005

Lam, J. (2015). Picky eating in children. *Frontiers in Pediatrics*, *3*, 41. https://doi.org/10.3389/fped.2015.00041

Lieberman, P. (1994). The origins and evolution of language. In *Companion Encyclopedia of Anthropology*.

Lieberman, P. (2000). The Origins of Complex Language: An Inquiry into the Evolutionary Beginnings of Sentences, Syllables, and Truth. *American Anthropologist*, *102*(3), 650–651.

Lieberman, P. (2002). On the nature and evolution of the neural bases of human language. *American Journal of Physical Anthropology*.

Lieberman, P. (2012). Vocal tract anatomy and the neural bases of talking. *Journal of Phonetics*, *40*(4), 608–622. https://doi.org/10.1016/j.wocn.2012.04.001

Lim, K. S., Hew, Y. C., Lau, H. K., Lim, T. S., & Tan, C. T. (2009). Bulbar Signs in Normal Population. *Canadian Journal of Neurological Sciences / Journal Canadien Des Sciences Neurologiques*, *36*(1), 60–64. https://doi.org/10.1017/S0317167100006326

Loomis, T., Timmons, M., Hogan, K., Jacobson, H., Lebarron, R., & Narzabal, S. (2017). Picky Eating and the Associated Nutritional Consequences. *Journal of Food and Nutritional Disorders*, *6*(3). https://doi.org/10.4172/2324-9323.1000227

Machado, B. C., Dias, P., Lima, V. S., Campos, J., & Gonçalves, S. (2016). Prevalence and correlates of picky eating in preschool-aged children: A population-based study. *Eating Behaviors*, *22*, 16–21. https://doi.org/10.1016/j.eatbeh.2016.03.035

Maitre, I., Van Wymelbeke, V., Amand, M., Vigneau, E., Issanchou, S., & Sulmont-Rossé, C. (2014). Food pickiness in the elderly: Relationship with dependency and malnutrition. *Food Quality and Preference*, *32*, 145–151. https://doi.org/10.1016/j.foodqual.2013.04.003

Maslin, K., Dean, T., Arshad, S. H., & Venter, C. (2015). Fussy eating and feeding difficulties in infants and toddlers consuming a cows' milk exclusion diet. Pediatric Allergy & Immunology, 26(6), 503-508.

Matheson, D., Spranger, K., & Saxe, A. (2002). Preschool Children's Perceptions of Food and Their Food Experiences. Journal Of Nutrition Education & Behavior, 34(2), 85-92.

Morgan, G. A. & George, A. (2013). *IBM SPSS for introductory statistics: use and interpretation*. Routledge.

Muller, M., Mast, J., Cui, J., Heffernan, M., Mcquillan, P., & Sinoway, L. (2013). Tactile stimulation of the oropharynx elicits sympathoexcitation in conscious humans. Journal of Applied Physiology (Bethesda, Md. : 1985), 115(1), 71-7.

Murphy, W. M. (1979). A clinical survey of gagging patients. *The Journal of Prosthetic Dentistry*. https://doi.org/10.1016/0022-3913(79)90163-X

Nicholls, D., Christie, D., Randall, L., & Lask, B. (2001). Selective Eating: Symptom, Disorder or Normal Variant. Clinical Child Psychology & Psychiatry, 6(2), 257.

Olatunji, B. O., Haidt, J., McKay, D., & David, B. (2008). Core, animal reminder, and contamination disgust: Three kinds of disgust with distinct personality, behavioral, physiological, and clinical correlates. *Journal of Research in Personality*. https://doi.org/10.1016/j.jrp.2008.03.009

Olatunji, B. O., Williams, N. L., Tolin, D. F., Abramowitz, J. S., Sawchuk, C. N., Lohr, J. M., & Elwood, L. S. (2007). The Disgust Scale: Item Analysis, Factor Structure, and Suggestions for Refinement. *Psychological Assessment*. https://doi.org/10.1037/1040-3590.19.3.281

