Tactile Disgust

Supreet Saluja

Bachelor of Psychology (Honours)

43654061

Supervisor: Dick Stevenson

Empirical Thesis presented to the Faculty of Human Sciences

Department of Psychology

Macquarie University

Submitted on the 19th of October, 2018, in partial fulfilment of the requirements for the degree of Master of Research Macquarie University, 2018.

Abstract

Tactile objects are reported to be important elicitors of disgust. However, only two studies have assessed what makes objects disgusting to touch. The first found that softness and wetness were disgust eliciting, and the second that oily and sticky textures could also elicit disgust (Oum et al., 2011; Skolnick, 2013). As these studies manipulated only a few tactile qualities, the ability of other qualities to elicit disgust remains untested. Further, it is unclear if one's belief about what the object is (and the disease-risk it poses) influences disgust. Thus, two questions remain unanswered about tactile disgust. First, what is the full range of tactile qualities which elicit disgust, and second, is tactile disgust influenced by belief of what the elicitor is, and the disease risk it poses? To answer these questions, 120 participants aged 17 to 42 were asked to feel a range of objects, which represented the major tactile qualities (i.e., sticky, hard, soft, oily, lumpy, viscous, wet, grainy, cold, warm), and rate how the objects felt (i.e., how sticky, hard, etc., it was), how the objects made them feel (i.e., disgust, fear and other emotions), and their disease risk belief (primarily how sick they thought the objects would make them). There were four groups, one could see the objects and the other three could not. To assess if participants' belief about what they were touching influenced disgust, labelling was used on participants who could not see the objects. Objects were either disgust labelled, truly labelled or not labelled and participants reported what they thought they were touching. The results show sticky and wet textures are highly disgust eliciting, and viscosity, cold and lumpy also elicit disgust (but to a lesser extent). This suggests the adherence-quality of objects predicts disgust. Further, labelling had a significant impact, with the Disgust-Label group having the highest disgust and fear ratings, and belief the objects would make them sick. Fear and sickness belief were powerful predictors of tactile disgust and explained the increased disgust in the Disgust-Label group. The results argue for a comprehensive model of tactile disgust, which takes into account sensory-level features and disease-risk beliefs.

Declaration of Originality

I hereby confirm that all material contained in this project are my original authorship and ideas, except where the work of others has been acknowledged or referenced. I also confirm that the work has not been submitted for a higher degree to any other university or institution. The research project was approved by the Macquarie University Human Research Ethics Committee (Approval No. 5201800064).

Supreet Saluja

Table of Contents

List of Tables and Figures

1. Introduction

Disgust is considered a basic emotion and it has a specific set of facial, behavioural, physiological and psychological features (Rozin & Fallon, 1987; Haidt, McCauley & Rozin, 1994; Lang, Greenwald, Bradley & Hamm, 1993). Disgust also has a specific function – it serves to facilitate disease-avoidance in humans. In line with this, many cues of disgust encountered via sight, sound, smell, taste, or touch, signal the presence of pathogens (Curtis & Biran, 2001; Curtis, Aunger & Rabie, 2004; Oaten, Stevenson & Case, 2009; Royzman & Sabini, 2001; Stafford, 2017). While there is general agreement about the cues that elicit disgust in vision, audition, olfaction and gustation – far less is known about somatosensory (tactile) cues. That is, even though tactile cues may be important indicators of pathogens, very little empirical research has identified what we find disgusting to *touch*. This is the primary focus of this thesis.

To date, only two tactile experiments have examined what individuals find disgusting to touch (Oum, Lieberman & Aylward, 2011; Skolnick, 2013). One study (Oum et al., 2011) found that soft and wet consistencies (akin to microbial decay) were strong elicitors of disgust. In contrast, the other (Skolnick, 2013) found that *no* single tactile dimension was associated with disgust, rather disgust was predicted by hedonics (i.e., texture-pleasantness). Importantly, no study to date has taken into account participants' belief about what they are touching – an important issue as it is not clear if knowledge of the elicitor and hence the potential disease risk it poses, or the tactile qualities in and of themselves elicit disgust. To address these issues, the current study aims to examine not only the role of sensory-features (i.e., tactile qualities) but also risk beliefs (i.e., knowledge of the elicitor) in tactile-disgust.

The Introduction is organised into five sections. The first begins by defining disgust and concludes by assessing the validity of measuring disgust by self-reports – a key step, as the current study uses self-report to measure tactile mediated disgust. The second section reviews sensory literature pertinent to tactile disgust, outlining disgust elicitors in the five main senses (i.e., olfaction, gustation, vision, audition and somatosensation), and the perception of temperature and texture – the somatic sensations relevant to this thesis. The third section focuses on the role of disease risk beliefs in disgust. Finally, study aims and design rationale are outlined.

1.1 What is disgust?

Disgust has been defined as “repulsion at the thought of oral incorporation of offensive objects (i.e., contaminants)”, which render acceptable objects (e.g., food), unacceptable after contact (Rozin & Fallon, 1987, p. 21). Other contemporary definitions of disgust move beyond its food locus – and suggest disgust is a form of rejection, and distancing of one’s self away from contaminants, including feelings of nausea and repulsion (Davey, 2011). In addition, most disgust theorists emphasise disease avoidance as central to defining disgust and its cues (Oaten, et al., 2009). Taken together, feelings of nausea and revulsion, and behavioural distancing from disgust elicitors, (especially those affiliated to diseases), are key characteristics of disgust.

1.2 Validity of disgust measures.

Self-report is the principle method used to measure disgust in the scientific literature and was also used to measure disgust in this study. As such, it is important to outline the validity of self-reports as measures of disgust. To do so, this section reviews convergence between subjective disgust measures and disgust-induced facial, physical, physiological and neural activity.

Self-reports and facial behaviours. Several studies have examined if self-reports of disgust are indicative of facial behaviours associated with repulsion (Ekman et al., 1987; Rozin, Lowery & Ebert, 1994; Chapman, Kim, Susskind & Anderson, 2009). In support of this, when asked to identify the *feeling* of disgust amongst a range of emotion-related faces both Western and non-Western preliterate cultures reliably select a face displaying rejection (i.e., mouth gape, upper lip raise; Ekman & Friesen, 1971; Ekman et al., 1987). Thus, reports of disgust are correlated with facial behaviours indicative of disgust. Further, facial changes induced from sickness are described as disgust – suggesting that self-reports of disgust are also affiliated with expressions of sickness (Widen, Pochedly, Pieloch & Russell, 2013).

In addition to this, tastes described as extremely unpleasant, and images and sounds reported as highly disgusting (e.g., images of sickness, faeces, injuries, insects and sounds of vomiting; Chapman et al., 2009; De Jong et al., 2002) elicit muscle-activity in the *levator labii* region of the face (i.e., nose wrinkle and upper lip raise). Further this facial expression is said to prevent ingestion of harmful substances (via the mouth gape) and malodours (via the nose wrinkle; Rozin et al., 1994). Taken together, when individuals self-report disgust to certain tastes, smells, sounds and sights this is correlated with facial behaviours of rejection and sickness (i.e., a gape, nose wrinkle and upper lip raise).

Self-report and avoidant-behaviours. There have been several attempts to investigate if self-reports of disgust are correlated with avoidant and cleaning related behaviours (i.e., physical distancing from contaminants, blocking one's nose, cleaning one's hands; Olatunji & Sawchuk, 2005; Roseman, Weist & Swartz, 1994; Rozin et al., 2000). Consistent with this, a number of experiments have shown that as self-reported feelings of disgust increase, so too do hand-washing behaviours (Pellegrino, Crandall, O'Bryan & Seo, 2015; Porzig-Drummond, Stevenson, Case & Oaten, 2009; Waller & Boschen, 2015; Zhong & Liljenquist, 2006) and food-avoidant behaviours (Brown & Harris, 2012). Thus, avoidant action tendencies and behaviours are correlated with self-reports of disgust.

Self-report and physiological changes. A great deal of behavioural research has investigated if self-reports of disgust are correlated to physiological behaviours akin to nausea (i.e., increase in heart rate, salivation, reduced gastrointestinal movement; Singh, Yoon & Kuo, 2016). While some studies find self-reported disgust is associated with an increase in heart rate variability, salivation, skin conductance and respiration rate (De Jong, van Overveld & Peters, 2011; Gilchrist, Vrinceanu, Beland, Bacon & Ditto, 2016; Ottaviani, Mancini, Petrocchi, Medea & Couyoumdjian, 2013), others find feelings of disgust are associated with a *decrease* in heart rate, heart rate variability, and salivation (Lang, Greenwald, Bradley & Hamm, 1993; Vicario et al., 2017). This suggests self-reported disgust is not consistently related to physiological behaviours experienced during nausea (i.e., sweating, salivation, etc.). This discrepancy between behavioural and self-report methods of disgust may be due to the different disgust elicitors used across studies, with recent research indicating indirect (disgust-imagery, disgust-films) and direct (disgusting smells, touches, and tastes) elicitors of disgust, create different physiological responses (Comtesse & Stemmler, 2016; Croy et al., 2013). In sum, current evidence suggests physiological responding is inconsistently correlated with self-reports of disgust.

Self-reports and neural processing. While a large number of neuroimaging studies assess the brain-areas activated by disgusting sounds, smells, sights, and recall of disgusting events, very few examine those activated by *self-reported* disgust. Of the few neuroimaging studies that have used self-reports, self-reported disgust sensitivity (i.e., disgust towards certain situations and stimuli) is shown to correlate with activity in the amygdala (Schienle, Schafer, Stark, Walter & Vaitl, 2005), and the orbitofrontal cortex (OFC; Stark et al., 2005). Further, greater disgust sensitivity leads to higher activity in the anterior insular and left pallidum (in the basal ganglia; Calder et al., 2007; Mataix-Cols et al., 2008), when viewing disgusting images. Activation in these areas is akin to the activation produced by sensory disgust elicitors and recall of disgusting events (Adolphs, 2002; Calder, Keane, Manes, Antoun & Young, 2000; Chapman & Anderson, 2012; Lindquist et al., 2012; Wager et al., 2015) – suggesting self-reports are correlated with neural activity indicative of disgust.

Conclusion. Self-reports of disgust correlate with facial and bodily actions related with repulsion and nausea, and brain areas activated by disgust elicitors, lending support for self-reports of disgust as valid and reliable measures of the emotion.

1.3 Disgust and the senses

This section details the sensory elicitors of disgust, these being summarised in Table 1. Sensory-disgusts are detailed for two reasons. First, to see if common features exist across all disgust elicitors, as these may reveal potential tactile-cues of disgust. Second, to review what is currently known about tactile-disgust, and what remains to be studied. Each sense is reviewed in turn.

Table 1. Sensory-Disgusts

	Sensory Elicitors	Sensory Features	'Hardwired'	Measured via
Olfaction	1. Faecal odours 2. Other disease & contamination related odours (vomit, decay, putrefaction, urine) 3. Odours from body secretions (sweat, bad breath, urine)	- Low molecular weight - Sulphur compounds (thiols) - Nitrogen compounds (indoles) - Short-chain fatty acids	Strong evidence	- Universal self-reports - Disgust-behaviours - Imaging
Gustation & flavour	1. Bitter, sour, strong tastants 2. Spoilt foods 3. Some animals/ animal-parts	- Bitter tastants - Highly sour tastants	Strong evidence	- Universal self-reports - Disgust behaviours - Imaging
Vision	1. Images of disease and decay 2. Body-envelop violations 3. Appearance of certain animals	- Irregular hole clusters? - Coiled body forms?	No evidence	- Universal self-reports - Disgust behaviours - Imaging
Audition	1. Sickness sounds (coughing mucous, retching, vomiting) 2. Digestive sounds (belching, loud-chewing) 3. Auditory textures (squelching)		No evidence	- Universal self-reports - Disgust behaviours - Imaging - Physiological
Somato-sensation	1. Disease related (vomit, faeces, cremated ashes, spoilt food) 2. Animal related disgusts (worms, pigs-head) 3. Miscellaneous (okras, dough, noodles, honey)	- Wet, soft, sticky, slimy (oily) surfaces	No evidence	- Two self-report studies

1.3.1 Olfaction. Several classes of odorant may evoke disgust. The most important is faecal odour, as faeces is said to be a universal elicitor of disgust in humans (i.e., foul smelling in 96% of adults; Stevenson, 2010), and can contain many pathogens (e.g., salmonella, hepatitis, typhoid, tetanus, cholera etc.; Curtis & Birian, 2001; Stevenson & Repacholi, 2005). Further, other odours associated with disease and contamination, such as those from vomit, organic decay and putrefaction (e.g., in rotting foods) and urine (foul smelling in 91% of adults; Stevenson, 2010) are potent elicitors of disgust in humans. Finally, bodily secretions such as sweat and foul-smelling breath (mouth odours) are reputed elicitors of disgust, commonplace in disgust research (Stevenson, 2010; see Table 1).

Chemical features of Olfactory Disgust Elicitors. While a large range of disgust odours exist, each composed of many chemicals, three compounds (all with low molecular weight) are found in most. These are sulphur containing thiols, nitrogen containing indoles and short chain fatty acids (James, Austin, Cox, Taylor & Cakvert, 2013; Laska, Bautisa, Hofelmann, Sterlemann & Salazar, 2007).

Sulphur containing molecules are found in faeces, malodorous toilets (Chappuis, Niclass, Cayeux & Starkenmann, 2015; Laska et al., 2007; Sato et al., 2002), foul-smelling human breath, and axillary malodours (Hughes & McNah, 2008). In addition, sulphur molecules (i.e., thiols) are also responsible for malodourous animal secretions (red fox urine, defensive spray of the striped-skunk; Apfelbach, Parsons, Soini & Notovy, 2015), and are reliable markers of decay (Kamiya & Ose, 1984; Watson & Juttner, 2017).

Similarly, nitrogen containing molecules (from the indole family), and short-chain fatty acids (e.g., isolveric, butyric acid) are found in latrine malodours (Laska et al., 2007), and mark decay (Hughes & Mcnab, 2008; Kamiya & Ose, 1984). Indoles are also found in foul smelling human breath, and short chain fatty acids are found in body and foot malodours (James et al., 2013). As thiols, indoles, and short chain fatty acids are found in a range of malodours, they are probably the odorant features of olfactory-disgust.

Are they really disgust evoking? Three pieces of information suggest that malodours (fecal, urine, rotting food etc.) and their aforementioned molecular classes evoke disgust. First, they are universally reported as repulsive in self-report measures (Stevenson, 2010). Second, odours reported as disgusting elicit repulsed facial expressions and behaviours in neonates and adults (e.g., nose wrinkling, hand-washing; Pellegrino, Crandall & Seo, 2016; Rozin et al., 1994; Steiner, 1979). Third, they reliably activate the insula, amygdala and OFC – i.e., neural regions implicated with disgust (Lundstrom, Boyle, Zatorre & Jones-Gotman, 2008; Wicker et al., 2003).

1.3.2 Gustation and flavour. Bitter, moderate sour and very concentrated salty and umami tastes in adults, can elicit disgust (Bredie, Tan & Wendin, 2014). In addition to these, spoilt foods are reported as universal disgusts – noting the latter is not pure gustation per se, but flavour (i.e., principally gustation and olfaction, [and sometimes texture]). Further, consuming certain foods (again not pure gustation) can be morally-offensive in many religions and cultural systems. These foods include some animals (e.g., dogs) and animal-parts (e.g., brains, tongue etc.; Rozin & Fallon, 1987). Furthermore, any food/taste can elicit disgust if it is in contact with a contaminant or associated with disease. This latter point is well demonstrated following gastrointestinal illness, in which pairing of foods with sickness and nausea turns non-disgusting foods, disgusting (Logue, Logue & Strauss, 1983). In sum, while some tastes and flavours may be disgusting to taste (e.g., bitter, spoilt), others are repulsive by *association* with disgust elicitors (e.g., taste-aversions) or offensive-acts (e.g., eating a dog).

Gustatory features of disgust. The two seemingly hardwired gustatory features of disgust (i.e., not a result of associative learning) are bitter and highly sour tastes. Aversion to these tastes is present in newborns and in nonhuman primates (e.g., rats, old-world and new-world monkeys, cats and ferrets; Chapman, Lee, Susskind, Bartlett & Anderson, 2017). Further ~60% of the bitter compounds identified in scientific literature are toxins, indicating aversion to bitter tastes adaptive (Nissim, Dagan-Wiener & Niv, 2017). Consistent with this, humans have a disproportionate number of bitter receptors (~25) to sweet, sour, salty and umami taste-receptors (i.e., only one type of each; Nissim et al., 2017) – suggesting we are hardwired to be disgusted to bitter tastes. In close parallel, as sour tastes are indicative of bacterial degradation (i.e., bacteria fermentation and acid release in spoilt foods; Huang et al., 2006), aversion to sour tastes may also facilitate disease-avoidance.

Are they really evoking disgust? Bitter and highly sour tastes elicit core disgust behaviours. For example, they are self-reported as highly aversive and bitter tastes as disgusting (Bredie et al., 2014; Schienle, Arendasy & Schwab, 2015). Further, bitter and highly sour tastes evoke a gustofacial distaste response (gaping as produced by the *levator labii* muscles) in humans – almost identical to the disgust face (Ganchrow, Steiner & Daher, 1983; Sullivan & Lewis, 2003). In neuroimaging research, bitter tastants activate the anterior insula and basal ganglia, indicative of disgust (Royet et al., 2016). In sum, the literature suggests that highly sour and bitter tastes have a strong tendency to elicit disgust, due to their inherently aversive nature and presence in toxic and spoilt foods.

1.3.3 Vision. Curtis and colleagues (2004) showed 40,000 individuals across the world, seven pairs of the same image. In each pair there was a neutral image and its disease relevant counterpart (e.g., a man and a feverish-man). A culturally invariant pattern emerged, with the disease-relevant image more effective in eliciting disgust than its neutral counterpart. Consistent with this, Xu et al. (2017) examined the types of disgust in pictures from the International Affective Picture System (normative visual-stimuli used in emotion research which reliably elicit disgust), using exploratory and confirmatory factor analysis. The authors found that mutilation (i.e., body-envelop violations), vomit, and food-disgust were the three categories of disgust in these photos. Taken together these studies suggest that visual representations of disease, putrefaction, and other sensory elicitors of disgust (e.g., feces, spoilt food) are reliable and universal elicitors of disgust.

Visual features of disgust. In contrast to the chemical senses (olfaction and gustation) there is little research on hardwired visual features (colour, shape form) of disgust. Two *possible* hardwired visual-disgusts in humans are irregular hole clusters and curvilinear-body forms. In relation to the former, it has been shown that humans are disgusted by irregular clusters of circles (e.g., the lotus seed), especially if clusters are present on the bodily surface and other organic matter (Kupfer & Le, 2018). Further, for some individuals these clusters bring extreme distress (a condition known as trypophobia). However, whether disgust to hole clusters is hardwired and present from a young age or comes from association with disease, (noting diseases often leave visible clusters of holes on the skin, and microorganisms and putrefaction a similar mark on food), is not known.

Coiled body-forms are another *potential* hardwired visual disgust. This is suggested for two reasons. First, humans are predisposed to detect coiled-shaped objects, such as snakes. In support of this, Lobue and Deloache (2011) had preschool children and adults detect snakes (coiled shape) in clustered visual displays – the distractor objects were manipulated to either be the same colour, surface appearance or shape as the snakes. The data showed that detection was faster for the snakes in visual displays with animals and objects of the same colour, or surface appearance, but not when the distractor objects had the same shape as snakes (i.e., coiled and curvilinear, e.g., hoses, ropes; Lobue & Deloache, 2011). Second, coiled animals (snakes, worms, millipedes) are disgusting to look at (Davey, 1991), lending support for coiled-shapes as a visual feature of disgust.

Are they really disgust evoking? Visual images of disgust elicit the core criteria of disgust. As already noted they are reported as universally disgusting in self-reports (Curtis, 2001; Curtis et al., 2004). Further images of mutilated bodies (Lang et al., 1993) and pathogens (Vartanian et al., 2018), produce *levator labii* muscle activity characteristic of the disgust face. Images of universal disgusts (e.g., dirty toilets, sickness) also increase disgust related actions (physical distancing, cleaning behaviours; Pellegrino et al., 2015; 2016), and reliably activate the insula, amygdala, basal-ganglia and OFC (i.e., brain regions affiliated with disgust; Lindquist et al., 2012; Wager et al., 2015). Taken together, visual-disgusts reliably induce disgust.

