

Embodied concept learning as a developmental pathway to social disgust

by

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*"The whole point of the research of the two truths [absolute and relative] is to see
whether there is a way out of the conceptual mind altogether."*

~ Dzigar Kongtrul Rinpoche

ABSTRACT

The body participates in conceptual thought, according to research in the burgeoning paradigm of embodied cognition. Even abstract concepts involve sensory imagery and the reenactment of bodily experiences in which they are rooted. A separate line of research has demonstrated that emotions like social disgust involve bodily experiences that resemble our conceptual understanding of the situations that trigger them. Social disgust involves actual physical disgust. Situations involving nothing physically repugnant can nevertheless evoke nausea and oral revulsion. While such results are predicted by embodiment, embodied cognition has not been established as a causal explanation. The purpose of this research was to explore whether the same learning process that grounds a concept in a bodily experience could be used to create social disgust for a new situation if it were characterized by that same concept. Three necessary factors for embodied concept learning were proposed: (1) an encounter with something physically disgusting, (2) a conceptual interpretation of the disgust, and (3) a recurrence of the conceptual interpretation in a novel social scenario. These factors were presented in two experiments. In both experiments, an encounter with a bad smell was accompanied by one of three concepts explaining its reason for being, and judgments of moral wrongness or unlikability were solicited for scenarios involving the same concepts. Because feelings of physical disgust make social judgments more severe, according to previous research, the judgments served as a probe for social disgust. For the less offensive scenarios, judgments were more harsh when the concept in the scenario had first explained the bad smell, suggesting that embodied concept learning was a pathway to social disgust. Individual

disgust sensitivity, the perceived repulsiveness of the odor, and the number of encounters with the scenario strongly moderated this effect.

INTRODUCTION

In psychological research, emotions are often conceptualized as a basic set of inborn responses to certain physical situations (LeDoux, 1996; Ekman, 1999; Cosmides & Toobey, 2000). Fear, for example, is an emotion involving avoidance or freezing behavior, a release of adrenaline and increased heart rate in response to the sight of a predator or the view from a great height, among other scenarios. Prototypically, the physical features of the external environment directly determine the emotional response, a coherent pattern of behavioral tendencies, physiological changes, and subjective feelings prepackaged since birth.

What this framework does not encompass are the many variegated emotions that arise every day in response to scenarios that have no actual physical reality. Such emotions compose a major portion of human emotional life. Feeling shame, for example, in response to the disappointment of a teacher can happen even if the disappointment is not explicitly represented in the external environment. Rather than expressing disappointment, the teacher might do nothing more than return a paper with a poor letter grade, and the student feels shame. How does the student know to experience shame in this context? Why not frustration or sadness, which might characterize the response of a student in the next seat? How do situations with no immediate physical consequences, situations whose personal significance is primarily abstract, nevertheless evoke bodily sensations and behavioral impulses like those generated by a physical scenario?

To understand the link between the abstract meaning of such scenarios and emotion, researchers in cognitive psychology and cognitive psychotherapy highlighted the importance of thought. Conceptual evaluations, analyses, appraisals, attributions, and other introspective

events entered the equation. Rather than physical scenarios directly triggering emotion, physical scenarios trigger thoughts about those scenarios which then trigger the emotion (Arnold & Gasson, 1954; Arnold, 1960, 1970; Lazarus, 1966; Weiner, 1985; Roseman, 1991; Parkinson & Manstead, 1992; Smith & Kirby, 2001; Abramson et al., 2002). The student thinks about the letter grade, and somehow, those thoughts conjure shame. This meant that changing how one feels is often as "simple" as changing how one thinks (Ellis, 1973; Beck, 1976).

Yet, how do thoughts trigger emotion, and why is it so difficult to separate the two? Thoughts often have an emotion-like quality, and emotions often have a thought-like quality. Sometimes, the emotion seems to come first, and the thought appears to be a byproduct, but if this were the case, what sort of internal processing can transform a scenario with little concrete meaning into a visceral, emotional response?