Oliveira, A. R. de S., Costa, A. G. de S., Morais, H. C. C., Cavalcante, T. F., Lopes, M. V. de O., & Araujo, T. L. de. (2015a). Clinical factors predicting risk for aspiration and respiratory aspiration among patients with Stroke. *Revista Latino-Americana de Enfermagem*, *23*(2), 216–224. https://doi.org/10.1590/0104-1169.0197.2545

Oliveira, A., Jones, L., De Lauzon-Guillain, B., Emmett, P., Moreira, P., Charles, M. A., & Lopes, C., (2015b). Early problematic eating behaviours are associated with lower fruit and vegetable intake and less dietary variety at 4–5 years of age. A prospective analysis of three European birth cohorts. 114(5), 763-771.

Parr, L. A., & Waller, B. M. (2006). Understanding chimpanzee facial expression: insights into the evolution of communication. *Social Cognitive and Affective Neuroscience*. https://doi.org/10.1093/scan/nsl031

Peleg, G., Katzir, G., Peleg, O., Kamara, M., Brodsky, L., Hel-Or, H., Keren, D., Nevo, E. (2006). Hereditary family signature of facial expression. *Proceedings of the National Academy of Sciences of the United States of America*. https://doi.org/10.1073/pnas.0607551103

Pradhan, A., & Gryst, M. (2015). Atraumatic restorative technique: case report on dental management of a patient with Moebius syndrome. *Australian Dental Journal*, *60*(2), 255–259. https://doi.org/10.1111/adj.12319

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Rodger, H., Vizioli, L., Ouyang, X., & Caldara, R. (2015). Mapping the development of facial expression recognition. *Developmental Science*. https://doi.org/10.1111/desc.12281

Rosted, P., & Warnakulasuriya, S. (2005). A survey on the uses of acupuncture by a group of UK dentists. *British Dental Journal*. https://doi.org/10.1038/sj.bdj.4812039

Rottman, J. (2014). Evolution, development, and the emergence of disgust. *Evolutionary Psychology*. https://doi.org/10.1177/147470491401200209

Rozin, P., Lowery, L., & Ebert, R. (1994). Varieties of disgust faces and the structure of disgust. *Journal of Personality and Social Psychology*. https://doi.org/10.1037/0022-3514.66.5.870

Scarborough, D., Bailey-Van Kuren, M., & Hughes, M. (2008). Altering the gag reflex via a palm pressure point. *Journal of the American Dental Association*. https://doi.org/10.14219/jada.archive.2008.0048

Schienle, A., Arendasy, M., & Schwab, D. (2015). Disgust Responses to Bitter Compounds: the Role of Disgust Sensitivity. *Chemosensory Perception*. https://doi.org/10.1007/s12078-015-9186-7

Schienle, A., Dietmaier, G., Ille, R., & Leutgeb, V. (2010). Eine Skala zur Erfassung der Ekelsensitivität (SEE) TT - A scale for assessing disgust sensitivity (SADS). *Zeitschrift Für Klinische Psychologie Und Psychotherapie*. https://doi.org/10.1026/1616-3443/a000016 LA - German

Schindler, J. S., & Kelly, J. H. (2002). Swallowing Disorders in the Elderly. *The Laryngoscope*, *112*(4), 589–602. https://doi.org/10.1097/00005537-200204000-00001

Schug, J., Matsumoto, D., Horita, Y., Yamagishi, T., & Bonnet, K. (2010). Emotional expressivity as a signal of cooperation. *Evolution and Human Behavior*. https://doi.org/10.1016/j.evolhumbehav.2009.09.006

Sherlock, J. M., Zietsch, B. P., Tybur, J. M., & Jern, P. (2016). The quantitative genetics of disgust sensitivity. *Emotion (Washington, D.C.)*. https://doi.org/10.1037/emo0000101

Sherwood. (2013). *Human Physiology: From Cells to Systems* (8th ed.). Belmont, CA: Brooks/Cole, Cengage Learning.