1.3.4 Audition. Sound-mediated disgust has been investigated in one international survey (Cox, 2008). Data from half a million people indicated vomit was the most repulsive sound – with the sound of sickness (e.g., coughing) and sounds mimicking bodily secretions (whoopee cushion) ranked in the top ten (Cox, 2007). In addition to these, data from the International Affective Digitised Sounds (normative sound-stimuli used in emotion research) indicates mouth-based sounds (belching, loud chewing, and snoring) and contamination-based sounds (toilet-flushing, nose-blowing) evoke disgust (Stevenson & James, 2008). The sound of diahorrea and sound-textures affiliated with contamination (e.g., squelching) are also potent elicitors of disgust (Croy et al., 2013; Stevenson, Case & Oaten, 2011).

Sound features of disgust. Currently there are no known structural features in audition (e.g., pitch, tone, timbre) which uniquely evoke disgust (Bowman & Yamauchi, 2017; Mohn, Argstatter & Wilker, 2010). Thus, sound-disgusts possibly form by association with disease.

Are they really disgust evoking? Auditory stimuli affiliated with sickness (e.g., sound of vomiting, coughing, diahorrea) elicit reliable-disgust behaviours. First, they are self-reported as highly disgusting (Croy et al., 2013; Stevenson & James, 2008). Next, audio-visual clips of vomiting (hearing and seeing someone vomit) elicit disgust-facial responses (i.e., *levator labii* activity; de Jong et al., 2002), and increase-hand washing behaviours (Pellegrino et al., 2016). Further, anecdotally it is recognised that hearing someone vomit, often drives a visceromotor gagging reflex (noting that the sight, and smell of vomit are also important). This latter point suggests that sounds associated to sickness can evoke nausea (i.e., the visceral signature of disgust). Further, sound and audio-visual depictions of vomiting are commonly used to activate the neural regions implicated with disgust (Lindquist et al., 2012; Phan, Wager, Taylor & Liberzon, 2002; Wager et al., 2015). In sum, there is general agreement that sounds associated with bodily fluids (e.g. loud-chewing, belching, vomiting) elicit are self-reported as disgusting, and those associated sickness are potent elicitors of disgust behaviours.

1.3.5. Somatosensation. While touch is said to be second to olfaction in its importance as a disgust elicitor (Curtis & Biran, 2001; Tybur, Lieberman, Kurzban & Descola, 2013), only five studies have used tactile stimuli to elicit disgust, with two directly examining the tactile-features of disgust. The earliest was a behavioural validation of the paper-pencil Disgust Scale (Rozin, Haidt, McCauley, Dunlop & Ashmore, 1999). While the authors showed tactile-stimuli (i.e., meal-worm, canned okras, pigs-head and cremated-ashes) elicit disgust, the study did not explore what tactile features were associated with disgust. The other four studies used a range of stimuli – i.e., wet-dough (in Oum et al., 2011), rubber pasta (labelled as spoiled food) and a soap-smeared tissue (labelled as synthetic mucous; in Croy et al., 2013), cold-pea soup (reminiscent of vomit; in Stevenson et al., 2011) and worms, honey and oily noodles (in Skolnick, 2013). However, there has been no attempt to identify universal-tactile disgusts (i.e., across multiple cultures).

Tactile features of disgust. The *hypothesised* tactile features of disgust are wet, soft, sticky and slimy (oily) textures – noting there is no consensus in the literature. This prediction comes from three pieces of evidence. The first are anecdotal reports, which mention sliminess, softness, and stickiness as potent elicitors of disgust (Angyal, 1941; Miller, 1997). The second is from two experimental studies (Oum et al., 2011; Skolnick, 2013). In one Oum et al. (2011) found that textures akin to organic matter (i.e., wet dough) were more disgusting and less liked than those affiliated with inanimate objects (i.e., dry hard rope). This study therefore provided the first empirical support for softness and wetness as tactile dimensions of disgust. Yet, as only three somatosensory features were manipulated (temperature, softness and wetness), and many more features exist (i.e., roughness, stickiness) – the study did not assess the full range of textures that facilitate disgust.

A second study (Skolnick, 2013) found honey, oily noodles and worms were potent tactile disgusts. Again, these stimuli were sticky (i.e., honey), oily and soft (i.e., oily noodles, worms) – supporting them as tactile-features of disgust. Surprisingly, this conclusion was not supported by sensory ratings – i.e., no tactile properties (stickiness, wetness, oiliness) were related with disgust ratings (Skolnick, 2013). Thus, not only did it not support Oum et al.'s (2011) findings, the study again (i.e., as with Oum et al., 2011) did not assess or identify the full range of textures that may drive disgust.

The third piece of evidence that wet, soft, slimy (oily) and sticky are tactile-features of disgust comes from the food-aversion literature. Correlational (Kauer et al., 2015; Egolf, Siegrist & Hartmann, 2018) and experimental studies (Martins & Pilner; 2005) indicate texture is a key predictor of food disgust (i.e., avoidance). For example, Martins and Pliner (2006) found sliminess, mushiness, goeeyness, rotting, gory and off-smelling sensory qualities explained 78% of the variability in disgust reactions to foods – noting most of these are somatosensory qualities. However, whether these features are equally as aversive in non-foods, is not established.

Finally, tactile qualities *may* be hardwired-disgusts. This is suggested by three pieces of evidence. First, sticky, wet, soft, and slimy tactile features are anecdotally said to mark decay and spoilage in food (e.g., rotten fruit). Thus, hardwired-disgust to these textures would presumably be of benefit to survival (Egolf et al., 2018). A second line of evidence comes from toilet training research. Here studies show that children manifest discomfort to wetness (as in soiled diapers) between 18 to 24 months, and that this discomfort is a sign for toilet training readiness (Kaerts et al., 2012; Spock & Bergen, 1964). Relatedly, toilet training is facilitated by emphasising feelings of wetness on the skin (i.e., not allowing the child to wear diapers that dry faeces and urine; Schmitt, 2004). That such aversion to wetness happens in infancy is consistent with it being a hardwired tactile-disgust. The last piece of evidence that suggests tactile disgusts are hardwired comes from a primate study. This study found that a significantly lower proportion of chimpanzees consumed a banana when it was on wet dough (i.e., only 54%), than when it was on dry rope (91%). This neophobic behaviour provides support that wetness and softness facilitate avoidant behaviours (Sarabian, Ngoubangoye & MacIntosh, 2017). In sum, disgust, appetite, toilet training and animal-behaviour studies are consistent with the existence of hardwired tactile features of disgust and avoidance. In spite of this, only two studies have tested tactile-disgust directly, with the full range of disgust eliciting textures yet to be identified.

Are they really evoking disgust? According to self-report, tactile-disgusts are highly disgusting (Oum et al., 2011; Skolnick, 2013; Croy et al., 2013). In contrast, no studies have formerly examined if tactile-disgusts elicit disgust behaviours.

Conclusion. In sum a large body of research has examined the olfactory, gustatory, auditory and visual elicitors of disgust. However, touch has received little empirical study in disgust.

1.4 Human Somatosensation

The somatosensory system provides individuals with texture, thermoceptive, pain, itch and proprioceptive information (Ma, 2010). As a number of these sensations were not relevant to this study (i.e., pain, itch, proprioception) only texture and temperature are detailed below, and in particular their sensory dimensions. The neural coding of texture and temperature is also briefly considered.

1.4.1 Texture

1.4.1 Texture. This section details the dimensions and coding of texture features.

Texture dimensions. Very little research (i.e., two studies) has examined what texture primaries exist (Hollins, Faldowski, Rao & Young, 1993; Hollins & Risner, 2000). In these studies the experimenter asked participants to divide 20 simplified tactile stimuli (e.g., gratings, sandpaper, sponges etc.) into 3-7 groups, based on similarity. Using multidimensional scaling, textural properties with the highest discriminating power were identified as texture primaries – these being smoothness/roughness, softness/hardness, and stickiness/slipperiness. Thus, other texture primaries likely exist, if a more extensive set of surfaces are used (e.g., dryness/wetness; Albertazzi, Bacci, Canal & Micciolo, 2016; Hollins, 2010).

Relatedly, consumer sensory research has shown that mechanical (lumpiness, hardness, brittleness, adhesiveness, viscosity), geometrical (graininess), chemical (i.e., wetness, oiliness) and thermal (warmth) qualities, are somatosensory features reliably used to describe the mouth and hand *feel* of foods (Engelen, Fontijn-Tekamp & van der Bilt, 2005; Lawless & Heymann, 2010; Szczesniak, 2002; Stevenson, 2009). Given the importance of somatosensation to food (Stevenson, 2009), and that these qualities overlap with those identified in earlier studies (Hollins et al., 1993; 2000), many may also qualify as texture primaries. Table 2 tabulates the texture primaries identified in multidimensional scaling experiments and consumer sensory research.

Table 2. Possible Texture Primaries

Tactile Primaries	
1.	Hardness
2.	Lumpiness
3.	Brittleness
4.	Stickiness
5.	Viscosity
6.	Graininess (roughness)
7.	Wetness
8.	Oiliness

Neural coding. Very little research has examined coding for tactile dimensions identified in food and consumer sensory research, thus this part only details coding of smoothness/ roughness, softness/ hardness and stickiness/ slipperiness.

Four low-threshold mechanoreceptors are likely involved in perceiving roughness/ smoothness. These are Merkel discs (located in the epidermis), Meissner cells (located between the epidermis and dermis), Ruffini endings and Pacinian Corpuscles (both located in the dermis). Roughness is likely coded by both Merkel Disks, with smoothness activating Meissner and/or Pacinian Corpuscles (Lumpkin & Caterina, 2007). This conclusion has been reached as the afferent fibres of these cells are responsive to spatial and temporal properties of rough/smooth surfaces (Hollins, 2010; Lucarotti, Oddo, Vitiello & Carrozza, 2013). For example, Weber et al. (2013) found coarse textures (e.g., corrugated paper) excited low-frequency fibres, responsive to small-receptive fields (as in Merkel Discs), and these fibres responded very *weakly* to smooth textures (e.g., satin). Further, smooth textures evoke high frequency vibrations to large receptive fields – compatible with Meissner and Pacinian Corpuscles' fibres (Bensmaia, 2013; Hollins, 2010; Johnson & Hsaio, 1992).

Turning to stickiness/slipperiness, it is *hypothesised* that stickiness would activate afferent fibres in Ruffini endings and hardness fibres in Merkel discs, with other cells activated, but to a lesser degree (Lucarotti et al., 2013). Yet whether sticky activates different neural cells than slippery textures (and vice versa for softness/hardness) is not known.

In summary, there remains a lack of understanding on how our skin perceives textures and relays this information to the brain. Further, the problem is not only *how* – but also *what*. That is, to date the full range of texture sensations that exist has not been studied – meaning the stimulus problem is not solved for touch.

1.4.2 Temperature. This section details the dimensions and coding of temperature.

Dimensions. Four widely agreed upon temperature primaries are innocuous warm and cool and noxious hot and cold. The discovery of temperature-specific skin spots (Von Frey, 1894, as cited in Melzack & Wall, 1965), and molecular studies (detailed below) validate them as distinct temperature features.

Coding. Cold and hot temperatures activate specific neural cells (Hollins, 2010). These neural cells are variants of free nerve endings, which innervate the skin's epidermis (outer) and dermis (inner) layer (Patapoutian, Peier, Story & Viswanath, 2003).

Free nerve endings contain a number of ion channels responsive to temperature and chemical-irritants. These ion channels come from the transient receptor vanilliod (TRPV) and m-family (TRPM) receptors, and are respectively responsible for heat and cold percept. Specifically, TRPV1 transduces temperatures ≥ 42ºC and capsaicin (irritant in chilli), TRPV2 temperatures ≥ 52ºC, TRPV3 ≥ 33ºC and TRPV4 ≥ 27-34ºC. Further, TRPM8 is a sensor activated by menthol (irritant in mint) and cold temperatures (i.e., < 25ºC; Lumpkin & Caterina, 2007). Importantly, molecular studies show sensitivity to cold and painful cooling is completely impaired when TRMP8 is ablated in rodents (Colburn et al., 2007; Knowlton et al., 2013), but heat percept is only *disrupted* when a TRPV channel is removed (Colburn et al., 2007; Lee, Iida, Mizuno, Suzuki & Caterina, 2005; Mishra, Tisel, Orestes, Bhangoo & Hoon, 2011). This suggests heat-percept results from activity across TRPV1-4 channels, and cold-percept from activity in TRMP8 only.

In closing, there is consensus of what temperature primaries exists (warm/hot, cool/cold), and how temperature input is relayed to and coded by the brain.

1.5 The Role of Disease Risk Beliefs in Disgust

Whether or not disgust is induced by an elicitor depends on its sensory features and associations, as well as the belief the elicitor poses a disease risk to our body (Oaten et al., 2009). Thus, it is also important to examine the role of disease risk belief in tactile-disgust.

The idea that the belief of disease risk may be an important mediator of disgust, comes from two areas of research. The first is the role of risk belief in pain – a somatosensory state with a related functional, hedonic, behavioural and neural profile to disgust (Kunz, Peter, Huster & Lautenbacher, 2013). As risk belief is core to pain experience, it may also be core to disgust. The second is from labelling literature in disgust, which either labels the disgust elicitor or its source as disease-risk related (Sharvit, Vuilleumier, Delpanque & Corradi-

Dell'Acqua, 2016).

1.5.1 Belief of Risk in Pain. Pain and disgust are two overlapping somatosensory states – i.e., they are both arousing, are immediately pertinent to one's survival, activate interoceptive brain regions, and share similar hedonic and behavioural (facial) profiles (Kunz, et al., 2013; Sharvit et al., 2016). Further, pain experience is the result of an aversive sensory elicitor (like disgust), as well as cognitive processes (i.e., the belief pain is a bodily-risk), which are referred to as bottom-up and top-down input, respectively (Torta, Legrain, Maouraux & Valentini, 2017). Thus, given the similarity between pain and disgust, top-down cognitive processes (i.e., belief of bodily-risk) may also contribute to disgust.

It is now well established in chronic pain therapy that the belief that pain poses a risk to one's physical functioning, is a significant predictor of pain-perception (Carlino, Frisaldi & Benedetti, 2014). A large body of research has also shown that labelling the risk of a painful stimulus as high, increases the belief it is an imminent risk to one's self, and thus the perceived pain (Leknes et al., 2013). Further observing pain in one's self results in greater neural activation of pain-related brain areas (i.e., the insular cortex, sensorimotor cortex and anterior cingulate cortex), than when pain is observed in close-others (e.g., partners). Thus, when a pain-elicitor (bottom-up sensory input) is believed to pose a risk to one's self (top-down risk belief), this results in greater pain-processing than when the elicitor is thought to be risk to others (Singer et al., 2006; Decety & Grezes, 2006). Given the aforementioned similarities between disgust and pain, it is likely that the belief of risk (i.e., disease risk) plays an equally important role for disgust.

1.5.2 Disgust Labelling and disease-risk belief in disgust. Labelling an ambiguous elicitor as disgust related, can increase disgust towards the elicitor. This presumably occurs because the label may increase the belief the elicitor is a disease risk, and thus the degree of experienced disgust. The effects of labelling on disgust has been well documented for olfactory and gustatory disgusts, and recently examined in a study using tactile disgusts. These studies are detailed below. As disgust-labelling has been less effective for visual or sound-disgusts (perhaps because they are less ambiguous; Croy et al., 2013), they are not mentioned here.

Olfactory. Disgust to any odourous compound is likely determined by the belief that it is from a disease-related odour. This supposition is supported by the fact that odour-molecules common to a range of malodors (i.e., thiols, indoles and short-chain fatty-acids) also contribute to pleasant smells (i.e., perfumes, roasted coffee and parmesan cheese, respectively; Bardon, 2010; Dulsat-Serra, Quintanilla-Casas, & Vichi, 2016; Herz & von Clef, 2001). This suggests that while certain molecules may have a greater tendency to elicit disgust, it is belief that this molecule comes from a disease related odour which determines whether or not it is disgusting

A series of experiments have examined the effect of adding labels (that influence the belief an odour is a disease-risk) on the perceived aversion of olfactory-disgusts (de Arujo, Rolls, Velazco, Margot & Cayeux, 2005; Bensafi, Rinck, Schaal & Rouby, 2007; Croy et al., 2013; Herz & von Clef, 2001; Herz, 2003; Manescu, Fransnelli, Lepore & Djordjevic, 2014). The first of which was the so-called olfactory illusion described by Herz and von Clef in 2001. Subjects in the study were given a number of different odorants with an ambiguous identity (e.g., a mixture of isovaleric and butyric [I-B] acid). Every odorant was sniffed twice, with one change in between each presentation – i.e., the label provided was positive (not disease related) in one session (e.g., parmesan cheese for the I-B acid), and negative (i.e., disease related; e.g., vomit for the I-B acid) in the other. Labelling had a significant effect – i.e., liking towards the odours was a function of what subjects were told they smelled. These so-called labelling effects in olfaction have been replicated several times in adults (de Araujo et al., 2005; Djordjevic et al., 2008; Manescu et al., 2014), and in children too (Bensafi et al., 2007). These studies suggest that when an olfactory disgust elicitor is no longer believed to be a disease risk, its capacity to disgust diminishes.

Finally, the effect of labels (that increase the belief of disease risk) has been tested recently on disgust responses to odours (Croy et al., 2013). Not surprisingly, the results mimic those of hedonic responses – i.e., disgust ratings increase when disgust-labels are associated with disease. For instance, labelling an odour as feces increases its disgust-ratings compared to when there is no label provided with the odour. This is likely because smelling the disgust-labelled odour is believed to be more of a disease-risk, than smelling the unlabelled odour. In summary, these studies suggest that many malodors (vomit, feces) are not entirely disgusting due to their structural features (i.e., molecular classes), but also due to the belief they can cause disease.

Gustation and flavour. Labelling also influences aversion related beliefs towards indiscernible flavours, and thereby manipulates disgust responses in gustation. Importantly, gustation labelling effects have only been studied for offensive flavors and foods (not pure disgust-tastes per se). Moreover, in contrast to olfaction, it is likely that aversion to pure-gustatory elicitors of disgust (sour and bitter tastes) is not modulated by labels (as these tastants reflexively trigger oral-rejection), however this is yet to be confirmed experimentally.

Setting aside the issue of pure-tastants belief a food or drink will be aversive in flavor, is a function of the label given. For example, labelling foods (Wolfson & Oshinsky, 1966) and drinks (Lee, Frederick & Ariely, 2006) as ambiguous (e.g., unknown food, Massachusetts Institute of Technology [MIT] brew), decreases liking of pleasant flavors (e.g., chocolate milk) but increases acceptance of offensive flavours (e.g., balsamic vinegar in beer). This suggests that as information about foods and drinks (provided via labelling) decreases, one's belief they will experience an aversive flavour increases.

Labelling can also increase aversion-beliefs (and in turn disgust) of foods, when the label provided is discordant with the expected flavor. In support of this, Yeomans and colleagues (2008) showed that when salmon-ice cream was labelled as just ice-cream, it was rated as extremely offensive and significantly more bitter (disgust related), than when labelled as salmon mousse. Again, it is likely that the belief the salmon ice-cream was aversive increased when it was labelled ice-cream (a label incongruent with the expected taste) – which in turn, increased aversion-related ratings.

Tactile. To date only one study has examined the effects of labelling on tactile disgusts. Croy et al. (2013) presented three tactile objects (i.e., rubber pasta, soap-smeared tissue, feces made of flour and water) with no label to some participants, and with disgust-labels (i.e., spoiled food, feces, sick person's tissue) to others. These labels likely increased the belief that touching tactile-objects would cause infection. As such, the objects were perceived as significantly more disgusting to touch when labelled, providing the first evidence that tactile-disgust (like olfactory) may be mediated by disease risk beliefs.

1.5.3 Labelling a *source.* A disgust elicitor labelled as coming from a stranger (host to novel-diseases), results in higher levels of disgust, than if it is said to come from a close other or self (i.e., a familiar) source – an effect known as the source effect (Stevenson & Repocholi, 2005). It is well established that novel pathogens (i.e., from strangers) pose a greater disease risk to an immune system, than those previously contracted from close others, or self, as memory-immune cells are developed for the latter but not the former (Peng, Chang & Zhaou, 2013). Thus, the source effect for disgust likely facilitates disease-avoidance (Curtis et al., 2004; Reicher, Templeton, Neville, Ferrari & Drury, 2016). To date, five studies have provided support for the source effect in disgust and its modulation by disease risk beliefs.

Curtis and colleagues (2004) first identified the source effect in their international disgust web-based survey (mentioned earlier, see Section 2.1.1). The survey's final question asked people whom they were least likely to share a toothbrush with. The most frequent choice was the postman, whom 59.3% were least likely to share their toothbrush with. The least frequent choices were one’s best friend and spouse/partners, whom 1.9% and 1.8%, respectively, were least likely to share their toothbrush with. Thus, the survey suggested that a disgust elicitor (e.g., germs from the mouth) is more avoided if labelled as emanating from an unfamiliar source (i.e., a stranger). Yet, this study did not assess if the stranger’s mouth-germs (i.e., the disgust-elicitor) was more avoided because it was believed to be a greater disease risk, than a close-other’s mouth-germs.

Stevenson and Repocholi (2005) first demonstrated that the source effect for disgust may be explained by the belief that strangers carry more of a disease risk than close-others. In their experiment, malodors (feces, body-sweat) were labelled as emanating from a stranger, a chosen person (close other), or the participant. The data showed that disgust to laboratory and everyday malodors increased when the odour was labelled as emanating from a stranger – and that this was due to the belief a stranger’s malodor poses a greater disease-risk than a close-other’s malodor. In addition to this, Case, Repocholi and Stevenson (2006) showed that mothers found the smell of their own offspring’s feces as less aversive and disgusting, than those labelled as coming from strangers. Further, reduction in disgust was compromised when the source of the disgust elicitor was reverse labelled (i.e., stranger said to be own child, and vice versa). This suggests that labelling a disgust-elicitor as emanating from a stranger, increases the belief it poses a disease risk, and thus disgust towards the elicitor.

Two subsequent studies have directly examined avoidance behaviors elicited from the source effect. Peng and colleagues (2013) demonstrated that disgust-behaviours elicited from strangers, yield greater avoidance than those of close-others. Further, Reicher and colleagues (2016) showed that university students report less disgust and engage in fewer cleaning behaviours to a sweaty t-shirt, labelled as coming from a student at their own university, than one affiliated with another university, or a random-source (no label). These studies again demonstrate that disgust stimuli are believed to be more diseased or contaminated (i.e., of greater risk to an immune system) when from an unfamiliar source, than a familiar source.

Conclusion. In closing, the reviewed studies suggest that disgust is the result of bottom-up sensory qualities (sensory-disgust elicitor) and top-down cognitive processes (disease risk beliefs of a disgust elicitor or its source). This is not unique to disgust and parallels other somatosensory-visceral states such as pain.

1.6 The Current study

The primary aim of this study was to examine what tactile qualities elicit disgust. To achieve this, participants touched nine different objects which represented eight tactile-dimensions identified in literature (i.e., sticky, hard, soft, oily, lumpy, viscous, wet, grainy). Each object was presented at room temperature, and at fridge temperature – so to examine the final tactile dimension of temperature. Participants then rated the objects on various sensory and affective dimensions. The sensory (tactile) ratings were composed of ten scales, which indexed how sticky, wet, grainy, oily, hard, soft, cold, warm, lumpy and viscous the object was (i.e., the tactile-dimensions). These ten dimensions were chosen, as they represented the tactile primaries identified in perceptual research (i.e., sticky, hard, rough [grainy], temperature), as well as textural dimensions in appetite and consumer-sensory research (Szczesniak, 2002; Martins & Pliner, 2005).

To disguise the study aims, participants were informed the experiment was designed to investigate emotion and touch. As such, affect ratings were composed of self-report scales representing the six basic emotions (i.e., how surprised, happy, disgusted, sad, angry and scared the participant felt; Ekman, 1992), as well as a hedonic rating scale measuring how pleasant the object was. Thus, aside from disgust (relevant to the primary aim) and fear (relevant to the second aim), other emotions were simply included as distractors. Based on prior research and the disease avoidant function of disgust, it was expected that sticky, wet, warm, soft and oily textures would be positively associated with disgust (Egolf et al., 2018; Oum et al., 2011; Skolnick, 2013).

The second aim of the study was to examine how belief of the elicitor (and the disease-risk it poses) influences tactile disgust. To this end the study used labelling as a way of manipulating beliefs about the objects (and the disease-risk they pose). In addition, the study included three self-report scales asking the participant how sick they thought the object would make them, how likely they were to put the object in their mouth, and how likely they were to retouch the object. These three scales were used to measure participants' cognitive belief of disease risk. To aid believability of the labels and avoid confounds, four groups were used in this experiment, and visibility of the stimuli was manipulated. The first group was the Disgust-Label group, to whom the stimuli were falsely labelled as disgusting (e.g., dried pears were labelled as pig ears) and were invisible, so they could not see they were being deceived. The second group was the True-Label group, to whom the stimuli were labelled truthfully. The third group – the No-Label group – was a self-manipulation group, to whom *no* labels were provided, and participants were asked to write what they believed they were touching. To remove potential confounds of vision on affect judgements, the stimuli were invisible to participants in the True-Label and No-Label groups. As the final group – the Visible group – formed the control, they were allowed to see what they were touching.

Labelling led to two hypotheses. First, the Disgust-Label group was expected to report more disgust and fear (measured on the affect scales), and less pleasantness (measured on the hedonic rating scale) than the other groups. Second, disgust was expected to be predicted by group and mediated by beliefs of disease-risk. Disease risk beliefs were primarily measured by two scales – i.e., how sick the person believed the stimuli would make them (the cognitive manifest of disease risk belief), as well as how scared (aka fearful) they felt touching the object (i.e., the emotive manifest of disease risk belief).

2. Method

2.1 Overview

This study was designed to examine the role of tactile qualities and belief about the elicitor (and the disease-risk it poses) in tactile disgust. It was a between-subjects design with four groups and it had four parts. In the first part participants were screened for tactile sensitivity. In the second, participants touched nine objects, which represented a range of textures and rated each one on tactile, affective and disease risk rating scales. The objects were presented and rated twice – once at room temperature and once cold (from the fridge), in counterbalanced order. To three groups of participants (i.e., the Disgust-Label, True-Label and No-Label groups) the objects were presented behind a screen, and to the last group (i.e., the Visible group, who formed the control) the participants could see the objects (see Table 3). Labelling was used to manipulate participants' belief about what they were touching, and was only used on participants who could not see the objects. Specifically, two groups (blind to the objects) were given labels either saying what the objects were (i.e., True-Label group), or falsely indicating they were a disgust elicitor (i.e., Disgust-Label group). The remaining two groups (i.e., the No-Label and Visible group) were not told what they objects were (i.e., not given any verbal or visual labels), and were asked to write what they believed they were touching. In the third part, participants were given the Disgust-Scale Revised (Olatunji et al., 2007) and basic demographic questions (age, gender). Fourth, participants were debriefed about the true aims of the study, with the Disgust-Label group additionally asked if they believed in the labels provided.

Table 3. Visibility of Objects and Label manipulation

Group	Visibility of Objects	Labels
Disgust-Label	Objects not visible	False disgust names of objects provided
No-Label	Objects not visible	No labels
True-Label	Objects not visible	Accurate (true) names of objects provided
Visible	Objects visible	No labels

2.2 Participants

One hundred and twenty students at Macquarie University were recruited through the psychology participant pool, to take part in the following study (See Appendix A). All participants were aged from 17 to 42 years of age (*M* = 19.8; *SD* = 4.4). To confirm self-reported normal tactile sensitivity, all participants were screened on arrival using the Semmes-Weinstein tactile sensitivity test (Hunt et al., 2017). There were 105 participants (87.5%) who had normal tactile sensitivity (*M* = 0.07; *SD* = 0), and 15 participants who had tactile sensitivity in the normal to light diminished touch range (*M* = 0.12; *SD* = 0.02). An exploratory analysis confirmed there were no differences in tactile quality ratings, between participants with normal range tactile sensitivity and participants with normal to light diminished touch sensitivity. Thus, all 120 participants were included in analysis.

2.3 Materials and Measures

2.3.1. Semmes-Weinstein Tactile-Sensitivity Test. The tactile sensitivity measurements were carried out using the Semmes-Weinstein Tactile Monofilaments. The set is composed of 20 thin nylon fibres that provide a non-invasive assessment of cutaneous sensitivity in the hand (Hunt et al., 2017). The filaments range from 0.0008 to 300 grams and are divided into ranges corresponding to sensitivity thresholds of the hand (see Table 4).

Table 4. Hand sensitivity thresholds indexed on Semmes Weinstein Monofilaments (SWM)

Hand sensitivity thresholds	Target force in grams
Normal	0.0008-0.07
Diminished light touch	0.16-0.4
Diminished protective sensation	0.6-2
Loss of protective sensation	4-180
Deep pressure only	300

2.3.2. Tactile stimuli. The stimuli were selected to correspond to the eight texture properties (hardness, brittleness, lumpiness, stickiness, graininess, oiliness, wetness, and viscosity). Temperature was assessed by presenting all objects, at cold (4°C) from the fridge and room temperature. Cold and room temperature presentation was counterbalanced across participants. To express the texture-qualities nine objects were used. These are as follow; Tapioca Balls in oil (tapioca; Wu Fu Yuan, China), Dried Pears (pears; Coles-brand, Australia), Dried Coconut Flakes (flakes; Edward & Sons, Sri Lanka), Ground Coffee waste (coffee; Leaf-Café house-blend, Australia), Oatmeal cooked in water (oatmeal; Coles-brand, Australia), Detergent Foam (foam; Morning fresh, Australia), Whole Egg Mayonnaise (mayonnaise; S&W, United States), Molasses with Pumpkin Seeds (molasses; Capilano, Australia; Coles-brand, Australia), and Drumstick Mushrooms (mushrooms; Awona, China. summary of the nine stimuli and tactile-property they correspond can be found in Table 5.

2.3.3 Nose plugs. Foam plugs (Mack's, United States) were used to block participants' sense of smell (as this could be used to identify the objects). The plugs were made of memory foam, and so naturally inflated to the shape and size of participants' nostrils. These foam plugs have been previously used to block olfaction experimentally (Memhut & Stevenson, 2015). To validate the plugs were successful in masking odours of the current objects pilot testing was conducted on friends of the experimenter. All pilot tested participants confirmed they could not smell the objects when they inserted the plugs.

2.3.4 Labels. Labels were provided both verbally (by the experimenter) and visually (presented on a laminated card in front of the participant). Labels for the True-Label group were identical to the stimuli name. Labels in the Disgust-Label group indicated the object was a disgust elicitor. The disgust labels were chosen to reflect the range of disgust elicitors identified in current literature (i.e., animal parts/products, disease-related fluids, waste) and modified from previous disgust-labels used in olfactory research (Haidt et al., 1994; Croy et al., 2013; Oaten et al., 2009). Table 5 details the disgust labels for each object.

Table 5. Tactile Stimuli and Labels used

Property	Stimuli	Disgust label
Hardness	Tapioca	Fish eyes
Brittleness	Flakes	Animal nail filings
Lumpiness	Oatmeal, Pears	Curdled milk, Pig ears
Stickiness	Molasses	Insect trap with dead insects
Graininess	Coffee	Animal droppings
Oiliness	Mayonnaise	Synthetic pus
Wetness	Foam, Mushrooms	Bathroom Scum, Dead Slugs
Viscosity	Molasses	Insect trap with dead insects

2.3.5 Rating Scales

Perceived texture and temperature, pleasantness, affect and risk were all measured by visual analogue scales (VAS). These were 13 cm line scales with anchors at 0cm ‘Not at all’ to 13cm ‘Very,’ with the exception of the Hedonic Rating scale, as described below.

2.3.5.1 Tactile Rating scales. Ten VAS scales were used to measure how the object felt. There was a separate line for each tactile quality, asking the participants to rate how sticky, wet, oily, lumpy, grainy, viscous, brittle, hard, cold and warm the object was.

2.3.5.2 Affect Rating scales. Six VAS scales were used to measure how the objects made the participants feel. There was a separate line for each emotion, asking the participants to rate how surprised, happy, disgusted, sad, angry and scared they felt.

2.3.5.3 Disease Risk Rating scales. Three VAS scales were used to measure if participants believed the objects posed a disease risk. There was a separate line for each VAS scale, asking the participants to rate how likely they were to put the object they touched in their mouth, how likely they were to retouch the object, and how sick they thought the item would make them if they ate it.

2.3.5.4. Hedonic Rating scale. One VAS scale was used to measure perceived pleasantness of the objects. This line asked participants to rate how pleasant/unpleasant the object felt. This scale was bidirectional such that it ranges from ‘Not at all’ (0cm) to ‘Extremely pleasant’ (13cm), with a label ‘Neutral’ (6.5cm) positioned at the centre.

2.3.6. The Disgust Scale Revised (DSR). A 25-item measure developed by Haidt et al. (1994) and modified by Olatunji et al. (2007) was included to measure disgust sensitivity – i.e., the tendency to experience disgust. Participants indicated true (1) or false (0) for the first 13 items. For the next 12 items participants indicated how disgusting they found the experiences, using a 3-point category scale from 0 (not at all) to 1 (very disgusting). Thus, the total score ranged from 0-25 with higher scores indicating greater disgust-sensitivity. Internal consistency for the DSR overall is reported as strong, at α = .87 (Otalunji et al., 2007)**.** In the current study the internal consistency for the DSR was moderate-strong, at α = .78. DSR subscales were not analysed in this study, and so are not detailed here.

2.4 Procedure

All participants attended a lab session lasting approximately 1 hr. Participants were informed that they would be partaking in an experiment examining the relationship between touch and emotion. After participants consented to the study, the experimental phase commenced and consisted of four parts.

Part 1: The experiment started with the Semmes Weinstein tactile sensitivity test. This was done to verify hand sensitivity was normal. The test was administered in accord to the manufacturer's testing procedure. Thus, four areas on the palmar surface of the participant's non-dominant hand were assessed (i.e., their index finger, thumb, little finger and hypothenar eminence). This was done using Semmes-Weinstein Monofilaments in the normal and light diminished touch range (see Table 4). Participants were asked to present their non-dominant hand for testing, as this was the hand participants were feeling the objects with. Their hand was placed flat on top of a tea towel, covering the experimenter's hand. Participants were informed that thin fibres would be pressed on their hand and putting the blind fold on they were to say yes when they felt something. The nylon fibres were applied with pressure to the participant's hand until it reached a 'C' shape. The largest force in the normal range (SWM 0.07g; see Table 4) was pressed twice on each area (i.e., the index finger, thumb, little finger, and hypothenar eminence), and this was repeated with stronger filaments (i.e., in the light diminished touch range) until the participant reported feeling something.

Part 2: Prior to commencing the touch task, all participants were asked to place a one mouldable nose-plug (made of memory foam) in each nostril – so to stop smell biasing affective ratings, and to mask object identity. As the touch task was slightly different for the blind and visible groups, they are detailed separately below.

Touch task (blind groups). The touch task for the blind groups (No-Label, Disgust-Label, and True-Label) started with a two-part training session using a trial object (i.e., water). The first part of training involved instructing participants on where to place their hand, and how to feel the trial-object (water). Participants were asked to stretch out their non-dominant hand through a small opening on a large cardboard screen (1.5m height x .8m wide) positioned to their right or left (i.e., if left handed to their right, and if right-handed to their left). Participants were then instructed to place their non-dominant hand in a prone position. A rectangular table (1.2 m x .6m) was angled at 45 degrees comfortably in front of the participants, allowing them to rest their dominant hand.

A plastic container half filled with tap water was then mounted on a box and placed behind the screen, beneath the participant’s non-dominant hand. Participants were asked to reach down and feel the water. The non-dominant hand was used for object-touching, as it allowed the participant to use their dominant hand to simultaneously rate how they objects felt and made them feel, on VAS scales. Therefore, after feeling the water, the VAS-rating scale training commenced. A 38-page booklet was placed in front of the participants. The booklet was made of two types of pages – the first, a page with ten tactile rating scales (see Appendix B) asking participants to judge how sticky, wet, grainy, brittle (and so on) the object was. The second contained the six affect scales, the hedonic-rating scale and the risk-scales (see Appendix C). For participants in the True-Label or Disgust-Label group, each page had a small line at the top asking participants what they touched (as indicated by the label). For participants in the No-Label group, the second page had a larger line at the bottom asking participants what they *thought* they touched (see Appendix C).

For the tactile, affect, pleasantness (hedonic-rating) and disease-risk rating scales, participants were asked to mark anywhere along the line, to index how they object felt (tactile-quality) and how it made them feel (affect, pleasantness, disease-risk). For the pleasantness scale only, participants were also informed that the centre (marked ‘Neutral’) meant they did not like or dislike touching the object. After filling out two pages in the booklet, participants were told that their non-dominant hand would be cleaned using antibacterial wipes, and that this process would be repeated for each experimental object. aS Participants were also told to feel the object and complete ratings simultaneously during the experiment. This concluded the training phase.

After training was complete, the experimental phase commenced. Nine objects were presented in plastic containers (one at a time) behind the cardboard screen. All objects were presented in a randomised order for each participant. For the True-Label group, the object name was verbalised by the experimenter, and was also presented on a laminated card in the participant’s view. For the Disgust-Label group, the false disgust label was also verbalised and presented on a laminated card (see Table 5 for label names). The No-Label group were only informed when the next object (no name given) would be presented. Participants were asked to feel the objects as much, and as long as they liked, while simultaneously filling out two pages in the booklet in front of them. Their hand was wiped thoroughly in between each object. There was no time limit to feeling the objects and completing the subjective ratings.

To assess temperature, all nine objects were presented again. Thus, the second presentation of objects was identical to the first, but contained one difference – i.e., the objects were either room temperature (if cold in the first presentation) or cold (if room temperature in the first presentation). Temperature order (room/cold) was counterbalanced across participants.

Touch task for the Visible group. The touch task for the Visible group was similar to the touch task for the blind groups, with two differences – i.e., objects were not behind a screen but in front of the participant (visible to them), and participants wiped their own hand. No label was provided to participants in the Visible group, and they were asked to write what they thought they were touching (as was the case with the No-Label group; see Appendix C). All objects were presented twice (either at room temperature followed by cold, or vice versa).

Part 3. After the touch task, all participants were handed a 2-page booklet, containing basic demographic questions (age, gender), and the DSR.

Part 4. The experiment concluded by debriefing participants about the true aims of the experiment. Participants were informed that the following experiment was examining the tactile cues associated with disgust (i.e., not emotion as advertised). The Disgust-Label group was also informed about the true nature of the objects (i.e., that the disgust-labels were false). Participants in the Disgust-Label group were also asked if they believed in the labels provided, and if not, which ones they did not believe in. All participants were handed debrief forms and reconsented to their data being used.

3. Data Analysis Approach

For all analyses relevant to the aims, only data from the first presentation of objects was used. This was conducted as habituation occurred to the objects, significantly attenuating disgust and fear ratings at second presentation. Group differences in habituation (i.e., fear and disgust reduction), are detailed prior to primary and secondary aim analyses. Distractor emotion-ratings (happy, surprise, anger and sadness) were not analysed, as these were not relevant to the primary or second aim of the study. Further, as Disgust Sensitivity did not differ systematically across the groups, it did not need to be controlled for. Thus, Disgust Sensitivity (i.e., DSR) data is not further reported.

To examine the primary aim of the study – i.e., what tactile qualities are associated with disgust – tactile quality ratings for the objects were screened to determine if they were suitable for parametric analyses. As normality was significantly violated, non-parametric and bootstrapped parametric analyses were used to examine these data. Similarly, to assess the role of Disgust-Labelling in disgust (i.e., the second aim), normality was examined for disgust, fear, pleasantness, and risk ratings. As these ratings were non-normally distributed, bootstrapped parametric analyses were adopted for these analyses.