Shutts, K., Kinzler, K. D., & DeJesus, J. M. (2013). Understanding infants' and children's social learning about foods: previous research and new prospects. *Developmental Psychology*. https://doi.org/10.1037/a0027551

Siegal, M., Fadda, R., & Overton, P. (2011). Contamination sensitivity and the development of disease-avoidant behaviour. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*. https://doi.org/10.1098/rstb.2011.0036

Singh, S., Ali, F., Nazirkar, G., Dole, V., & Gaikwad, B. (2013). Gag- Etiology and its Skillfull Management- A Review. Journal of Evolution of Medical and Dental Sciences, 2(10), 1509-1516.

Slauson-Blevins, K., & Johnson, K. M. (2016). Doing Gender, Doing Surveys? Women's Gatekeeping and Men's Non-Participation in Multi-Actor Reproductive Surveys. *Sociological Inquiry*, *86*(3), 427–449. https://doi.org/10.1111/soin.12122

Smith, G. (2008) "Does gender influence online survey participation?: A record-linkage analysis of university faculty online survey response behavior." ERIC Document Reproduction Service No. ED 501717.

Student Diversity Statistics. (2017). Western Washington University. Retrieved May 3, 2018, from http://www.wwu.edu/diversity/stats.shtml

Tan, H. S. G., Fischer, A. R. H., Tinchan, P., Stieger, M., Steenbekkers, L. P. A., & van Trijp, H. C. M. (2015). Insects as food: Exploring cultural exposure and individual experience as determinants of acceptance. *Food Quality and Preference*. https://doi.org/10.1016/j.foodqual.2015.01.013

Tan, H. S. G., van den Berg, E., & Stieger, M. (2016). The influence of product preparation, familiarity and individual traits on the consumer acceptance of insects as food. *Food Quality and Preference*. https://doi.org/10.1016/j.foodqual.2016.05.003

Teachman, B. A., & Saporito, J. (2009). I am going to gag: Disgust cognitions in spider and blood-injury-injection fears. *Cognition and Emotion*. https://doi.org/10.1080/02699930801961731

Tettamanti, M., Rognoni, E., Cafiero, R., Costa, T., Galati, D., & Perani, D. (2012). Distinct pathways of neural coupling for different basic emotions. *NeuroImage*, *59*(2), 1804–1817. https://doi.org/10.1016/j.neuroimage.2011.08.018

Thompson, C., Cummins, S., Brown, T., & Kyle, R. (2015). What does it mean to be a 'picky eater'? A qualitative study of food related identities and practices. Appetite, 84235-239.

Toyama, H., & Agras, W. S. (2016). A test to identify persistent picky eaters. *Eating Behaviors*. https://doi.org/10.1016/j.eatbeh.2016.07.003

Van Tine, M. L., McNicholas, F., Safer, D. L., & Agras, W. S. (2017). Follow-up of selective eaters from childhood to adulthood. *Eating Behaviors*. https://doi.org/10.1016/j.eatbeh.2017.01.003

Vicario, C. M., Rafal, R. D., Borgomaneri, S., Paracampo, R., Kritikos, A., & Avenanti, A. (2017). Pictures of disgusting foods and disgusted facial expressions suppress the tongue motor cortex. *Social Cognitive and Affective Neuroscience*. https://doi.org/10.1093/scan/nsw129

Wardle, J., & Cooke, L. J. (2010). One man's meat is another man's poison. *EMBO Reports*. https://doi.org/10.1038/embor.2010.161

Werthmann, J., Jansen, A., Havermans, R., Nederkoorn, C., Kremers, S., & Roefs, A. (2015). Bits and pieces. Food texture influences food acceptance in young children. Appetite, 84181-187.

Wildes, J. E., Zucker, N. L., & Marcus, M. D. (2012). Picky eating in adults: Results of a web-based survey. *International Journal of Eating Disorders*, *45*(4), 575–582. https://doi.org/10.1002/eat.20975

Wind, J. (1970). *On the phylogeny and the ontogeny of the human larynx; a morphological and functional study*. Groningen: Wolters-Noordhoff. Retrieved from 9001954502

Yetter, G., & Capaccioloi, K. (2010). Differences in responses to Web and paper surveys among school professionals. *Behavior Research Methods*, *42*(1), 266–272. https://doi.org/10.3758/BRM.42.1.266

Zickgraf, H. F., & Schepps, K. (2016). Fruit and vegetable intake and dietary variety in adult picky eaters. *Food Quality and Preference*, *54*, 39–50. https://doi.org/10.1016/j.foodqual.2016.06.012

Zickgraf, H. F., Franklin, M. E., & Rozin, P. (2016). Adult picky eaters with symptoms of avoidant/restrictive food intake disorder: comparable distress and comorbidity but different eating behaviors compared to those with disordered eating symptoms. *Journal of Eating Disorders*, *4*(1), 26. https://doi.org/10.1186/s40337-016-0110-6

Zucker, N., Copeland, W., Franz, L., Carpenter, K., Keeling, L., Angold, A., & Egger, H. (2015). Psychological and Psychosocial Impairment in Preschoolers with Selective Eating. *Pediatrics*, *136*(3), e582-90. https://doi.org/10.1542/peds.2014-2386

# Appendix A

## Disgust Scale-Revised

**Q1** Please indicate how much you agree with each of the following statements, or how true it is about you.

| | Strongly disagree | Mildly disagree | Neither agree nor disagree | Mildly agree | Strongly agree |
|---|---|---|---|---|---|
| 1) I might be willing to try eating monkey meat, under some circumstances. | ○ | ○ | ○ | ○ | ○ |
| 2) It would bother me to be in a science class, and to see a human hand preserved in a jar. | ○ | ○ | ○ | ○ | ○ |
| 3) It bothers me to hear someone clear a throat full of mucous. | ○ | ○ | ○ | ○ | ○ |
| 4) I never let any part of my body touch the toilet seat in public restrooms. | ○ | ○ | ○ | ○ | ○ |
| 5) I would go out of my way to avoid walking through a graveyard. | ○ | ○ | ○ | ○ | ○ |

**Q2** Please indicate how much you agree with each of the following statements, or how true it is about you.

| | Strongly disagree | Somewhat disagree | Neither agree nor disagree | Somewhat agree | Strongly agree |
|---|---|---|---|---|---|
| 6) Seeing a cockroach in someone else's house doesn't bother me. | ○ | ○ | ○ | ○ | ○ |
| 7) It would bother me tremendously to touch a dead body. | ○ | ○ | ○ | ○ | ○ |
| 8) If I see someone vomit, it makes me sick to my stomach. | ○ | ○ | ○ | ○ | ○ |
| 9) I probably would not go to my favorite restaurant if I found out that the cook had a cold. | ○ | ○ | ○ | ○ | ○ |
| 10) It would not upset me at all to watch a person with a glass eye take the eye out of the socket. | ○ | ○ | ○ | ○ | ○ |

**Q3** Please indicate how much you agree with each of the following statements, or how true it is about you.

| | Strongly disagree | Somewhat disagree | Neither agree nor disagree | Somewhat agree | Strongly agree |
|---|---|---|---|---|---|
| 11) It would bother me to see a rat run across my path in a park. | ○ | ○ | ○ | ○ | ○ |
| 12) I would rather eat a piece of fruit than a piece of paper. | ○ | ○ | ○ | ○ | ○ |
| 13) Even if I was hungry, I would not drink a bowl of my favorite soup if it had been stirred by a used but thoroughly washed flyswatter. | ○ | ○ | ○ | ○ | ○ |
| 14) It would bother me to sleep in a nice hotel room if I knew that a man had died of a heart attack in that room the night before. | ○ | ○ | ○ | ○ | ○ |