3.1. Habituation in Fear and Disgust

To determine if there was an effect of Group (Disgust-Label, No-Label, True-Label, Visible) on the reduction of fear and disgust of the objects, three analyses were conducted. First, two disgust and two fear scores were calculated by separately averaging disgust and fear ratings of the nine objects at first presentation and at second presentation. Second, disgust and fear difference scores were formed by the respectively subtracting averaged disgust and fear at the first presentation, from the averaged disgust and fear scores at second presentation. Third, two separate bootstrapped ANOVAs were run with the disgust and fear difference scores as the dependent variables, and Group (Disgust-Label, No-Label, True-Label and Visible) as the between subjects variable. Post-Hoc REGWF contrasts were used to examine how the groups (Disgust-Label, No-Label, True-Label, Visible) differed in reduction of fear and disgust from the first presentation to second presentation of the objects. As two ANOVAs were run the Bonferroni adjusted alpha was set at 0.025 (0.05/2).

3.2. Primary Aim (Tactile Qualities related to Disgust).

The analyses below set out to assess which tactile qualities were associated with disgust (i.e., the primary aim). The Disgust-Label group was omitted from these analyses, as their disgust-ratings were influenced by disgust-labels and tended to be reactive to all stimuli. Tactile qualities were collapsed across the No-Label, Visible, and True-Label groups, as there were no differences between these groups for the tactile quality ratings. To assess the primary aim, two analyses were completed. The first used Spearman correlations, examining the relationship between tactile quality and disgust ratings for each participant individually (i.e., the Individual approach). The second used Factor Analysis (i.e., the Group approach).

3.2.1 Individual approach. To examine the tactile qualities correlated with disgust, disgust and tactile ratings were correlated for each participant separately. As tactile quality ratings were non-normal (i.e., 70% had skewness values ≥ 4, and 44.4% ≥ 4), non-parametric Spearman correlations were performed, for each participant separately. Only data from participants in the No-Label, True-Label and Visible groups (i.e., 90 participants) were used.

The Individual Approach involved three steps. First, 10 Spearman correlations for each participant were performed, by correlating each participant's stickiness, wetness, oiliness, brittleness, hardness, coldness, warmness, lumpiness, graininess and viscosity ratings (i.e., the 10 tactile qualities), with their disgust ratings, across the nine objects. For example, for each individual the perceived stickiness of tapioca, pears, flakes, coffee, oatmeal, foam, mayonnaise, molasses and mushrooms, was correlated with the perceived disgust of tapioca, pears, flakes, coffee, oatmeal, foam, mayonnaise, molasses and mushrooms – creating a single sticky-disgust correlation. This process was repeated with the remaining nine tactile qualities (wetness, oiliness, brittleness, hardness, coldness, warmness, lumpiness, graininess and viscosity), for every participant. Thus, in total the data set was composed of 900 Spearman correlations – 90 participants each with 10 tactile quality-disgust correlations. Second, these Spearman correlations were standardised and transformed to an r', using Fisher transformation. Third, one samples t-tests were run on participants' standardised correlation coefficients, comparing them to a mu of zero (i.e., the null hypothesis that there is no relationship between tactile qualities and disgust), for each of the 10 tactile-disgust relationships.

3.1.2 Group Approach. To examine which tactile qualities were associated with disgust across the sample (i.e., participants in the True-Label, Visible, and No-Label groups), a Factor Analysis approach was used. This Group Approach involved five steps. First, the nine objects (tapioca, pears, flakes, coffee, oatmeal, foam, mayonnaise, molasses and mushrooms) had to be categorised as a high, medium or low disgust (three objects for each category), based on their mean disgust value (i.e., at the aggregate level for all participants). This led to the flakes, foam and coffee being categorised as low disgusts, the tapioca, pears, and mayonnaise as medium disgusts, and the oatmeal, molasses and mushrooms as high disgusts. Second, sticky, wet, oily, lumpy, grainy, viscous, brittle, hard, cold and warm values (one for each object) were averaged in accord to their group classification. For example, sticky ratings were averaged for the low-disgust objects (flakes, foam and coffee), the medium-disgust objects (tapioca, pears and mayonnaise), and the high-disgust objects (oatmeal, molasses and mushrooms) – resulting in three sticky values for each participant (high-, low-, medium-sticky). This process was repeated for the other nine ratings (wet, oily, lumpy, grainy, viscous, brittle, hard, cold and warm), for each object, leading to 2700 data points (10 ratings x 3 disgust-categories x 90 participants).

Third, to see if tactile-ratings differed by Object-Group (high, medium, low disgust), Friedman tests (nonparametric analogue of one-way repeated measures ANOVA) were run, as tactile-ratings for the object groups (low, medium, high) were skewed. Ten Friedman tests were run – i.e., one for each tactile quality (sticky, wet, oily, lumpy, grainy, viscous, brittle, hard, cold and warm). For all Friedman tests the within subject factor was Object-Group (high, medium and low). As ten Freidman tests were run, the Bonferroni adjusted alpha was set at 0.005 (0.05/10).

Fourth, to determine *how* tactile qualities differed by Object-Group, difference scores were calculated for each tactile rating, between high and low disgust groups (e.g., for sticky this was the sticky rating averaged for the high disgust objects minus the sticky rating averaged for the low disgust objects). This led to 10 difference scores – one for each tactile rating. Fifth, as difference scores were suitable for factor analysis (i.e., normally distributed), a Factor Analysis was run with these 10 difference scores, examining which difference scores best discriminated high disgust objects from low disgust objects.

3.3 Second Aim (The Role of Labelling and Disease Risk Belief in Tactile-Disgust).

Analyses in this section relate to the second aim of the study – i.e., how does labelling influence disgust, fear and pleasantness of the objects, and the belief they pose a disease risk?

3.3.1 Role of Disgust Labelling. The role of disgust-labelling was examined on affect ratings relevant to disease risk beliefs (i.e., disgust, fear and pleasantness ratings) and cognitive measures of disease risk belief (i.e., retouch-likelihood, likelihood to put-in-mouth and sickness-belief ratings). This was conducted averaging across objects (Group analysis), and for each object separately (Object analysis). Each is detailed below. Averaged affect and cognitive measures (used in Group-Level analyses) were normally distributed. All affect and cognitive measures of disease risk in the Object-Level Analyses were non-normal, and thus used bootstrapped parametric analyses.

Group Level. To assess the role of disgust-labelling (Group) on affect and cognitive ratings of disease risk belief, six separate analysis of variances (ANOVAs) were run on disgust, fear, pleasantness, retouch-likelihood, likelihood to put-in-mouth, and sickness-belief ratings, averaged across the nine objects. The between subject factor for all ANOVAs was Group (Disgust-Label, No-Label, True-Label, Visible). A-priori Helmert contrasts were used to compare the Disgust-Label group to the other groups (No-Label, True-Label, Visible). These Helmert contrasts also explored if the No-Label, True-Label, and Visible groups differed in averaged affect ratings and cognitive measures of disease risk belief. As six ANOVAs were run, the Bonferroni adjusted alpha was set at 0.008 (0.05/6).

Object Level. Six bootstrapped Multivariate ANOVAs were run to examine the effect of Group (Disgust-Label, No-Label, True-Label, Visible) on affect ratings (disgust, fear, pleasantness) and cognitive measures of disease risk belief (i.e., retouch-likelihood, likelihood to put-in-mouth and sickness-belief ratings), for each object separately. A-priori Helmert contrasts were run on affect ratings and cognitive measures of disease risk belief. These Helmert contrasts compared the Disgust-Label group, to the other groups, for each object separately. They also compared the No-Label, True-Label, and Visible groups in affect and cognitive ratings of disease risk, for each object separately. As each affect rating and cognitive measure of disease risk belief had nine Helmert Contrasts (one for each object),

3.3.2 Disease Risk Belief as a mediator of Tactile Disgust. To examine if beliefs about the object (i.e., the disease risk it posed) mediated the relationship between Disgust-Labelling and Disgust, a simple mediation analysis was used. The mediators of interest were Fear (emotive manifestation of disease risk belief) and Sickness-Belief ratings (cognitive manifestation of disease risk belief). Disgust Sensitivity (i.e., participants' total score on the DSR) was not included as a mediator, as it was not associated with Disgust-Labelling (r = -.09, p = .29). The predictor variable was Group (Disgust-Label, No-Label, True-Label, Visible), and the outcome variable was disgust-ratings.

To make sure data was suitable for mediation analysis three preliminary analyses were done. First, a single Disgust, Sickness-Belief, and Fear score, was formed for each participant, by averaging each participant's disgust, sickness-belief and fear ratings across the nine objects, respectively (as done in 3.2.1). Second, the predictor variable Group was dummy coded such that the Disgust-Label group was coded as 1, and all other groups (No-Label, True-Label and Visible) were coded as 0. Dummy coding was done in this way, to give a measure of disgust-labelling vs. no disgust-labelling. Third, all variables (i.e., Fear, Disgust, Sickness-Belief, Disgust-Labelling) were standardised prior to mediation analysis.

To test the significance of mediation by Fear and Sickness-Belief, Preacher and Hayes' (2008) nonparametric bootstrapping method was used, with 5000 resamples and 95% bias corrected confidence intervals (CI). Pairwise contrasts were also run comparing the mediation of Fear and Sickness-Belief to each other. For mediation analysis significance is reached if the confidence intervals do not pass through zero.

3.4. Qualitative Data

3.4.1 Subject Generated Names. To assess the accuracy and content of self-generated object names (in the No-Label and Visible group), names were classified as correct, incorrect-neutral (i.e., not disgust related) or incorrect-negative (i.e., related to disgusting animals, textures, or disease). Names generated from the No-Label and Visible group, for each object, were analysed for accuracy separately.

3.4.2 Believability of labels. Two analyses were conducted on believability of the disgust (risk) labels. First, the proportion of Disgust-Label participants who believed in the labels, and the average number of labels believed was calculated. Second, to examine if believing in disgust-labels, influenced the belief they pose a disease-risk, six Forsythe-Brown tests were run (non-parametric analogue of a one-way ANOVA) on averaged disgust, fear, pleasantness, retouch-likelihood, likelihood to put-in-mouth, and sickness-belief ratings. Non-parametric tests were used as there were unequal sample sizes and data did not meet homogeneity of variance assumptions. The independent variable for all Forsythe-Brown tests was Believability-Status (i.e., Believers [participants who believed in all disgust-labels] and Non-Believers [participants who did not believe in all disgust-labels]). As six Forsythe-Brown tests were run, the Bonferroni adjusted alpha was set at 0.008 (0.05/6).

4. Results

4.1. Habituation in Disgust and Fear. A main effect of Group (Disgust-Label, No-Label, Visible and True-Label) was seen for difference in disgust ratings and difference in fear ratings (between first and second presentation). Follow up REGWF contrasts showed the Disgust-Label group had a significantly greater reduction in disgust and fear, from first presentation to the second presentation of the objects and formed a separate homogenous subset to the other groups (see Table 6).

Table 6. Disgust and Fear reduction

Variable	**F (3,116)**	**Group**			
		Disgust M	**No-Label** M	**True** M	**Visible** M
Disgust	5.73^{**}	2.1^{+}	.4	.8	.8
Fear	8.62^{**}	1.9^{+}	.6	.3	.5

** $p < 0.025$
Homogenous subsets marked; $^{+}$Disgust vs Other groups ($p < 0.05$)

4.2 Tactile qualities associated with disgust.

This set of results examine which tactile qualities are associated with disgust.

4.2.1 Individual-level Approach.

Stickiness, wetness, oiliness, viscosity, coldness, and lumpiness were all significantly positively correlated with disgust, with large effect sizes. Brittleness and hardness were significantly negatively correlated to disgust, with large and moderate effect sizes, respectively – thus indicating less brittle and softer textures are associated with disgust. Graininess, and warmness were not significantly correlated to disgust. The mean correlation (r') between each tactile quality and disgust, and their associated effect sizes (r^2) are presented in Table 7 ($p < 0.005$, Bonferroni adjusted).

Table 7. Spearman Correlation between Tactile Qualities and Disgust Ratings

	Mean r'	t	df	r^2 (effect size)
sticky-disgust	0.49	9.31**	87	0.52
wet-disgust	0.29	9.31**	87	0.50
oily-disgust	0.42	8.30**	85	0.45
viscous-disgust	0.37	7.22**	87	0.37
cold-disgust	0.26	6.92**	85	0.36
lumpy-disgust	0.28	6.16**	87	0.30
brittle-disgust	-0.18	-5.31**	87	0.25
hard-disgust	-0.11	-3.24*	87	0.11
grainy-disgust	-0.05	-1.15	87	0.02
warm-disgust	0.01	-0.06	81	0.00

Note: the effect size r^2 was calculated from t value.
* $p < 0.005$
** $p < 0.0005$

4.2.2 Group Approach.

Friedman tests for Object-Group. For all tactile qualities (sticky, wet, oily, lumpy, grainy, viscous, brittle, hard, cold and warm) there was a significant effect of Object Disgust-Status (low, medium, high disgust; $p < 0.005$, Bonferroni adjusted; see Table 8).

Table 8. Tactile Quality by Object-Group tests

Tactile Quality	Low-Disgust M (SD)	Medium-Disgust M (SD)	High-Disgust M (SD)	$\chi(2)$
Wet	4.9 (1.4)	6.4 (1.7)	9.9 (2.1)	147.31*
Sticky	1.0 (1.4)	5.9 (2.1)	6.6 (2.0)	131.52*
Oily	1.3 (1.5)	5.1 (2.9)	3.9 (2.8)	109.30*
Cold	4.8 2.6)	5.3 (3.1)	8.3 (2.9)	106.54*
Lumpy	3.8 (2.0)	5.2 (2.5)	8.3 (2.8)	105.90*
Brittle	4.5 (2.0)	1.4 (1.5)	1.9 (2.1)	96.62*
Grainy	4.6 (1.6)	1.6 (1.5)	4.5 (2.7)	88.41*
Viscous	2.1 (2.3)	4.8 (2.8)	6.4 (3.1)	78.91*
Hard	5.0 (1.2)	5.3 (1.9)	3.6 (2.2)	35.77*
Warm	1.9 (1.9)	2.6 (2.6)	1.6 (2.1)	19.51*

*$p < 0.0005$

Factor Analysis. A Factor Analysis was run on the difference in tactile quality ratings between low (coffee, flakes, foam) and high (oatmeal, mushrooms, molasses) disgust objects. The data were appropriate for factor analysis (Kaiser-Meyer-Olkin = .55, Bartlett's test $\chi2$ (45) = 96.149, $p < .0005$). Five factors had an Eigenvalue of > 1.0, and this was confirmed by the scree plot (See Appendix D). The Factor Analysis used a varimax rotation and principle components extraction. Communalities are shown below (see Table 9). Wet and sticky were the most predictive of disgust status. The second factor was brittle and hardness, the third was warm (negative loading) and cold. Lumpy, grainy and oily (negative loading) loaded onto the fourth factor, and viscous loaded on the fifth factor. The initial Eigenvalues revealed, that the first factor explained 21.2% of the variance, the second 14.5%, the third 12.5%, the fourth 10.5%, and the fifth 10.2% - equating to 68.9% of the variance explained.

Thus, as with the Individual Approach, the Group Approach (Factor Analysis) indicates that wetness and stickiness are the tactile qualities most predictive of disgust, with coldness, lumpiness, and viscosity also predictive of disgust, but to a lesser extent. The Group Approach results were different to the Individual Approach data, in three ways. First, in the Group Approach oiliness was not positively associated to high disgust objects or negatively to those low disgust objects. Second, brittleness and hardness were not negatively associated with high disgust objects or positively to those low in disgust. Third, graininess was associated with high disgust objects and negatively with low disgust objects (see Table 9).

Table 9. Tactile Qualities discriminating High Disgusts from Low Disgusts

	1	2	3	4	5
Wet	**.80**	.13	.13	.09	-.03
Sticky	**.75**	-.09	-.05	.15	-.01
Brittle	-.02	**.79**	-.04	.07	-.22
Hard	.05	**.68**	.13	.10	.11
Warm	.15	.03	**-.88**	-.07	-.02
Cold	.31	.14	**.76**	-.08	-.06
Lumpy	.26	.09	.09	**.75**	.07
Grainy	.13	.45	-.06	**.67**	.09
Oily	.44	.31	.13	**-.56**	.31
Viscous	-.04	-.06	-.05	.05	**.94**

4.3 The role of Disgust-Labelling in Tactile Disgust.

This set of results examine how disgust labelling influenced disgust, fear and pleasantness of the objects, and the belief the objects posed a disease-risk.

4.3.1.1 Disgust-Labelling with Disgust Ratings.

Group-Level. A main effect of Group (Disgust-Label, No-Label, Visible and True-Label) was seen for disgust-ratings, $F(3, 116) = 19.79$, partial $\eta 2 = .34$, $p < .0005$. Follow up Helmert contrasts showed the Disgust-Label group ($M = 7.1$, $SD = 2.6$) found the objects significantly more disgusting to touch than the other groups (No-Label, $M = 3.1$, $SD = 1.8$;

True-label, *M* = 3.8, *SD* = 2.1; Visible, *M* = 4.3, *SD* = 2.0; $p < 0.05$). Helmert contrasts comparing the No-Label, True-Label and Visible groups in disgust ratings, did not reach significance.

Object-Level. For 7/9 objects (all excluding oatmeal, and mayonnaise) the Disgust-Label group had significantly higher disgust-ratings, than the other groups ($p < 0.0056$, Bonferroni adjusted). Helmert contrasts comparing the No-Label, True-Label and Visible groups in their disgust-ratings, did not reach statistical significance (see Table 10).

Table 10. Disgust ratings for each object by Group

Object	**Disgust** M (SD)	**No Label** M (SD)	**True** M (SD)	**Visible** M (SD)
Tapioca	7.0 (4.8)*	3.2 (2.9)	3.5 (3.8)	4.9 (3.8)
Pear	6.9 (4.4)*	3.1 (3.1)	2.7 (3.3)	2.3 (3.0)
Flakes	4.5 (4.0)*	0.8 (1.9)	0.3 (0.8)	2.1 (3.0)
Coffee	7.5 (4.2)*	1.4 (2.5)	1.5 (2.6)	1.1 (1.9)
Oatmeal	7.5 (4.4)	4.8 (4.3)	5.8 (3.9)	6.0 (3.8)
Foam	5.6 (4.4)*	1.4 (2.6)	0.7 (1.6)	0.7 (1.0)
Mayonnaise	6.4 (4.8)	3.3 (3.6)	6.1 (3.8)	6.2 (3.9)
Molasses	9.1 (4.1)*	5.2 (4.2)	7.7 (4.0)	6.5 (4.2)
Mushrooms	9.3 (3.4)*	4.9 (4.2)	6.1 (4.4)	8.6 (3.7)

Significant contrasts marked; *Disgust vs Other, + No Label vs True and Visible, ^ True vs Visible ($p < 0.0056$, Bonferroni adjusted)

4.3.1.2 Disgust-Labelling with Fear Ratings.

Group-Level. There was a main effect of Group (Disgust-Label, No Label, Visible and True-Label) on fear-ratings, $F(3, 89) = 16.02$, partial $\eta 2 = .35$, $p < .0005$. Post-hoc Helmert contrasts, confirmed the Disgust-Label group rated the objects as significantly more fear-inducing (*M* = 4.3, *SD* = 3.0) than the other groups (No-Label, *M* = 1.4, *SD* = 1.5; True-Label, *M* = 0.9, *SD* = 1.2; Visible, *M* = 1.4, *SD* = 1.3, $p < 0.05$). Helmert contrasts comparing the No-Label, True-Label and Visible groups in fear ratings, did not reach significance.

Object-Level. The Disgust-Label group rated all objects as significantly more fear inducing than the other groups (No-Label, True-Label, Visible; $p < 0.0056$, Bonferroni adjusted, see Table 11). Helmert contrasts comparing the No-Label, True-Label and Visible groups in fear ratings did not reach statistical significance, indicating no differences in object fear ratings, among these groups (see Table 11)

Table 11. Fear ratings for each object by Group

Object	**Disgust** M (SD)	**No Label** M (SD)	**True** M (SD)	**Visible** M (SD)
Tapioca	5.4 (4.7)*	1.1 (1.7)	0.9 (1.9)	1.5 (2.4)
Pear	4.8 (4.2)*	1.1 (1.9)	0.3 (0.5)	0.9 (1.7)
Flakes	2.6 (3.4)*	1.0 (1.4)	0.3 (0.5)	0.6 (0.6)
Coffee	3.2 (3.4)*	1.0 (1.7)	0.2 (0.4)	0.4 (0.6)
Oatmeal	3.5 (3.5)*	1.7 (2.1)	0.8 (1.4)	1.8 (2.7)
Foam	2.6 (3.3)*	0.9 (1.5)	0.2 (0.3)	0.5 (0.8)
Mayonnaise	4.0 (4.4)*	1.7 (2.4)	1.6 (3.1)	1.0 (1.4)
Molasses	6.2 (4.9)*	1.9 (2.7)	1.5 (2.7)	2.0 (2.3)
Mushrooms	6.5 (4.6)*	2.5 (2.6)	1.8 (2.8)	4.2 (4.5)

Significant contrasts marked; *Disgust vs Other, + No Label vs True and Visible, ^ True vs Visible ($p < 0.0056$, Bonferroni adjusted)

4.2.1.3 Disgust-Labelling with Pleasantness Ratings.

Group Level. A main effect of Group (Disgust-Label, No-Label, True-Label, Visible) was seen on pleasantness ratings, $F(3, 116) = 12.21$, $\eta2 = 24$, $p < .0005$. A post-hoc Helmert contrast showed that the Disgust-Label group (M = -2.8, SD = 0.2) found the objects as significantly more unpleasant to touch compared to the other groups (No-Label, M = -0.8, SD = 0.2; True-Label, M = -1.2, SD = 0.2; Visible, M = -1.2, SD = 0.2; $p < 0.05$). Helmert contrasts comparing the No-Label, True-Label and Visible groups in pleasantness ratings, did not reach significance.

Object-Level. The Disgust-Label group rated 3/9 objects (i.e., the pear, coffee and foam) as significantly more unpleasant to touch, compared to the other groups. The No-Label group rated the mayonnaise as significantly more pleasant to touch, compared to the Visible and True-Label groups. There were no significant differences in pleasantness ratings, between the Visible and True-Label groups ($p < 0.0056$, Bonferroni adjusted; see Table 12)

Table 12. Pleasantness Ratings for each object by Group

Object	**Disgust** M (SD)	**No Label** M (SD)	**True** M (SD)	**Visible** M (SD)
Tapioca	-2.4 (2.7)	-1.2 (2.2)	-1.2 (2.8)	-2.1 (2.5)
Pear	-3.4 (2.6)*	-0.4 (2.6)	-0.6 (1.6)	-0.2 (2.1)
Flakes	-1.2 (2.6)	-0.6 (2.1)	0.2 (2.2)	0.1 (2.4)
Coffee	-3.3 (2.8)*	0.4 (2.7)	0.0 (3.2)	0.5 (2.4)
Oatmeal	-2.7 (3.1)	-2.1 (3.0)	-2.5 (2.7)	-2.7 (2.7)
Foam	-1.2 (3.5)*	0.8 (2.7)	2.3 (2.3)	2.4 (2.0)
Mayonnaise	-2.4 (3.4)	-0.2 (3.1)+	-2.8 (2.6)	-2.4 (2.6)
Molasses	-4.1 (2.6)	-2.2 (2.4)	-3.8 (2.4)	-2.8 (2.2)
Mushrooms	-4.1 (2.5)	-2.1 (2.5)	-2.5 (2.9)	-3.7 (2.3)

Significant contrasts marked; *Disgust vs Other, + No Label vs True and Visible, ^ True vs Visible ($p < 0.0056$, Bonferroni adjusted)

4.2.2.1. Disgust-Labelling with Retouch-Likelihood Ratings.

Group Level. A main effect of Group (Disgust-Label, No-Label, Visible and True-Label) was seen for retouch-likelihood ratings, $F(3, 116) = 10.05$, $\eta 2 = .26$, $p < .0005$. A post-hoc Helmert contrast confirmed the Disgust-Label group ($M = 2.6$, $SD = 0.4$), was significantly less likely to retouch the objects compared to the other groups (True-Label, $M = 4.9$, $SD = 0.4$; No-Label, $M = 5.3$, $SD = 0.4$; Visible, $M = 5.7$, $SD = 0.4$; $p < 0.05$). Helmert contrasts comparing the No-Label, True-Label and Visible groups in retouch-likelihood ratings, did not reach significance.

Object Level. For 4/9 objects (i.e., the pear, flakes, coffee, and foam) the Disgust-Label group was significantly less likely to retouch them, compared to the other groups. The No-Label group was significantly less likely to retouch the flakes, compared to the Visible and True-Label groups. There was no difference between the Visible and True-Label groups in retouch-likelihood ratings ($p < 0.0056$, Bonferroni adjusted; see Table 13).

Table 13. Retouch-Likelihood Ratings for each object by Group

Object	**Disgust** M (SD)	**No-label** M (SD)	**True** M (SD)	**Visible** M (SD)
Tapioca	2.4 (3.2)	3.9 (4.0)	4.7 (4.2)	4.1 (4.1)
Pear	2.8 (4.1)*	6.3 (4.1)	5.7 (4.3)	7.9 (4.1)
Flakes	4.0 (4.2)*	5.3 (4.1)+	9.0 (3.5)	6.8 (3.9)
Coffee	1.9 (3.3)*	7.0 (4.6)	6.5 (4.5)	8.3 (3.1)
Oatmeal	3.2 (3.8)	3.6 (3.9)	3.1 (3.6)	3.9 (3.4)
Foam	3.3 (3.9)*	8.6 (4.6)	8.1 (4.4)	10.4 (3.1)
Mayonnaise	2.9 (3.9)	6.1 (4.2)	2.9 (3.4)	5.2 (3.9)
Molasses	1.0 (1.5)	3.5 (3.4)	1.8 (2.8)	3.0 (3.6)
Mushrooms	1.8 (2.5)	3.2 (3.5)	2.6 (3.0)	2.1 (2.8)

Significant contrasts marked; *Disgust vs Other, + No Label vs True and Visible, ^ True vs Visible ($p < 0.0056$, Bonferroni adjusted)

4.2.2.2. Disgust-Labelling with Likelihood to Put-in-Mouth Ratings.

Group-Level. A main effect of Group (Disgust-Label, No-Label, Visible and True-Label) was seen for likelihood to put-in-mouth ratings, $F(3, 116) = 19.64$, $\eta 2 = .34$, $p < .0005$. Post-hoc Helmert contrasts confirmed the Disgust-Label group ($M = 0.6$, $SD = 0.3$) were significantly less likely to put the objects in their mouth, compared to the other groups (No-Label, $M = 2.9$, $SD = 0.3$; True-Label, $M = 3.7$, $SD = 0.3$; Visible, $M = 3.4$, $SD = 0.3$; $p <$

.05). Helmert contrasts comparing the No-Label, True-Label and Visible groups in likelihood to put-in-mouth ratings, did not reach significance.

Object-Level. For 7/9 objects (all excluding the oatmeal and foam), the Disgust-Label group was significantly less likely to put the object in their mouth compared to the other groups. The No-Label group was significantly less likely to put the flakes and mayonnaise in their mouth compared to the Visible and True-Label groups. The Visible group was significantly less likely to put the flakes in their mouth, compared to the True-Label group ($p < 0.0056$, Bonferroni adjusted; see Table 14).

Table 14. Likelihood to Put-in-Mouth Rating for each object by Group

Object	**Disgust** M (SD)	**No-label** M (SD)	**True** M (SD)	**Visible** M (SD)
Tapioca	0.6 (1.3)*	1.7 (2.8)	2.76 (3.7)	2.7(3.6)
Pear	1.4 (3.0)*	4.8 (4.4)	5.55 (3.9)	7.1 (4.5)
Flakes	0.4 (1.0)*	2.2 (3.6)+	7.76 (4.3)^	3.7 (3.8)
Coffee	0.4 (1.3)*	2.7 (4.0)	3.14 (3.4)	3.8 (3.9)
Oatmeal	1.4 (3.1)	2.7 (3.8)	5.00 (4.9)	3.9 (4.3)
Foam	0.4 (0.8)	4.0 (4.6)	0.22 (0.4)	0.7 (1.7)
Mayonnaise	0.4 (0.8)*	3.0 (4.4)+	4.45 (4.5)	5.0 (4.3)
Molasses	0.3 (0.6)*	2.6 (3.8)	1.79 (2.9)	1.8 (2.1)
Mushrooms	0.3 (0.6)*	2.0 (3.1)	2.71 (3.3)	1.8 (2.6)

Significant contrasts marked; *Disgust vs Other, + No Label vs True and Visible, ^ True vs Visible ($p < 0.0056$, Bonferroni adjusted)

4.2.2.3. Disgust-Labelling with Sickness-Belief Ratings.

Group Level. A main effect of Group (Disgust-Label, No Label, Visible and True-Label) was seen for sickness-belief ratings, $F(3, 116) = 34.57$, $\eta 2 = .47$, $p < .0005$. A post-hoc Helmert contrast confirmed the Disgust-Label group ($M = 11.0$, $SD = 0.4$) had higher sickness-belief ratings compared to the other groups (Visible, $M = 6.9$, $SD = 0.4$; No-Label, $M = 7.2$, $SD = 0.4$; True-Label, $M = 5.1$, $SD = 0.4$; $p < 0.005$). The No-Label group had significantly higher sickness-belief ratings compared to the Visible and True Label groups ($p < 0.05$). The Visible group had significantly higher sickness-belief ratings compared to the True-Label group ($p = 0.003$).

Object-Level. The Disgust-Label group had significantly higher sickness-belief ratings for 7/9 objects (all excluding the tapioca, and foam) compared to the other groups. The No-Label group had higher sickness-belief ratings for the flakes, and oatmeal, and significantly lower sickness-belief ratings for the foam, compared to the True-Label and Visible groups. The Visible Group had higher sickness-belief ratings for the tapioca, mushrooms, and flakes compared to the True-Label group (see Table 15, $p < 0.0056$, Bonferroni adjusted).

Table 15. Sickness-Belief for each object by Group

Object	**Disgust** M (SD)	**No-label** M (SD)	**True** M (SD)	**Visible** M (SD)
Tapioca	8.7 (4.5)	7.9 (4.0)	5.2 (4.3)$^{\wedge}$	8.6 (3.9)
Pear	9.7 (4.4)*	4.9 (3.8)	2.7 (3.0)	3.5 (3.7)
Flakes	11.4 (2.5)*	7.9 (4.7)$^{+}$	1.9 (2.4)$^{\wedge}$	6.3 (3.8)
Coffee	12.3 (1.3)*	6.8 (5.1)	5.0 (4.1)	4.4 (4.4)
Oatmeal	10.3 (3.9)*	7.5 (4.3)$^{+}$	3.8 (4.5)	5.5 (5.0)
Foam	11.3 (2.5)	6.5 (4.5)$^{+}$	11.2 (3.5)	11.1 (2.9)
Mayonnaise	11.0 (3.1)*	7.2 (5.0)	5.1 (3.9)	4.6 (4.1)
Molasses	12.2 (1.8)*	7.8 (4.6)	6.2 (4.7)	8.9 (3.5)
Mushrooms	11.9 (1.6)*	8.3 (4.1)	4.9 (4.8)$^{\wedge}$	9.2 (3.7)

Significant contrasts marked; *Disgust vs Other, $^{+}$ No Label vs True and Visible, $^{\wedge}$ True vs Visible ($p < 0.0056$, Bonferroni adjusted)

4.2.3. Disease Risk Belief as a mediator of Disgust-Labelling on Disgust.

To assess the significance of Fear (measured by averaged fear-ratings) and Sickness-Belief (measured by averaged sickness-belief ratings) as mediators of Disgust (measured by averaged disgust-ratings), Preacher and Hayes (2008) mediational approach was used. The indirect effect of Sickness-Belief (on Disgust Labelling [Group] and Disgust) had a point estimate of .15, and 95% CI between .05 and .26. This indicated that the belief the objects would cause sickness (if consumed), was a significant mediator of Disgust Labelling (group) on Disgust. Similarly, the indirect effect of Fear (on Disgust Labelling and Disgust) yielded a point estimate of .32, and a 95% CI between .16 and .53, verifying fear was also a significant mediator of Disgust.

Further, the relationship between Disgust Labelling and Disgust, was no longer significant with Fear and Sickness-Belief (i.e., the mediators) added in. This is shown in Figure 1, where the association between Disgust Labelling and Disgust is significant, before mediation (point estimate of .60, and 95% CI between .43, and .78), and non-significant after (i.e., a point estimate of .17, and a 95% CI between -.07 and .32). Thus, disease risk expectation (as measured by Sickness-Belief and Fear) mediates the relationship between Disgust Labelling and Disgust. There was no significant difference, between the ability of Fear to mediate Disgust than there was of Sickness (pairwise contrast yielded a 95% CI between -.04 and .39).

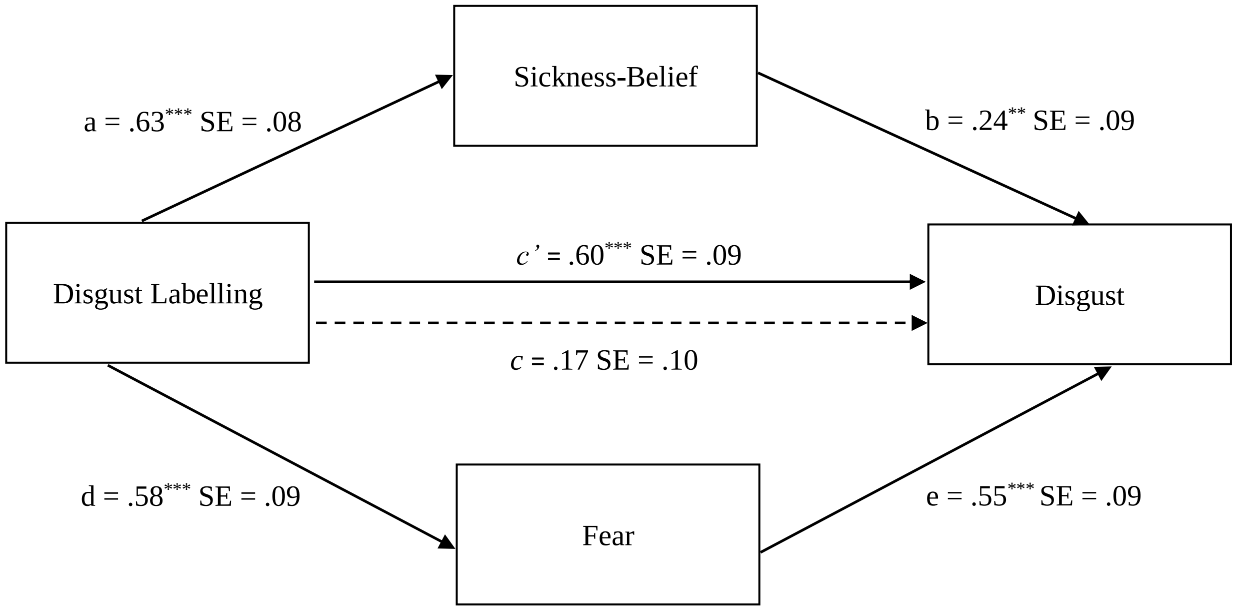

Figure 1. Mediation between Disgust Labelling and Overall Disgust, through Sickness-Belief and Fear

Note. a, b, d, e, *c*' represent standardised regression β coefficients. The path *c*' represents the effect of Disgust Labelling on Disgust, when Sickness-Belief and Fear are not included in the model. The dotted line represents path *c* (i.e., the indirect effect of Disgust Labelling on Disgust, through Sickness-Belief and Fear).
$^{**}p < 0.01$; $^{***}p < 0.005$

4.3. Qualitative data

4.3.1. Subject generated names by Group. To assess whether participants in the No-Label group and Visible group, were correct about what they thought they were touching, the frequency of correct and incorrect answers, was calculated for each group. This was calculated for every object. Guesses were categorised as being correct, incorrect negative (i.e., disgust animal, texture, or disease related) or incorrect neutral (i.e., not disgust related). For both the No-Label and Visible group the object with the highest percentage of correct answers, was the detergent foam. The Molasses had the highest percentage of wrong-neutral guesses for the Visible group, and the Flakes had the highest percentage of wrong-neutral guesses for the No-Label group. For both groups, the mushrooms had the highest percentage of wrong disgust-related guesses (see Table 16).

Table 16. Subject Generated Names in No label Groups

	Correct		Incorrect Neutral		Incorrect Negative*	
Object	Visible (%)	Blind (%)	Visible (%)	Blind (%)	Visible (%)	Blind (%)
Tapioca	23.3	3.5	70.0	82.8	0.0	10.3
Pear	70.0	37.9	30.0	58.6	0.0	3.5
Flakes	30.0	6.7	70.0	93.3	0.0	0.0
Coffee	70.0	0.0	26.7	63.3	3.3	36.7
Oatmeal	83.3	13.8	13.3	55.2	3.3	31.3
Foam	100.0	50.0	0.0	50.0	0.0	0.0
Mayonnaise	66.7	3.3	33.3	60.0	0.0	36.7
Molasses	3.3	10.0	96. 7	70.0	0.0	20
Mushrooms	40.0	13.3	26. 7	43.3	33.3	43.3

* negative were items described as contamination, disgust texture or animal related

4.3.2 Believability of labels. To assess whether participants in the Disgust-Label group believed in the labels provided, all participants were asked if they believed in the labels, and if not, what labels they specifically did not believe. The data indicated 21 out of 30 participants, believed in all labels. No participant indicated they did not believe in any of the labels. On average, two labels were not believed (*SD* = 1.11). Participants who did not believe in all the labels (non-believers) had significantly lower averaged sickness-belief ratings, to those who did believe in all the disgust-labels (believers). There were no differences between believers and non-believers, in averaged disgust, fear, pleasantness, likelihood to put-in-mouth, and retouch-likelihood ratings (see Table 17). Thus, in general, believability of labels did not affect the belief the objects posed a disease-risk.

Table 17. Believability-Status on Measures related to Disease Risk Belief

Measures associated with Disease Risk	F	Believers M (SD)	Non-Believers M (SD)
Disgust	1.23	7.5 (2.6)	6.3 (2.6)
Fear	0.05	4.2 (3.1)	4.6 (2.9)
Pleasantness	4.27	-3.2 (1.6)	-1.8 (1.7)
Likelihood to Put-in-Mouth	3.82	.4 (.5)	1.2 (1.2)
Retouch-Likelihood	4.43	2.1 (1.6)	3.8 (2.3)
Sickness-Belief	10.47*	11.5 (1.6)	9.8 (1.2)

Note: all measures of disease risk, were averaged across the nine tactile objects.
* $p < 0.0083$, Bonferroni adjusted (0.05/6)

5. Discussion

The first aim of this study was to identify the tactile qualities that drive disgust. The second aim of the study was to determine how participants' belief about what they were touching (and the disease-risk it poses) influences tactile disgust. It was argued in the Introduction that tactile-disgust would be influenced by the physical characteristics of an object and by Disgust-Labelling. Disgust-Labelling was expected to increase participants' belief that touching the objects was a disease risk. This belief of disease risk was measured primarily by fear and sickness-belief ratings. The prediction that both sensory level features and disgust labelling (i.e., the increased belief of disease risk) would contribute to tactile disgust, came from pain research (i.e., another aversive somatosensory state). That is, in pain both somatosensory-level features and beliefs about risk significantly contribute to pain experience and are referred to as bottom-up and top-down input, respectively (Torta et al., 2017). Paralleling pain, the findings of this study show that while several 'bottom-up' tactile qualities are associated with disgust, tactile-disgust is also highly influenced by disgust-labelling, and the 'top-down' belief of risk (i.e., disease-risk). The Discussion will detail each finding relative to the aims and predictions. The limitations of the current study will be examined before implications and future directions are outlined.

5.1 Primary Aim: The role of 'bottom-up' tactile qualities in disgust.

It was hypothesised that wetness, stickiness, oiliness, softness and warmness would be positively associated with disgust. These tactile qualities were also expected to be present in objects rated as high in disgust, and less present in objects rated as low in disgust. These hypotheses were based on two previous tactile disgust studies which found that wet and soft textures were disgust eliciting (Oum et al., 2011), and suggested that oily, warm, and sticky objects may also be disgust-eliciting (Oum et al., 2011; Skolnick, 2013). The results of this study are generally in line with these hypotheses. Sticky and wet were found to be positively related to disgust and high-disgust objects were more sticky and wet than low-disgust objects. In contrast to these hypotheses, coldness (not warmness) was associated with disgust, and high-disgust objects were judged to be more cold, and less warm, than low-disgust objects.