**Q4** How disgusting would you find each of the following experiences?

| | Not disgusting at all | Slightly disgusting | Moderately disgusting | Very disgusting | Extremely disgusting |
|---|---|---|---|---|---|
| 15) You see maggots on a piece of meat in an outdoor garbage pail. | ○ | ○ | ○ | ○ | ○ |
| 16) You see a person eating an apple with a knife and fork. | ○ | ○ | ○ | ○ | ○ |
| 17) While you are walking through a tunnel under a railroad track, you smell urine. | ○ | ○ | ○ | ○ | ○ |
| 18) You take a sip of soda, and then realize that you drank from the glass that an acquaintance of yours had been drinking from. | ○ | ○ | ○ | ○ | ○ |

**Q5** How disgusting would you find each of the following experiences?

| | Not disgusting at all | Slightly disgusting | Moderately disgusting | Very disgusting | Extremely disgusting |
|---|---|---|---|---|---|
| 19) Your friend's pet cat dies, and you have to pick up the dead body with your bare hands. | ○ | ○ | ○ | ○ | ○ |
| 20) You see someone put ketchup on vanilla ice cream, and eat it. | ○ | ○ | ○ | ○ | ○ |
| 21) You see a man with his intestines exposed after an accident. | ○ | ○ | ○ | ○ | ○ |
| 22) You discover that a friend of yours changes underwear only once a week. | ○ | ○ | ○ | ○ | ○ |
| 23) A friend offers you a piece of chocolate shaped like dog doo. | ○ | ○ | ○ | ○ | ○ |

**Q6** How disgusting would you find each of the following experiences?

| | Not disgusting at all | Slightly disgusting | Moderately disgusting | Very disgusting | Extremely disgusting |
|---|---|---|---|---|---|
| 24) You accidentally touch the ashes of a person who has been cremated. | ○ | ○ | ○ | ○ | ○ |
| 25) You are about to drink a glass of milk when you smell that it is spoiled. | ○ | ○ | ○ | ○ | ○ |
| 26) As part of a sex education class, you are required to inflate a new unlubricated condom, using your mouth. | ○ | ○ | ○ | ○ | ○ |
| 27) You are walking barefoot on concrete, and you step on an earthworm. | ○ | ○ | ○ | ○ | ○ |

# Appendix B

## Predictive Gagging Survey

The gag reflex is a contraction of the muscles of the pharyngeal sphincter (upper esophagus or throat). The gag reflex is a natural protective measure of the body to protect an airway from blocking and remove material from the throat and upper gastrointestinal tract (Fiske & Dickinson, 2001). Although the gag reflex typically serves this protective function, a strong gag reflex may impact daily life.

**Q8** Do you have a gag reflex

- ○ Yes
- ○ No

**Q9** For the following questions, please use the scale of 1-7, in which 1 is the least severe and 7 is the most. For this question, a strong gag reflex indicates that you gag frequently and easily.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| How strong would you say your gag reflex is? | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

**Q10** Have you ever had a negative incident with gagging?

- ○ Yes
- ○ No

**Q11** Have you ever gagged at a dentist/orthodontist office before?

- ○ Yes
- ○ No

**Q12** Please indicate any of the following experiences that have caused you to gag:

- ○ Routing teeth-cleaning
- ○ Cavity filling
- ○ Dental x-ray
- ○ Other dental work
- ○ Root canal
- ○ Dental impression
- ○ Other orthodontic work

**Q13** Please indicate the corresponding number on the following scale.
never ----------seldom----------sometimes----------often

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| When you are going to the dentist, how much stress (if any) do you experience that is related to your gag reflex? | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

**Q14** Have daily activities, like brushing or flossing your teeth, ever made you gag?

- ○ Yes
- ○ No

**Q15** If yes, then indicate how often: never ----------seldom----------sometimes----------often

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| How often are these occurrences? | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