Furthermore, while oiliness was positively associated with disgust, and hardness negatively associated (in line with the hypothesis that oily and soft textures are positively related to disgust), high disgust objects were not significantly more oily and soft than low disgust objects. It was also found that lumpiness and viscosity were positively associated with disgust, and objects high in disgust were more lumpy and viscous than those low in disgust. The findings that stickiness, viscosity, coldness and lumpiness are related to disgust are novel. This is because no study to date has explored if most of these object qualities could elicit disgust – i.e., previous studies had only used two (Oum et al., 2011) or three objects (Skolnick, 2013) to elicit disgust, meaning that many textures (e.g., graininess, lumpiness, viscosity, brittleness) had been neglected (until now) in tactile-disgust research. Importantly, wetness and stickiness were found to be the tactile qualities which were most associated with disgust, and were the best at discriminating high disgust objects, from low disgust objects. Possible explanations for why each of these qualities is disgust eliciting are detailed below.

The Adherence Quality Theory. That stickiness and wetness are the strongest tactile-elicitors of disgust, and viscous, and lumpy textures also reliably cued disgust, suggests that properties of materials which adhere to the skin’s surface are more disgust eliciting and pose (potentially at least) a disease risk, than those which do not. *Hypothetically* if a contaminated object was sticky and wet (i.e., liquid adhering to the skin) and/or viscous and lumpy too, touching this object would allow pathogen containing materials to adhere to the skin’s surface, thereby making it more of a disease-risk than if it was not-sticky, dry, smooth etc. Further, as water is key to life and moist environments facilitate bacterial proliferation, wet materials likely cue the presence of living organisms (e.g., pathogens) greater than dry materials. This means, that if a wet-material (predictor of living matter) adheres to the skin, it likely poses much more of a disease risk, than if a dry material (likely inanimate) adheres to the skin (Oum et al., 2011). Finally, that sticky and wet adhere more to the skin than lumpy and viscous textures, may also explain why sticky and wet were *more* predictive of disgust than lumpy and viscous.

The supposition that the adherence-quality of objects predicts disgust, is supported by two findings in literature. The first is Oum et al.'s (2011) finding that wetness (i.e., liquid sticking to skin) was the most predictive tactile-cue of sickness likelihood. This indicates that textures that adhere to the skin (i.e., wet), are perceived as more contaminating (disease-related) than those which do not (e.g., dry textures). The second finding which supports the adherence-quality theory, comes from toilet training literature. The toilet-training literature reveals that children aged between 18 to 24 months exhibit discomfort to the feeling of being wet (i.e., urine [disease-related] sticking to skin), and soiled (i.e., feces [disease-related] sticking to the skin; Kaerts et al., 2012; Spock & Bergen, 1964). This suggests that displeasure associated with adhering textures (wet, sticky) may occur early in development (i.e., 18-24 months) and may be the first sign of tactile disgust.

However, there is one contradiction to the adherence quality theory – i.e., wetness is not always disgusting. For example, humans regularly *clean* themselves with water (shower), water is used in religious ceremonies where it is associated with *purification* (e.g., baptism), and water-sports (swimming) are readily accepted recreational activities. All these examples of water adhering to the skin, are not disgusting – and, conversely, the former two are associated with cleaning. This indicates, that while adherence may be a powerful predictor of tactile disgust, beliefs about contamination (and cleaning) may also be very important.

To summarise, the current findings and extant literature suggest that it may be the adherence quality of textures (i.e., wet, sticky, and to a lesser extent lumpy and viscous) which makes them disgust-eliciting. The adherence quality theory has three predictions. First, it posits that textures which adhere to the skin's surface will be *more* contaminating and therefore disgust eliciting, than textures which do not adhere to the skin. Second and relatedly, it hypothesises that the relationship between adherence and disgust is positive. Third, it suggests that the relationship between contamination and adherence appears early in development and therefore may be hardwired.

Why did coldness elicit disgust? The finding that coldness was consistently predictive of disgust was not in line with previous disgust research (Oum et al., 2011). Further it was in the opposite direction to the hypothesis, which predicted warmness would be associated with disgust. A possible explanation for why coldness may have been predictive of disgust, lies in coldness-perception. It has been shown that people perceive cold-wet stimuli as significantly more wet, than warm-wet and room-temperature wet objects (Filingeri, Fournet, Hodder & Havenith, 2014). Further, when cold-dry stimuli are pressed on the skin and reduce skin temperature, at the same rate water reduces skin temperature, the feeling of wetness can result (Filingeria, Redortier, Hoddera & Havenitha, 2013). Coldness and wetness also share overlapping peripheral coding mechanisms (Filingeri et al., 2014). Thus, as wetness and coldness are strongly associated with each other peripherally and mistaken for each other perceptually – *and* wetness was strongly predictive of disgust – it is not surprising that coldness (by relation to wetness), was also associated with disgust. This may also explain why Oum et al. (2011) found no association between warmth and disgust, when using wet-dough.

To examine the supposition that coldness and wetness were strongly related to each other, and thus coldness (by relation to wetness) elicited disgust, a post-hoc correlation analysis was conducted on coldness and wetness ratings. There were three steps involved. First, each individual's coldness ratings for the nine objects were correlated with their wetness ratings for the nine objects, at first presentation. Thus, each participant had a single coldness-wet correlation. Second, these coldness-wetness correlations were standardised to r' (i.e., using fisher transformation). Third, a t-test was run to compare the standardised coldness-wetness correlations to a mu of zero. The coldness-wetness correlations were found to be significantly different to zero ($t(120) = 16.22$, $p <.0001$). The mean correlation (r') was 0.86 ($SD = .58$) validating that wetness and coldness were very strongly and positively related. The strength and significance of this correlation supports the supposition that coldness elicited disgust by its relation to wetness.

Conclusion. In sum, the findings of the current study show that there are several bottom-up tactile features, that elicit disgust. The most potent are sticky, and wet, with oily, viscous, lumpy and coldness, also moderately disgust eliciting. As most of these textures adhere to the skin, the adherence-quality of an object may predict its ability to elicit disgust.

5.2 Second Aim: Disgust Labelling and Top-down Disease Risk Belief in Tactile Disgust.

5.2.1 Disgust Labelling on Disgust, Fear and Pleasantness. It was hypothesised that the Disgust-Label group would rate objects as higher on disgust, fear (i.e., the emotive manifest of disease risk belief), and unpleasantness, compared to the True-Label, No-Label, and Visible groups. Consistent with these predictions, overall the Disgust-Label group rated objects as significantly more disgusting, fear-inducing, and unpleasant, compared to the other groups. The finding that the Disgust-Label group had higher disgust ratings and lower pleasantness ratings, is consistent with olfactory-disgust research, which finds that disgust-labelling significantly increases aversion and disgust towards odours (Herz & von Clef, 2001; Croy et al., 2013). Further, it replicates Croy et al.'s (2013) finding, that disgust-labelling tactile-objects makes objects more disgusting and unpleasant, than when no-labels are given to the same objects.

Importantly, the current findings also extend Croy et al.'s (2013) research in three ways. First, the current study used nine objects (all with different textures), in comparison to Croy et al. (2013) who only used three objects. This is important, as it means the current results generalise to a large range of tactile objects and therefore indicate disgust-labelling can increase disgust and aversion to almost any tactile-object. Second, this study also measured participants' perceived fear (through their fear ratings) of the objects – and showed that disgust-labelling also increased fear (the emotive manifest of disease risk belief) for all objects. This provides the first evidence, that disgust labels are potent manipulators of disgust in touch, as they increase the belief that touching an object poses a disease risk. Third, in the current study, participants who were not given any labels (i.e., the No-Label and Visible group) were asked what *they* thought they were touching. As a result, the current findings indicate disgust-labelling increases disgust and the belief the object is a disease risk, above and beyond visibility of the stimuli and what participants (who are not given any labels) believe they are touching.

5.2.2 Disgust labelling on disease risk belief. It was hypothesised the Disgust-Label group would rate the objects as higher on measures of disease risk belief. Specifically, it was predicted that the Disgust-Label group would report they were less likely to retouch the objects (via the retouch-likelihood rating), less likely to put the objects in their mouth (via the likelihood to put-in-mouth rating) and thought the objects would make them more sick if they ate them (via the sickness-belief rating). Consistent with the predictions, overall the Disgust-Label group was significantly less willing to retouch the objects, put them in their mouth, and thought the objects would make them more sick, than the True-Label, Visible and No-Label groups. These results indicate that disgust-labelling increased the belief that touching the objects was a disease risk and suggest top-down beliefs of disease risk influence disgust towards tactile objects. The next question then was, what extent do top-down beliefs of disease risk explain disgust towards tactile-objects? This question is answered in the next section.

Hypothesis 2.3: What extent does disease risk belief explain tactile-disgust? It was hypothesised that belief of disease risk (as measured by fear and sickness-belief), would significantly mediate the relationship between disgust-labelling and tactile-disgust. Put less formally, it was expected that participants in the Disgust-Label group had increased disgust (compared to the other groups), due to their belief the objects posed a disease risk. Consistent with this hypothesis, the mediation analysis revealed that the relationship between disgust-labelling and disgust was *completely* mediated by disease risk beliefs. Thus, the increased disgust in the Disgust-Label group was explained by their increased fear and sickness belief (i.e., emotive and cognitive disease risk belief) of the objects. The role of disease risk belief in disgust is analogous to the role fear and risk-belief in pain. The parallel between pain and the current findings on tactile-disgust is explained in detail below.

5.3 The Parallel between Tactile Disgust and Pain.

The findings from the primary and second aim of the study indicate that tactile-disgust results from the tactile qualities of an elicitor (sticky, wet), as well as the belief that touching an object poses a disease risk (as produced from disgust-labelling). The role of tactile qualities and disease risk beliefs (from disgust-labelling) in tactile-disgust, is analogous to the role of bottom-up sensory input, and top-down fear and risk belief (from risk-labelling) in pain. The role of sensory input, fear and risk belief in pain, is detailed in the fear-avoidance model of pain (Vlaeyen & Linton, 2000; Leeuw et al., 2007). This model posits that when an aversive somatosensory elicitor causes an injury, and this injury is labelled or interpreted as a risk to one’s physical functioning, pain-related fear results. This fear then increases attention to the pain, and avoidance of the pain elicitor – which in turn, increases the perceived pain. Paralleling pain, the current study showed that when a bottom-up tactile-feature of disgust (e.g., a sticky object) is disgust-labelled, the fear and sickness-belief of the object is increased (i.e., emotive and cognitive disease risk belief). As a result, the object is rated as more disgusting and aversive, than when there is no disgust labelling and thus disease risk belief. This model also suggests that the object will be more avoided if it is believed to be a disease risk (see Figure 2).

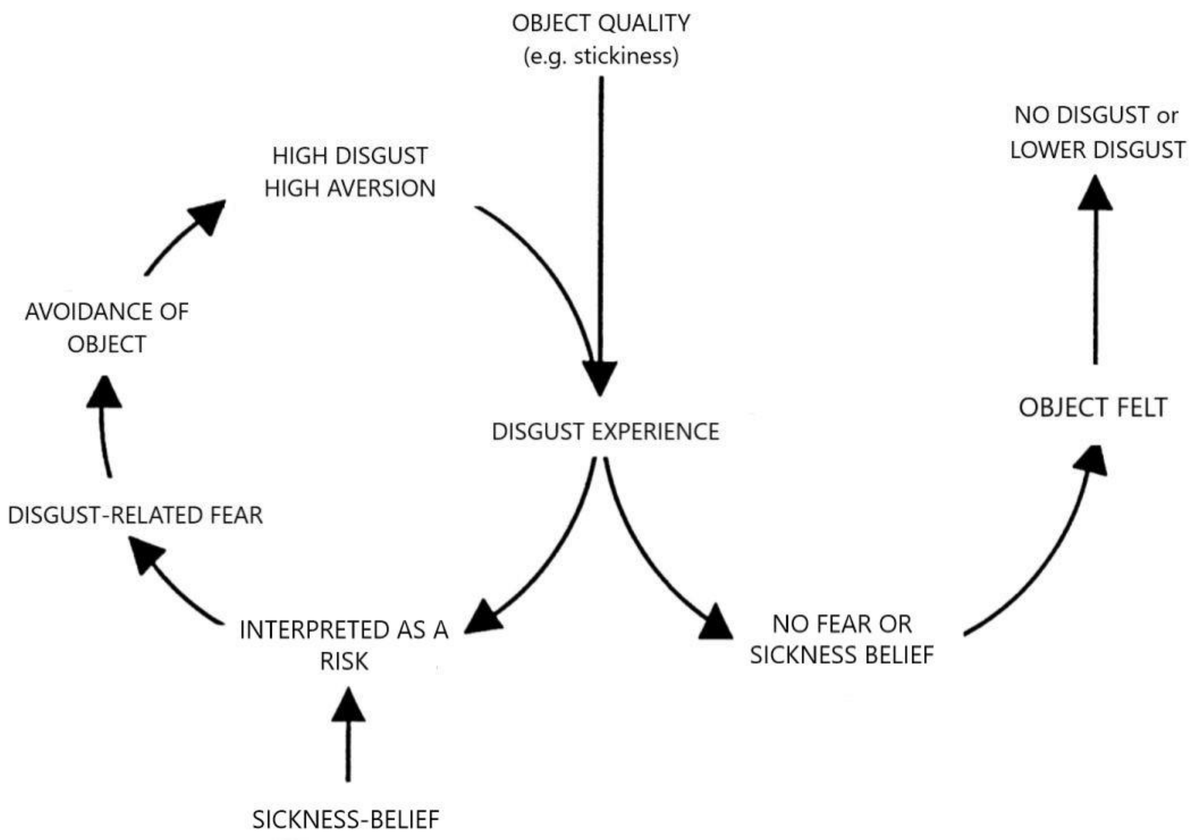

Figure 2. Fear Avoidance Model of Tactile-Disgust (adapted from the Fear Avoidance Model of Pain, Vlaeyen & Linton, 2000). Tactile Disgust is predicted by bottom-up tactile qualities and top-down belief of disease-risk (i.e., fear and sickness belief)

5.4 Accuracy in naming tactile-objects.

This study explored how accurate people were in naming the objects, when there were no labels provided based on touch. When participants were able to see the objects and touch them (i.e., the Visible group), on average half the participants were able to correctly name the objects. In contrast, when there were no visual cues given (No-Label group), on average only 15% of the participants correctly identified all the objects. Further, the ability to correctly name *any* of the tactile objects, did not exceed 50%. These results on tactile-identification are similar to odour-identification. In olfaction, it has been shown that the ability to correctly name everyday odours also rarely exceeds 50%, and that this is even lower for novel or unfamiliar odours (Herz & Engen, 1996; Jonsson & Stevenson, 2014). The similarity between touch and olfaction is important to note, because it may explain why these objects were so susceptible to labelling.

In olfaction it is well known that the ambiguous nature of odours, makes their emotive-ratings strongly influenced by labels (Bensafi et al., 2007; Herz & von Clef, 2001; Herz, 2003). Thus, the strong influence of disgust-labelling on the affect and disease risk ratings of the objects in the current study, is likely explained by the ambiguous nature of tactile-objects. This supposition is also supported by pain literature, which shows that the ambiguous nature of pain elicitors, makes their perceived-aversion highly influenced by labels. For instance, it has been shown that when noxious heat is labelled as low-pain, it is rated as relieving and pleasant, but when it is labelled as high-pain it is rated as aversive (Leknes et al., 2013). Thus emotive-ratings to disgust odours, tactile-disgusts, and pain-elicitors, are highly influenced by semantic labels (contextual information), as these stimuli are ambiguous.

The No-Label group also provided a measure for what the objects were believed to be without visual or contextual information, and more importantly how disgust-related these beliefs were. It was shown, that over one-third of the No-Label group believed the mushrooms, mayonnaise, coffee and oatmeal, were disgust-related objects, with the majority of the No-Label group believing these objects were neutral (i.e., not disgust related). The other objects were rarely disgust-related (i.e., < 10% of guesses were negative). Thus, as the objects were generally believed to be neutral without any labels, labelling tactile-objects appears to have a very powerful role in the reaction to these stimuli.

5.5 Limitations

Few limitations need to be borne in mind. First, the current study used a limited range of temperatures – i.e., objects were either presented at room temperature or cold (from the fridge), but not warm (25-42℃). The reason objects were not presented at warm temperatures was because some of the objects' physical properties (e.g., mushrooms, foam), would have changed if they were presented at these temperatures. Further, some objects (e.g., coconut flakes) could not retain heat for the duration of the experiment. Nonetheless, the role of temperature in disgust was still assessable by using participants' perceived-warmness and coldness ratings. Further, the finding that warmness (i.e., 31-33℃) was not associated with tactile disgust is in line with Oum et al.'s (2011) study, which also found that warmness was not predictive of disgust. However, as the current study and Oum et al. (2011) used a narrow range of temperatures, it is plausible objects have not been presented warm *enough,* to be perceived as disgusting. Future research should look to present objects in larger range of a warm temperatures (e.g., 33-42℃), to further discern whether warmth is associated with disgust.

A second limitation was that there was no attempt made to mask sounds elicited from touching the objects (i.e., by using ear plugs). The sounds elicited, could have been used to identify the objects, and may have caused scepticism in the Disgust-Label group if the sounds elicited from touching the objects, were different to the sounds expected to be elicited from the objects. However, as pilot testing confirmed the sounds elicited from the objects was very minimal, and no Disgust-Label participant reported the sounds aided identification of the objects, it is not likely sound cues contributed to scepticism of the labels. Nonetheless, to ensure that there is no effect of sound cues on tactile-identification, future tactile-disgust studies should use ear plugs.

The third limitation was that some of the Disgust-Label group were sceptical about the Disgust Labels used, and on average these people did not believe the disgust labels for two out of the nine objects. This scepticism appeared to have little impact on the results – i.e., Disgust-

Label participants who believed in all the disgust labels were not significantly different to those who were sceptical, on disgust, fear and pleasantness ratings of the objects. Further, with the exception of the sickness-belief rating, there was no significant difference on disease risk rating scales, between sceptical Disgust-Label participants and non-sceptical participants. Further, while sceptical people rated the objects as *lower* than non-sceptical people on sickness-belief, their sickness-belief ratings were still high – i.e., on average, ratings were in the upper 25% of the sickness-belief scale. This indicated that participants who were sceptical still believed that the objects would make them very sick. This suggests that sceptical disgust-label participants were still cautious of the objects, as they were associated with a contaminant. This is supported by Rozin and Fallon's (1987) study, which showed that adults were less likely to drink out of a glass which had contained a cockroach, even though they were aware this glass had been thoroughly sterilised. Thus, even if people believe (or are aware) an object is not-disgust related the mere association of this object with a contaminant, will make people more cautious of the object than if it was not associated with a contaminant.

The fourth limitation was that the current study relied solely on subjective (self-report) measures of disgust. Thus, it is not clear if disgust-labelling simply made participants rate objects higher on disgust due to a demand characteristic (i.e., figuring out the experiment is measuring disgust, and so objects should be rated high on disgust), or because they actually felt more disgusted. However, considering the following experiment was advertised as examining touch and *emotion*, and the majority of the disgust label group believed in the labels – it is not likely a demand characteristic explained the increased disgust in the Disgust-Label group. To ensure disgust-labelling (and not demand characteristics) increase feelings of disgust and nausea to tactile objects, future tactile-disgust studies could use additional objective measures of disgust response (e.g., facial responding, EEG).

5.6 Implications

The findings here have three implications. First, they show that there are several bottom-up tactile qualities that are associated with disgust – with stickiness and wetness of particular importance. Thus, it is likely that textures which adhere to the skin's surface are more disgust eliciting, than those which do not adhere to the skin's surface. This adherence-quality theory of disgust is yet to be tested empirically. Second, the study shows that disgust-labelling has a powerful rnoole in the reaction to tactile objects, and that this is likely because tactile-objects (like odours) are ambiguous. Therefore, paralleling olfaction literature, which has shown that disgust-labelling odours is predictive of neural activation in the amygdala, orbitofrontal cortex and anterior cingulate gyrus (de Araujo et al., 2005) – future tactile disgust studies should examine if disgust-labelling influences brain-responses to tactile objects. This will also provide insight on how verbal information contributes to the neural coding of tactile objects (Bensafi et al., 2014).