**Q16** Do you ever worry that daily activities other than brushing or flossing your teeth will cause you to gag?

- ○ Yes
- ○ No

**Q17** Does coughing ever cause you to gag?

- ○ Yes
- ○ No

**Q18** Have you ever gagged while trying to swallow pills?

- ○ Yes
- ○ No

# Appendix C

## Selective eating questionnaire

**Q19** Do you consider yourself a selective eater?

- o Definitely yes
- o Probably yes
- o Might or might not
- o Probably not
- o Definitely not

---

**Q20** If yes, when did you start becoming a selective eater?

_____

---

**Q21** Do others label you as a selective or "picky" eater?

- o Always
- o Most of the time
- o About half the time
- o Sometimes
- o Never

---

**Q22** Are your choice of foods influenced by religious practices, nutritional or health concerns (for example, low-salt diet), or ethical considerations (for example, vegetarian diet).

- o Yes
- o No

---

**Q23** Do you have food allergies or medically imposed dietary restrictions?

- o Yes
- o No

---

**Q24** Are you often on a diet to lose weight?

- o Yes
- o No

---

**Q25** Have you ever been diagnosed with ADHD?

- o Yes
- o No

---

**Q26** Have you ever thought that you might have ADHD?

- o Definitely yes
- o Probably yes
- o Might or might not
- o Probably not
- o Definitely not

---

**Q25** Do you eat from a very narrow range of foods?

- o Never
- o Sometimes
- o About half the time
- o Most of the time
- o Always

---

**Q26** Do you avoid one or more major food group(s) (for example, meat, vegetables, dairy products, starches/grains, sweets)?

- o Never
- o Sometimes
- o About half the time
- o Most of the time
- o Always

---

**Q27** If yes, which one(s)?

_____

---

**Q28** Are you willing to try foods that you have never eaten before?

- o Never
- o Sometimes
- o About half the time
- o Most of the time
- o Always

---

**Q29** Please indicate how much you agree with each statement

| | Never | Sometimes | About half the time | Most of the time | Always |
|---|---|---|---|---|---|
| I reject bitter foods | ○ | ○ | ○ | ○ | ○ |
| I reject sour foods | ○ | ○ | ○ | ○ | ○ |
| I reject salty foods | ○ | ○ | ○ | ○ | ○ |
| I reject sweet foods | ○ | ○ | ○ | ○ | ○ |

**Q30** Please indicate how often you relate to these statements

| | Never | Sometimes | About half the time | Most of the time | Always |
|---|---|---|---|---|---|
| I avoid foods with a particular consistency (texture) (for example, foods that are crunchy, gelatinous, or very chewy) | ○ | ○ | ○ | ○ | ○ |
| I reject foods that are slippery or "slimy" (for example, okra, oysters, soft boiled eggs or fried eggs) | ○ | ○ | ○ | ○ | ○ |

**Q31** Please indicate how much you relate to these statements

| | Never | Sometimes | About half the time | Most of the time | Always |
|---|---|---|---|---|---|
| I reject only foods that are a particular color | ○ | ○ | ○ | ○ | ○ |
| I prefer to eat only foods that are a particular color | ○ | ○ | ○ | ○ | ○ |

**Q32** Do you reject foods that are mixed or combined (for example, peas and carrots, a sandwich with several things in it, or things like tuna salad)?

- o Like a great deal
- o Like somewhat
- o Neither like nor dislike
- o Dislike somewhat
- o Dislike a great deal

---

**Q33** Do you reject foods with "lumps" in them (for example, a sauce with pieces in it or a stew), even if they are supposed to be that way (so this does not mean lumpy oatmeal or gravy)?

- o Never
- o Sometimes
- o About half the time
- o Most of the time
- o Always

---

**Q34** Do you refuse foods that have "things" in them (for example, a cookie with raisins in it, a brownie with nuts in it)?

- o Never
- o Sometimes
- o About half the time
- o Most of the time
- o Always

---

**Q35** Do you refuse foods with sauces on them (for example, pasta with tomato sauce, turkey with gravy)?

- o Never
- o Sometimes
- o About half the time
- o Most of the time
- o Always

---

**Q36** Do you reject foods if there is something you can't see in them (for example, filled foods like egg rolls, dumplings, ravioli)?