Third, the following findings have important theoretical implications. It was found that as the belief of disease risk associated with touching an object increased, so too did its ability to elicit disgust. This finding is consistent with the disease-avoidance hypothesis of disgust and suggests that tactile-disgusts (like other sensory disgusts) are highly receptive to disease-cues. Further, the findings shed light on the parallels between pain and disgust – i.e., both pain and disgust involve an aversive sensory elicitor and the cognitive belief of risk. Yet, in disgust, there is no comprehensive model which explains how disgust can be predicted by bottom-up sensory elicitors and top-down cognitive processes. This is in contrast to pain, where a number of established theories (e.g., Gate theories, Fear-Avoidance Models, Motivational theories, Affective theories; Leeuw, et al., 2007; Melzack & Wall, 1965; Torta et al., 2017) explain *how* bottom-up sensory qualities and top-down cognitive processes (e.g., risk-belief, attention) contribute to pain experience. Therefore, the following findings provide strong empirical support for development of a comprehensive disgust model, which explains *how* disgust can be predicted by the sensory properties of elicitors, and belief of disease risk.

5.7 Future studies.

To test the adherence quality theory, it would be important to discern if the adherence-quality of an object is sufficient (in and of itself) to elicit disgust. As noted above, while the adherence of textures is likely a strong predictor of disgust, belief that the elicitor is contaminating (or cleansing), is also likely important. To examine the interplay between adherence quality and contamination beliefs on disgust, a similar study to the current one could be conducted. Participants would be asked to touch a range of textures which were sticky, wet, sticky and wet, sticky and dry, and wet and not-sticky. Participants would then be asked to rate how sticky and wet the textures were, as well as how unpleasant, disgusting and contaminating they were. To one group of participants, the objects would be labelled as contaminating (e.g., water labelled as toilet water), to another group they would be positively labelled (e.g., water labelled as soapy water), and to the last group there would be no label, and participants would be asked to write what they thought they were touching. This suggested study would examine if wet and sticky textures elicit disgust in and of themselves (when no labels are given), and if they are perceived as more disgust-related than non-adhering (dry) textures. Further, it would assess if stickiness augments the ability of wetness (or vice versa) to elicit disgust. In addition, the suggested study would explore if the role of labels (contaminating and positive) on aversion and disgust, is modulated by the stickiness and/or wetness of textures.

The second step for tactile-disgust research is to assess if self-reports of tactile-disgust can be behaviourally validated. To do so, two studies should be conducted. First, following other sensory disgusts, it should be examined if touching disgusting textures and disgust-labelled objects, elicits the same disgust facial expression as other forms of disgust. In line with previous facial-expression disgust studies, participants would be asked to touch disgust-labelled objects that were highly disgust-evoking in the current study (e.g., insect trap [molasses], curdled milk [oatmeal], dead slugs [mushrooms]). As with the current experiment, the stimuli would be rated on their disgust, fear, pleasantness, and disease risk belief. During the touching, the facial expression elicited by the subject would be recorded using a digital camera, and facial electromyography would be used to examine the muscle-movements produced by tactile disgusts (de Jong et al., 2002). A panel of trained volunteers would also be asked to evaluate the faces on how much of the six basic emotions they manifest. Second, it will be important to test what textures and tactile objects, catalyse cleaning and avoidant behaviours. Participants could be asked to handle a range of different objects (as with the current study) and rate these objects on their perceived tactile ratings, and disgust. Their hand washing behaviours would be correlated with their perceived tactile-ratings – i.e., to see what textures elicit the greatest cleaning behaviours. Interestingly, in the current experiment, textures that were sticky, wet and viscous (e.g., the molasses, and mayonnaise) were the most difficult to clean off the skin. Thus, it is expected that sticky, wet and viscous (i.e., adhering textures) would elicit the greatest cleaning behaviours.

Third, to further explore the sickness-mediation hypothesis future tactile-disgust experiments should examine how positively labelling an object, manipulates tactile disgust to them. To do so, a similar study to the current study could be done. Ninety participants (using touch alone), would be asked to feel objects that were highly-disgusting to touch in the current study (e.g., drumstick-mushrooms, molasses with seeds, oatmeal, mayonnaise), and rate how the object felt (i.e., tactile-quality ratings) and made them feel (i.e., using disgust, fear, pleasantness, sickness-likelihood ratings). This suggested study would require three groups, with thirty participants in each. To one group the objects would be labelled as disgusting (as in the current study), to another truly-labelled, and to the final positively-labelled (as non-disease related). For example, mayonnaise could be labelled as synthetic pus (disgust-label), mayonnaise (true-label) and moisturiser (positive label). Such a study would extend understanding on how sickness-beliefs mediate tactile disgust.

Fourth, future studies should examine how motivational states effect disgust to tactile objects. Previously it has been shown that disgust is attenuated in the presence of other evolutionary drives (hunger, sexual arousal). For instance, disgust to bodily fluids and sticky textures (e.g., a lubricated condom), is shown to decrease under sexual arousal (Oaten, Stevenson & Case, 2011). Similarly, self-reported disgust and disgust facial expressions (i.e. *levator labii* activity) towards images of unpalatable and spoilt foods, are shown to reduce under starvation (Hoefling & Strack, 2009). This reduction in disgust in the presence of other evolutionary drives, is suggested to be adaptive as it allows for reproduction (under sexual arousal) and survival (under starvation; Oaten et al., 2011). Thus to determine if tactile-disgust, is also adaptive and mediated by motivational states, future studies could examine if disgust to *touching* spoilt foods and other bodily fluids (e.g., sweat, semen) is respectively reduced under hunger, and sexual arousal.

5.8 Conclusion

In conclusion, the present study reveals that sticky, wet, viscous, lumpy and cold tactile qualities elicit disgust in adults, and suggests that it is the adherence quality of these textures which makes them disgust-eliciting. The findings further demonstrate that disgust labelling is a potent manipulator of tactile disgust, and that this is because disgust-labelled objects are believed to be a disease risk, and tactile-stimuli are ambiguous. Taken collectively the findings of the study highlight the similarity between pain and disgust. Thus, paralleling pain literature the current findings argue for the development of a disgust-model which takes into account the multiple bottom-up and top-down inputs involved in disgust processing. The development of such a model and future-tactile disgust studies would beneficially address many questions that remain unanswered about disgust.

References

Adolphs, R. (2002). Neural systems for recognizing emotion. *Current Opinions Neurobiology, 12*(2), 169-177. doi:10.1016/S0959-4388(02)00301-X

Albertazzi, L., Bacci, F., Canal, L., & Micciolo, R. (2016). The tactile dimensions of abstract paintings: A cross-modal study. *Perception, 45*(7), 805-822. doi:10.1177/0301006616643660

Angyal, A. (1941). Disgust and related aversions. *Journal of Abnormal and Social Psychology, 36,* 393-412. doi:10.1037/h0058254

Apfelbach, R., Parsons, M. H., Soini, H. A., & Novotny, M. V. (2015). Are single odorous components of a predator sufficient to elicit defensive behaviors in prey species? *Frontiers in Neuroscience, 9*(263), 1-14. doi:10.3389/fnins.2015.00263

Bensafi, M., Croy, I., Phillips, N., Rouby, C., Sezille, C., Gerber, J., . . . Hummel, T. (2014).

The effect of verbal context on olfactory neural responses. *Human Brain Mapping, 35*(3), 810-818. doi:10.1002/hbm.22215

Bensafi, M., Rinck, F., Schaal, B., & Rouby, C. (2007). Verbal cues modulate hedonic perception of odors in 5-year-old children as well as in adults. *Chemical Senses, 32*(9), 855-862. doi:10.1093/chemse/bjm055

Bensmaia, S. J. (2013). Spatial and temporal codes mediate the tactile perception of natural textures. *Proceedings of the National Academy of Sciences, 110*(42), 17107-17112. doi:10.1073/pnas.1305509110

Bowman, C., & Yamauchi, T. (2017). Processing emotions in sounds: Cross-domain aftereffects of vocal utterances and musical sounds. *Cognition and Emotion*, *31*(8), 1610-1626. doi:10.1080/02699931.2016.1255588

Bredie, W. L. P., Tan, H. S. G., & Wendin, K. (2014). A comparative study on facially expressed emotions in response to basic tastes. *Chemosensory Perception*, *7*(1), 1-9. doi:10.1007/s12078-014-9163-6

Brown, S. D., & Harris, G. (2012). Disliked food acting as a contaminant during infancy. A disgust based motivation for rejection. *Appetite, 58*(2), 535-538. doi:10.1016/j.appet.2012.01.010

Calder, A. J., Beaver, J. D., Davis, M. H., van Ditzhuijzen, J., Keane, J., & Lawrence, A. D. (2007). Disgust sensitivity predicts the insula and pallidal response to pictures of disgusting foods. *The European Journal of Neuroscience, 25*(11), 3422-3428. doi:10.1111/j.1460-9568.2007.05604.x

Calder, A. J., Keane, J., Manes, F., Antoun, N., & Young, A. W. (2000). Impaired recognition and experience of disgust following brain injury. *Nature Neuroscience, 3*(11), 1077-1078. doi:10.1038/80586

Carlino, E., Frisaldi, E., & Benedetti, F. (2014). Pain and the context. *Nature Reviews*

Rheumatology, 10(6), 348-355. doi:10.1038/nrrheum.2014.17

Case, T. I., Repacholi, B. M., & Stevenson, R. J. (2006). My baby doesn't smell as bad as yours. *Evolution and Human Behavior, 27*(5), 357-365. doi:10.1016/j.evolhumbehav.2006.03.003

Chapman, H. A., & Anderson, A. K. (2012). Understanding disgust. *Annals of New York Academy of Sciences, 1251*, 62-76. doi:10.1111/j.1749-6632.2011.06369.x

Chapman, H. A., Kim, D. A., Susskind, J. M., & Anderson, A. K. (2009). In bad taste: evidence for the oral origins of moral disgust. *Science, 323*(5918), 1222-1226. doi:10.1126/science.1165565

Chapman, H. A., Lee, D. H., Susskind, J. M., Bartlett, M. S., & Anderson, A. K. (2017). The Face of Distaste: A Preliminary Study. *Chemical Senses*, *42*(6), 457–463. doi:10.1093/chemse/bjx024

Chappuis, C. J. F., Niclass, Y., Vuilleumier, C., & Starkenmann, C. (2015). Quantitative headspace analysis of selected odorants from latrines in Africa and India. *Environmental Science & Technology, 49*(10), 6134-6140. doi:10.1021/acs.est.5b00692

Colburn, R. W., Lubin, M. L., Stone, D. J., Jr., Wang, Y., Lawrence, D., D'Andrea, M. R., . . . Qin, N. (2007). Attenuated cold sensitivity in TRPM8 null mice. *Neuron, 54*(3), 379-386. doi:10.1016/j.neuron.2007.04.017

Comtesse, H., & Stemmler, G. (2016). Cardiovascular regulation pattern of contamination-related disgust: Consistency and context dependence. *Psychophysiology, 53*(9), 1407-1416. doi:10.1111/psyp.12684

Cox, T. J. (2008). Scraping sounds and disgusting noises. *Applied Acoustics, 69*(12), 1195-1204. doi:10.1016/j.apacoust.2007.11.004

Croy, I., Laqua, K., Süß, F., Joraschky, P., Ziemssen, T., & Hummel, T. (2013). The sensory channel of presentation alters subjective ratings and autonomic responses toward disgusting stimuli—Blood pressure, heart rate and skin conductance in response to visual, auditory, haptic and olfactory presented disgusting stimuli. *Frontiers in Human Neuroscience, 7,* 1-10. doi:10.3389/fnhum.2013.00510

Curtis, V., & Biran, A. (2001). Dirt, disgust, and disease. Is hygiene in our genes? *Perspectives in Biology and Medicine, 44*(1), 17-31. doi:10.1353/pbm.2001.0001

Curtis, V., Aunger, R., & Rabie, T. (2004). Evidence that disgust evolved to protect from risk of disease. *Proceedings of the Royal Society B: Biological Sciences, 271*, 131-133. doi:10.1098/rsbl.2003.0144

Davey, G. C. (2011). Disgust: The disease-avoidance emotion and its dysfunctions. *Philosophical Transactions of The Royal Society B: Biological Sciences, 366*(1583), 3453-3465. doi:10.1098/rstb.2011.0039

Davey, G. C. L. (1991). Characteristics of individuals with fear of spiders. *Anxiety Research, 4*(4), 299-314. doi:10.1080/08917779208248798

de Araujo, I. E., Rolls, E. T., Velazco, M. I., Margot, C., & Cayeux, I. (2005). Cognitive modulation of olfactory processing. *Neuron, 46*(4), 671-679. doi:10.1016/j.neuron.2005.04.021

de Jong, P. J., Peters, M., & Vanderhallen, I. (2002). Disgust and disgust sensitivity in spider phobia: Facial EMG in response to spider and oral disgust imagery. *Journal of Anxiety Disorders, 16*(5), 477-493. doi:10.1016/S0887-6185(02)00167-6

de Jong, P. J., van Overveld, M., & Peters, M. L. (2011). Sympathetic and parasympathetic responses to a core disgust video clip as a function of disgust propensity and disgust sensitivity. *Biological Psychology, 88*(2-3), 174-179. doi:10.1016/j.biopsycho.2011.07.009

Decety, J., & Grezes, J. (2006). The power of simulation: Imagining one's own and other's behavior. *Brain Research, 1079*(1), 4-14. doi:10.1016/j.brainres.2005.12.115

Djordjevic, J., Lundstrom, J. N., Clément, F., Boyle, J. A., Pouliot, S., & Jones-Gotman, M. (2008). A rose by any other name: Would it smell as sweet? *Journal of Neurophysiology, 99*(1), 386-393. doi:10.1152/jn.00896.2007

Egolf, A., Siegrist, M., & Hartmann, C. (2018). How people's food disgust sensitivity shapes their eating and food behaviour. *Appetite, 127*, 28-36. doi:10.1016/j.appet.2018.04.014

Ekman, P. (1992). An argument for basic emotions. *Cognition and Emotion, 6*(3-4), 169-200. doi:10.1080/02699939208411068

Ekman, P., & Friesen, W. V. (1971). Constants across cultures in the face and emotion. *Journal of Personality and Social Psychology, 17*(2), 124-129. doi:10.1037/h0030377

Ekman, P., Friesen, W. V., O'Sullivan, M., Chan, A., Diacoyanni-Tarlatzis, I., Heider, K., . . . Ricci-Bitti, P. E. (1987). Universals and cultural differences in the judgments of facial expressions of emotion. *Journal of Personality and Social Psychology, 53*(4), 712-717.

Engelen, L., Fontijn-Tekamp, A., & van der Bilt, A. (2005). The influence of product and oral characteristics on swallowing. *Archives of Oral Biology, 50*(8), 739-746. doi:10.1016/j.archoralbio.2005.01.004

Filingeri, D., Fournet, D., Hodder, S., & Havenith, G. (2014). Why wet feels wet? A neurophysiological model of human cutaneous wetness sensitivity. *Journal of Neurophysiology, 112*(6), 1457-1469. doi:10.1152/jn.00120.2014

Filingeri, D., Redortier, B., Hodder, S., & Havenith, G. (2013). The role of decreasing contact temperatures and skin cooling in the perception of skin wetness. *Neuroscience Letters, 551*, 65-69. doi:10.1016/j.neulet.2013.07.015

Ganchrow, J. R., Steiner, J. E., & Daher, M. (1983). Neonatal facial expressions in response to different qualities and intensities of gustatory stimuli. (1983). *Infant Behavior and Development, 6*(4), 473-484. doi:10.1016/S0163-6383(83)90301-6

Gilchrist, P. T., Vrinceanu, T., Beland, S., Bacon, S. L., & Ditto, B. (2016). Disgust stimuli reduce heart rate but do not contribute to vasovagal symptoms. *Journal of Behavior Therapy and Experimental Psychiatry, 51*, 116-122. doi:10.1016/j.jbtep.2016.01.005

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, 16*(5), 701-713. doi:10.1016/0191-8869(94)90212-7

Herz, R. S. (2003). The effect of verbal context on olfactory perception. J*ournal of Experimental Psychology General*, *132*(4), 595-606. doi:10.1037/0096-3445.132.4.595

Herz, R. S., & Engen, T. (1996). Odor memory: Review and analysis. *Psychonomic Bulletin & Review, 3*(3), 300-313. doi:10.3758/bf03210754

Herz, R. S., & von Clef, J. (2001). The influence of verbal labeling on the perception of odors: Evidence for olfactory illusions? *Perception, 30*(3), 381-391. doi:10.1068/p3179

Hollins, M. (2009). Somesthetic senses. *Annual Review of Psychology, 61*(1), 243-271. doi:10.1146/annurev.psych.093008.100419

Hollins, M., & Risner, S. R. (2000). Evidence for the duplex theory of tactile texture perception. *Perception & Psychophysics, 62*(4), 695-705. doi:10.3758/BF03206916

Hollins, M., Faldowski, R., Rao, S., & Young, F. (1993). Perceptual dimensions of tactile surface texture: A multidimensional scaling analysis. *Perception & Psychophysics, 54*(6), 697-705.

Huang, A. L., Chen, X., Hoon, M. A., Chandrashekar, J., Guo, W., Tränkner, D., . . . Zuker, C. S. (2006). The cells and logic for mammalian sour taste detection. *Nature, 442,* 934-938. doi:10.1038/nature05084

Hughes, F. J., & McNab, R. (2008). Oral malodour – A review. *Archives of Oral Biology, 53,* 1-7. doi:10.1016/s0003-9969(08)70002-5

Hunt, D. F., Cannell, G., Davenhill, N. A., Horsford, S. A., Fleischman, D. S., & Park, J. H. (2017). Making your skin crawl: The role of tactile sensitivity in disease avoidance. *Biological Psychology, 127,* 40-45. doi:10.1016/j.biopsycho.2017.04.017

James, A. G., Austin, C. J., Cox, D. S., Taylor, D., & Calvert, R. (2013). Microbiological and biochemical origins of human axillary odour. *FEMS Microbiology Ecology, 83*(3), 527-540. doi:10.1111/1574-6941.12054

Johnson, K. O., & Hsiao, S. S. (1992). Neural mechanisms of tactual form and texture perception. *Annual Review of Neuroscience, 15*(1), 227-250. doi:10.1146/annurev.ne.15.030192.001303

Jönsson, F. U., & Stevenson, R. J. (2014). Odor knowledge, odor naming, and the “tip-of-the-nose” experience. In B. L. Schwartz, & A. S. Brown (Eds.), *Tip-of-the-Tongue States and Related Phenomena* (pp. 305-326). New York: Cambridge University Press. doi:10.1017/CBO9781139547383.014

Kaerts, N., Van Hal, G., Vermandel, A., & Wyndaele, J. J. (2012). Readiness signs used to define the proper moment to start toilet training: a review of the literature. *Neurourology and Urodynamics, 31*(4), 437-440. doi:10.1002/nau.21211

Kamiya, A., & Ose, Y. (1984). Study of odorous compounds produced by putrefaction of foods: V. Fatty acids, sulphur compounds and amines. *Journal of Chromatography A, 292*(2), 383-391. doi:10.1016/S0021-9673(01)83617-7

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

Knowlton, W. M., Palkar, R., Lippoldt, E. K., McCoy, D. D., Baluch, F., Chen, J., & McKemy, D. D. (2013). A sensory labeled-line for cold: TRPM8-expressing sensory neurons define the cellular basis for cold, cold pain, and cooling-mediated analgesia. *The Journal of Neuroscience: The Official Journal of the Society for Neuroscience, 33*(7), 2837-2848. doi:10.1523/jneurosci.1943-12.2013

Kunz, M., Peter, J., Huster, S., & Lautenbacher, S. (2013). Pain and disgust: The facial signaling of two aversive bodily experiences. *PLOS ONE, 8*(12), 1-11. doi:10.1371/journal.pone.0083277

Kupfer, T. R., & Le, A. T. D. (2018). Disgusting clusters: Trypophobia as an overgeneralised disease avoidance response. *Cognition and Emotion, 32*(4), 729-741. doi:10.1080/02699931.2017.1345721

Lang, P. J., Greenwald, M. K., Bradley, M. M., & Hamm, A. O. (1993). Looking at pictures: Affective, facial, visceral, and behavioral reactions. *Psychophysiology, 30*(3), 261-273. doi:10.1111/j.1469-8986.1993.tb03352.x

Laska, M., Bautista, R. M. R., Höfelmann, D., Sterlemann, V., & Salazar, L. T. H. (2007). Olfactory sensitivity for putrefaction-associated thiols and indols in three species of non-human primate. *Journal of Experimental Biology, 210*(23), 4169. doi:10.1242/jeb.012237

Lawless, H. T., & Heymann, H. (2010). *Sensory evaluation of food*. Gaithersburg, MD: Aspen Publishers

Lee, H., Iida, T., Mizuno, A., Suzuki, M., & Caterina, M. J. (2005). Altered thermal selection behavior in mice lacking transient receptor potential vanilloid 4. *Journal of Neuroscience, 25*(5), 1304-1310. doi:10.1523/jneurosci.4745.04.2005

Lee, L., Frederick, S., & Ariely, D. (2006). Try it, you'll like it: The influence of expectation, consumption, and revelation on preferences for beer. *Psychological Science, 17*(12), 1054-1058. doi:10.1111/j.1467-9280.2006.01829.x

Leeuw, M., Goossens, M. E. J. B., Linton, S. J., Crombez, G., Boersma, K., & Vlaeyen, J. W. S. (2007). The fear-avoidance model of musculoskeletal pain: Current state of scientific evidence. *Journal of Behavioral Medicine, 30*(1), 77-94. doi:10.1007/s10865-006-9085-0

Leknes, S., Berna, C., Lee, M. C., Snyder, G. D., Biele, G., & Tracey, I. (2013). The importance of context: When relative relief renders pain pleasant. *Pain*, *154*(3), 402-410. doi:10.1016/j.pain.2012.11.018

Lindquist, K. A., Wager, T. D., Kober, H., Bliss-Moreau, E., & Barrett, L. F. (2012). The brain basis of emotion: A meta-analytic review. *Behaviour and Brain Sciences, 35*(3), 121-143. doi:10.1017/s0140525x11000446

Lobue, V., & Deloache, J. S. (2011). What's so special about slithering serpents? Children and adults rapidly detect snakes based on their simple features. *Visual Cognition, 19*(1), 129-143. doi:10.1080/13506285.2010.522216

Logue, A. W., Logue, K. R., & Strauss, K. E. (1983). The acquisition of taste aversions in humans with eating and drinking disorders. *Behaviour Research and Therapy*, *21*(3), 275-289. doi:10.1016/0005-7967(83)90210-3

Lucarotti, C., Oddo, C. M., Vitiello, N., & Carrozza, M. C. (2013). Synthetic and Bio-Artificial Tactile Sensing: A Review. *Sensors (Basel, Switzerland), 13*(2), 1435-1466. doi:10.3390/s130201435

Lumpkin, E. A., & Caterina, M. J. (2007). Mechanisms of sensory transduction in the skin. *Nature, 445*(7130), 858-865. doi:10.1038/nature05662

Lundstrom, J. N., Boyle, J. A., Zatorre, R. J., & Jones-Gotman, M. (2008). Functional neuronal processing of body odors differs from that of similar common odors. *Cerebal Cortex, 18*(6), 1466-1474. doi:10.1093/cercor/bhm178

Ma, Q. (2010). Labeled lines meet and talk: Population coding of somatic sensations. *The Journal of Clinical Investigation, 120*(11), 3773-3778. doi:10.1172/JCI43426

Manescu, S., Frasnelli, J., Lepore, F., & Djordjevic, J. (2014). Now you like me, now you don't: impact of labels on odor perception. *Chemical Senses, 39*(2), 167-175. doi:10.1093/chemse/bjt066

Martins, Y., & Pliner, P. (2005). Human food choices: an examination of the factors underlying acceptance/rejection of novel and familiar animal and nonanimal foods. *Appetite, 45*(3), 214-224. doi:10.1016/j.appet.2005.08.002

Martins, Y., & Pliner., P. (2006). “Ugh! That's disgusting!”: Identification of the characteristics of foods underlying rejections based on disgust. *Appetite, 46*(1), 75-85. doi:10.1016/j.appet.2005.09.001

Mataix-Cols, D., An, S. K., Lawrence, N. S., Caseras, X., Speckens, A., Giampietro, V., . . . Phillips, M. L. (2008). Individual differences in disgust sensitivity modulate neural responses to aversive/disgusting stimuli. *European Journal of Neuroscience, 27*(11), 3050-3058. doi:10.1111/j.1460-9568.2008.06311.x

Melzack, R., & Wall, P. D. (1965). Pain Mechanisms: A new theory. *Science, 150,* 971-978. doi:10.1126/science.150.3699.971

Miller, W. I. (1997). *The anatomy of disgust*. William Ian Miller. Cambridge, Mass: Harvard University Press.

Mishra, S. K., Tisel, S. M., Orestes, P., Bhangoo, S. K., & Hoon, M. A. (2011). TRPV1-lineage neurons are required for thermal sensation. *The EMBO journal, 30*(3), 582-593. doi:10.1038/emboj.2010.325

Mohn, C., Argstatter, H., & Wilker, F. W. (2010). Perception of six basic emotions in music. *Psychology of Music, 39*(4), 503-517. doi:10.1177/0305735610378183

Nissim, I., Dagan-Wiener, A., & Niv, M. Y. (2017). The taste of toxicity: A quantitative analysis of bitter and toxic molecules. *IUBMB Life, 69*(12), 938-946. doi:10.1002/iub.1694

Oaten, M., Stevenson, R. J., & Case, T. I. (2009). Disgust as a disease-avoidance mechanism. *Psychological Bulletin, 135*(2), 303-321. doi:10.1037/a0014823

Olatunji, B. O., & Sawchuk, C. N. (2005). Disgust: Characteristic features, social manifestations, and clinical implications. *Journal of Social and Clinical Psychology, 24*(7), 932-962. doi:10.1521/jscp.2005.24.7.932

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, 19*(3), 281-297. doi:10.1037/1040-3590.19.3.281

Ottaviani, C., Mancini, F., Petrocchi, N., Medea, B., & Couyoumdjian, A. (2013). Autonomic correlates of physical and moral disgust. *International Journal of Psychophysiology, 89*(1), 57-62. doi:10.1016/j.ijpsycho.2013.05.003

Oum, R. E., Lieberman, D., & Aylward, A. (2011). A feel for disgust: Tactile cues to pathogen presence. *Cognition and Emotion, 25*(4), 717-725. doi:10.1080/02699931.2010.496997

Patapoutian, A., Peier, A. M., Story, G. M., & Viswanath, V. (2003). ThermoTRP channels and beyond: Mechanisms of temperature sensation. *Nature Reviews Neuroscience, 4*(7), 529-539. doi:10.1038/nrn1141

Pellegrino, R., Crandall, P. G., & Seo, H. S. (2016). Using olfaction and unpleasant reminders to reduce the intention-behavior gap in hand washing. *Scientific Reports, 6, 18890*, 1-9. doi:10.1038/srep18890

Pellegrino, R., Crandall, P. G., O'Bryan, C. A., & Seo, H.-S. (2015). A review of motivational models for improving hand hygiene among an increasingly diverse food service workforce. *Food Control, 50*, 446-456. doi:10.1016/j.foodcont.2014.09.015

Peng, M., Chang, L., & Zhou, R. (2013). Physiological and behavioral responses to strangers compared to friends as a source of disgust. *Evolution and Human Behavior, 34*(2), 94-98. doi:10.1016/j.evolhumbehav.2012.10.002

Phan, K. L., Wager, T., Taylor, S. F., & Liberzon, I. (2002). Functional neuroanatomy of emotion: A meta-analysis of emotion activation studies in PET and fMRI. *Neuroimage, 16*(2), 331-348. doi:10.1006/nimg.2002.1087

Porzig-Drummond, R., Stevenson, R., Case, T., & Oaten, M. (2009). Can the emotion of disgust be harnessed to promote hand hygiene? Experimental and field-based tests. *Social Science & Medicine*, *68*(6), 1006-1012. doi:10.1016/j.socscimed.2009.01.013

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods, 40*(3), 879-891. doi:10.3758/BRM.40.3.879

Reicher, S. D., Templeton, A., Neville, F., Ferrari, L., & Drury, J. (2016). Core disgust is attenuated by ingroup relations. *Proceedings of the National Academy of Sciences, 113*(10), 2631-2635. doi:10.1073/pnas.1517027113

Roseman, I. J., Wiest, C., & Swartz, T. S. (1994). Phenomenology, behaviors, and goals differentiate discrete emotions. *Journal of Personality and Social Psychology, 67*(2), 206-221. doi:10.1037/0022-3514.67.2.206

Royet, J. P., Meunier, D., Torquet, N., Mouly, A.-M., & Jiang, T. (2016). The neural bases of disgust for cheese: An fMRI study. *Frontiers in Human Neuroscience, 10*(511), 1-15. doi:10.3389/fnhum.2016.00511

Royzman, E. B., & Sabini, J. (2001). Something it takes to be an emotion: The interesting case of disgust. *Journal for the Theory of Social Behaviour, 31*(1), 29-59. doi:10.1111/1468-5914.00145

Rozin, P., & Fallon, A. E. (1987). A perspective on disgust. *Psychological Review, 94*(1), 23-41. doi:10.1037//0033-295X.94.1.23

Rozin, P., Haidt, J., McCauley, C., Dunlop, L., & Ashmore, M. (1999). Individual Differences in Disgust Sensitivity: Comparisons and evaluations of paper-and-pencil versus behavioral measures. *Journal of Research in Personality, 33*(3), 330-351. doi:10.1006/jrpe.1999.2251

Rozin, P., Lowery, L., & Ebert, R. (1994). Varieties of disgust faces and the structure of disgust. *Journal of Personality and Social Psychology, 66*(5), 870-881. doi:10.1037/0022-3514.66.5.870

Sarabian, C., Ngoubangoye, B., & MacIntosh, A. J. J. (2017). Avoidance of biological contaminants through sight, smell and touch in chimpanzees. *Royal Society Open Science, 4*(11), 1-11. doi:10.1098/rsos.170968

Sato, H., Morimatsu, H., Kimura, T., Moriyama, Y., Yamashita, T., & Nakashima, Y. (2002). Analysis of malodorous substances of human feces. *Journal of Health Science, 48*(2), 179-185. doi:10.1248/jhs.48.179

Schienle, A., Arendasy, M., & Schwab, D. (2015). Disgust responses to bitter compounds: The role of disgust sensitivity. *Chemosensory Perception, 8*(4), 167-173. doi:10.1007/s12078-015-9186-7

Schienle, A., Schafer, A., Stark, R., Walter, B., & Vaitl, D. (2005). Relationship between disgust sensitivity, trait anxiety and brain activity during disgust induction. *Neuropsychobiology, 51*(2), 86-92. doi:10.1159/000084165

Schmitt, B. D. (2004). Toilet training: Getting it right the first time. *Contemporary Pediatrics, 21*(3), 105-122.

Sharvit, G., Vuilleumier, P., Delplanque, S., & Corradi-Dell'Acqua, C. (2015). Cross-modal and modality-specific expectancy effects between pain and disgust. *Scientific Reports,* *5*(17487), 1-14. doi:10.1038/srep17487

Singer, T., Seymour, B., O'Doherty, J. P., Stephan, K. E., Dolan, R. J., & Frith, C. D. (2006). Empathic neural responses are modulated by the perceived fairness of others. *Nature, 439*(7075), 466-469. doi:10.1038/nature04271

Singh, P., Yoon, S. S., & Kuo, B. (2016). Nausea: A review of pathophysiology and therapeutics. *Therapeutic Advances in Gastroenterology, 9*(1), 98-112. doi:10.1177/1756283x15618131

Skolnick, A. J. (2013). Gender differences when touching something gross: Unpleasant? No. Disgusting? Yes! *The Journal of General Psychology, 140*(2), 144-157. doi:10.1080/00221309.2013.781989

Spock, B., & Bergen, M. (1964). Parents' fear of conflict in toilet training. *Pediatrics, 34*, 112-116.

Stafford, L. D. (2017). The role of the chemical senses in disgust’s disease avoidance. *Chemical Senses, 42*(6), 455-456. doi:10.1093/chemse/bjx033

Stark, R., Schienle, A., Sarlo, M., Palomba, D., Walter, B., & Vaitl, D. (2005). Influences of disgust sensitivity on hemodynamic responses towards a disgust-inducing film clip. *International Journal of Psychophysiology, 57*(1), 61-67. doi:10.1016/j.ijpsycho.2005.01.010

Steiner, J. E. (1979). Human facial expressions in response to taste and smell stimulation. *Advances in Child Development and Behavior*, *13*, 257-295. doi:10.1016/S0065-2407(08)60349-3

Stevenson, R. A., & James, T. W. (2008). Affective auditory stimuli: characterization of the international affective digitized sounds (IADS) by discrete emotional categories. *Behaviour Research Methods, 40*(1), 315-321.

Stevenson, R. J. (2009). The psychology of flavour. United Kingdom: Oxford University

Press.

Stevenson, R. J. (2010). An initial evaluation of the functions of human olfaction. *Chemical Senses, 35*(1), 3-20. doi:10.1093/chemse/bjp083

Stevenson, R. J., & Repacholi, B. M. (2005). Does the source of an interpersonal odour affect disgust? A disease risk model and its alternatives. *35*(3), 375-401. doi:10.1002/ejsp.263

Stevenson, R. J., Case, T. I., & Oaten, M. J. (2011). Effect of self-reported sexual arousal on responses to sex-related and non-sex-related disgust cues. *Archives of Sexual Behavior, 40*(1), 79-85. doi:10.1007/s10508-009-9529-z

Sullivan, M. W., & Lewis, M. (2003). Emotional Expressions of Young Infants and Children. *Infants and Young Children, 16*(2), 120-142. doi:10.1097/00001163-200304000-00005

Szczesniak, A. S. (2002). Texture is a sensory property. *Food Quality and Preference, 13*(4), 215-225. doi:10.1016/S0950-3293(01)00039-8

Torta, D. M., Legrain, V., Mouraux, A., & Valentini, E. (2017). Attention to pain! A neurocognitive perspective on attentional modulation of pain in neuroimaging studies. *Cortex, 89*, 120-134. doi:10.1016/j.cortex.2017.01.010

Tybur, J. M., Lieberman, D., Kurzban, R., & DeScioli, P. (2013). Disgust: Evolved function and structure. *Psychological Review, 120*(1), 65-84. doi:10.1037/a0030778

Vartanian, L. R., Trewartha, T., Beames, J. R., Azevedo, S. M., & Vanman, E. J. (2018). Physiological and self-reported disgust reactions to obesity. *Cognition and Emotion, 32*(3), 579-592. doi:10.1080/02699931.2017.1325728

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, 12*(2), 352-362.

doi:10.1093/scan/nsw129

Vlaeyen, J. W., & Linton, S. J. (2000). Fear-avoidance and its consequences in chronic musculoskeletal pain: a state of the art. *Pain, 85*(3), 317-332. doi:10.1016/S0304-3959(99)00242-0

Wager, T. D., Kang, J., Johnson, T. D., Nichols, T. E., Satpute, A. B., & Barrett, L. F. (2015). A Bayesian model of category-specific emotional brain responses. *PLOS Computational Biology, 11*(4), 1-27. doi:10.1371/journal.pcbi.1004066

Waller, K., & Boschen, M. J. (2015). Evoking and reducing mental contamination in female perpetrators of an imagined non-consensual kiss. *Journal of Behavior Therapy and Experimental Psychiatry, 49,* 195-202. doi:10.1016/j.jbtep.2014.07.009

Watson, S. B., & Juttner, F. (2017). Malodorous volatile organic sulfur compounds: Sources, sinks and significance in inland waters. *Critical Reviews in Microbiology, 43*(2), 210-237. doi:10.1080/1040841x.2016.1198306

Whitton, A. E., Henry, J. D., Rendell, P. G., & Grisham, J. R. (2014). Disgust, but not anger provocation, enhances levator labii superioris activity during exposure to moral transgressions. *Biological Psychology, 96*, 48-56. doi:10.1016/j.biopsycho.2013.11.012

Wicker, B., Keysers, C., Plailly, J., Royet, J. P., Gallese, V., & Rizzolatti, G. (2003). Both of us disgusted in my insula: The common neural basis of seeing and feeling disgust. *Neuron, 40*(3), 655-664.

Widen, S. C., Pochedly, J. T., Pieloch, K., & Russell, J. A. (2013). Introducing the sick face. *Motivation and Emotion, 37*(3), 550-557. doi:10.1007/s11031-013-9353-6

Wolfson, J., & Oshinsky, N. S. (1966). Food names and acceptability. *Journal of Advertising Research, 6*(1), 21-23.

Xu, Z., Zhu, R., Shen, C., Zhang, B., Gao, Q., Xu, Y., & Wang, W. (2017). Selecting pure-emotion materials from the International Affective Picture System (IAPS) by Chinese university students: A study based on intensity-ratings only. *Heliyon, 3*(8), 1-16. doi:10.1016/j.heliyon.2017.e00389

Yeomans, M. R., Chambers, L., Blumenthal, H., & Blake, A. (2008). The role of expectancy in sensory and hedonic evaluation: The case of smoked salmon ice-cream. *Food Quality and Preference, 19*(6), 565-573. doi:10.1016/j.foodqual.2008.02.009

Zhong, C. B., & Liljenquist, K. (2006). Washing away your sins: Threatened morality and physical cleansing. *Science, 313*(5792), 1451-1452. doi:10.1126/science.1130726

Appendix A. Study Participant Pool Study Information

Study Information	
Study Name	Tactile cues associated with emotion
Duration	60 minutes
Credits	2 Credits
Abstract	This study aims to look at the emotions elicited by touching different textures
Description	The experiment takes around one hour and we will ask you to touch a range of textures, and make various judgments about them and how they make you feel. You will receive one hour of credit for participation. Location: C3B, Lvl 5 Lab 2 (building to the right of the library)

Appendix B. Tactile-Rating Scales

Please answer all the questions about the OBJECT you have just touched

How sticky was it?	Not at all	Very
How grainy was it?	Not at all	Very
How wet was it?	Not at all	Very
How cold was it?	Not at all	Very
How brittle was it?	Not at all	Very
How viscous was it?	Not at all	Very
How lumpy was it?	Not at all	Very
How warm was it?	Not at all	Very
How hard was it?	Not at all	Very
How oily was it?	Not at all	Very

Appendix C. Affect Rating Scales

For the Disgust and True-Label Group

Please answer all the questions about the OBJECT you have just touched **WHAT YOU TOUCHED** ____________

How SUPRISED did you feel? Not at all — Very

How HAPPY did you feel? Not at all — Very

How DISGUSTED did you feel? Not at all — Very

How SAD did you feel? Not at all — Very

How ANGRY did you feel? Not at all — Very

How SCARED did you feel? Not at all — Very

How PLEASANT was it? Extremely Unpleasant — Neutral — Extremely Pleasant

How likely is it, that you would put the object in your MOUTH? Not at all — Very

How likely are you to TOUCH the object again? Not at all — Very

How SICK would the item make you, if you ATE it? Not at all — Very

For the Visible and No-Label Group

Please answer all the questions about the OBJECT you have just touched

How SUPRISED did you feel? Not at all — Very

How HAPPY did you feel? Not at all — Very

How DISGUSTED did you feel? Not at all — Very

How SAD did you feel? Not at all — Very

How ANGRY did you feel? Not at all — Very

How SCARED did you feel? Not at all — Very

How PLEASANT was it? Extremely Unpleasant — Neutral — Extremely Pleasant

How likely is it, that you would put the object in your MOUTH? Not at all — Very

How likely are you to TOUCH the object again? Not at all — Very

How SICK would the item make you, if you ATE it? Not at all — Very

What do you THINK you touched? ____________

Appendix D: Scree Plot from Factor Analysis


Scree Plot
Eigenvalue
2.0
1.5
1.0
0.5
1
2
3
4
5
6
7
8
9
10
Component Number