- o Never
- o Sometimes
- o About half the time
- o Most of the time
- o Always

---

**Q37** Do you try not to let different foods touch on the plate?

- Never
- Sometimes
- About half the time
- Most of the time
- Always

---

**Q38** Do you reject foods that have touched on the plate?

- Never
- Sometimes
- About half the time
- Most of the time
- Always

---

**Q39** Do you prefer to eat with a special person(s), in a special place or with special utensils/dishes?

- Never
- Sometimes
- About half the time
- Most of the time
- Always

---

**Q40** Do you usually eat foods in sequence in the main course (for example, all peas first, then all mashed potatoes, etc)?

- Never
- Sometimes
- About half the time
- Most of the time
- Always

---

**Q41** Do you eat foods in an unusual order (for example, dessert first)?

- Never
- Sometimes
- About half the time
- Most of the time
- Always

---

**Q42** Please indicate how often these statements are true for you

| | Never | Sometimes | About half the time | Most of the time | Always |
|---|---|---|---|---|---|
| I eat the same meal for breakfast everyday or most days | ○ | ○ | ○ | ○ | ○ |
| I eat the same meal for lunch everyday or most days | ○ | ○ | ○ | ○ | ○ |
| I eat the same meal for dinner every day or most days | ○ | ○ | ○ | ○ | ○ |

**Q43** I will not eat food if I saw someone else touch it

- ○ Never
- ○ Sometimes
- ○ About half the time
- ○ Most of the time
- ○ Always

**Q44** I look forward a lot to eating

- ○ Never
- ○ Sometimes
- ○ About half the time
- ○ Most of the time
- ○ Always

**Q45** Do you miss meals because you are preoccupied or busy and forget to eat?

- ○ Never
- ○ Sometimes
- ○ About half the time
- ○ Most of the time
- ○ Always

**Q46** When you go out, do your activities often include food as a central focus?

- ○ Never
- ○ Sometimes
- ○ About half the time
- ○ Most of the time
- ○ Always

**Q47** How much do you agree with the following statement: Enjoying food is one of the most important pleasures in my life.

- A great deal
- A lot
- A moderate amount
- A little
- None at all

---

**Q48** Do you prefer to leave a clean plate?

- Never
- Sometimes
- About half the time
- Most of the time
- Always

---

**Q49** When you are invited to dinner, do you worry that there may be nothing that you can eat?

- A great deal
- A lot
- A moderate amount
- A little
- None at all

---

**Q50** Do you have fond memories of family food occasions?

- A great deal
- A lot
- A moderate amount
- A little
- None at all

---

**Q51** Please indicate how much you agree with this statement:My memories of meals with my family when I was a child include a lot of tension about what or how much I was eating

- A great deal
- A lot
- A moderate amount
- A little
- None at all

---

**Q52** Please indicate how much you agree with each statement

| | Strongly agree | Somewhat agree | Neither agree nor disagree | Somewhat disagree | Strongly disagree |
|---|---|---|---|---|---|
| I am a healthy eater | ○ | ○ | ○ | ○ | ○ |
| I prefer to eat "health food" | ○ | ○ | ○ | ○ | ○ |
| I usually choose low- or no-fat foods over the full-fat version | ○ | ○ | ○ | ○ | ○ |

# Appendix D

## Demographics

**Q53** Sex

- Male
- Female
- Prefer not to say

---

**Q54** Date of birth (mm/dd/yyyy)

_____

---

**Q55** Weight (in pounds)

_____

---

**Q56** Height (in inches)

_____

---

**Q57** Education level

- Some high school
- High school
- Graduated/GED
- Some college
- College degree

---

**Q58** Ethnicity

- White
- Black or African American
- American Indian or Alaska Native
- Asian
- Native Hawaiian or Pacific Islander
- Other

---

**Email address**

**Q59** Please provide your name and email if you would like to be included in the raffle

- Email _____
- Name _____