One framework capable of answering this question is embodiment. Research in embodied cognition suggests that the body participates in conceptual thought (Lakoff & Johnson, 1980, 1999; Barsalou, 1999; Gallese and Lakoff, 2005; Glenberg, 2010; for a review, see Barsalou, 2008). A concept of something physical, such as an apple or a kick of the leg, is wielded using sensory-motor memories of past experiences with apples and kicking (Hauk, Johnsrude, and Pulvermüller, 2004; Tettamanti et al., 2005; Kable, Lease-Spellmeyer, & Chatterjee, 2002). Abstract concepts such as opportunity, responsibility, togetherness, and time also have roots in sensory experience. Time, for example, is often understood using sensory memories of movement through space (Boroditsky, 2000; Boroditsky & Ramscar, 2002). These sensory memories and imagery are facilitated by corresponding bodily activity

(Glenberg & Kaschak, 2002; Stanfield & Zwaan, 2001; Meteyard, Bahrami, & Vigliocco, 2007), giving even abstract concepts a place in the body.

Could some emotional experiences *be* the bodily activity and sensory memory brought forth when an abstract concept is applied to our situation in life? When we perceive social exclusion, we feel physically colder (Zhong & Leonardelli, 2008), and receiving positive regard, which is often conflated with physical affection in early experience, generates feelings of physical warmth (Williams & Bargh, 2008). Social rejection and insults evoke physical pain (Eisenberger et al., 2006). Grave responsibilities, social pressure, and obligations generate feelings of physical weight and heaviness (Lindeman, unpublished experimental data), and believing that one is powerless in an abstract sense to change the outcome of a situation leads to physical sluggishness as though one's physical movement were impeded (Abramson et al., 2002; Lindeman & Abramson, 2008). The following research explores the idea that in some cases, our emotional response to a situation *is* what our concept for that situation feels like (Lindeman, 2007).

Social Disgust: A Test Case

Among those emotional experiences which represent a bodily manifestation of abstract thought, social or moral disgust is perhaps the most pronounced. In social disgust, a strong, acute bodily function—oral repulsion and digestive rejection—is evoked by scenarios which concern nothing physically disgusting. Yet, the scenarios are rife with abstract meaning. Consider these fictional portrayals:

The idea of being a clown recurred to him now, only to fill him with disgust. For frivolity and jokes and spotted tights were an offense, when they intruded themselves upon a spirit that was exalted into the vague august realm of the romantic. No, he would be a soldier, and return after long years, all war-worn and illustrious.

-- Mark Twain in *The Adventures of Tom Sawyer*

"They're too many for us," he whimpered. "We can't fight them all." I turned my back on him in disgust.

-- Jack London in *Tales of the Fish Patrol*

How do things like cowardice or frivolity become disgusting? They lack anything repugnant to the senses, and yet like many other social triggers of disgust, they evoke a response characterized by oral revulsion (Rozin et al., 2000; Vrana, 1993; Izard, 1971; Ekman, 1972; Ekman and Friesen, 1975; Rozin, Lowery, and Ebert, 1994). Physical or "core" disgust arises as a result of bodily contact with foul substances, like tasting something bitter, smelling something rotten, or touching something filthy (Rozin & Fallon, 1987). However, situations with social or moral significance, including abnormal or unethical behavior (Rozin et al., 2000; Haidt, 2003), unfairness (Sanfey et al., 2003; Moretti & di Pellegrino, 2010) and, anecdotally, psychological weakness, desperation, irresponsibility,

excessive emotional expression, callousness, or even unwarranted disdain, can also trigger this physiological response.

Is Social Disgust Really Disgust?

The disgust response to such scenarios is not just an expression. Research suggests that behaviors like cowardice and inappropriate silliness really can evoke disgust. Many cultures characterize social disgust using words associated with core disgust (Haidt, Rozin, McCauley, & Imada, 1997), implying that the choice of words is driven by more than poetic license.

Neuroimaging studies provide more compelling evidence. The physiology of social disgust resembles core disgust (Moll et al., 2005; Zhong & Liljenquist, 2006; Borg, Lieberman, & Kiehl, 2008; Schnall et al., 2008; Danovitch & Bloom, 2009). Areas of the brain that become active during moral indignation overlap partially with areas of the brain that are active during core disgust (Moll et al., 2002, 2005; Harris & Fiske, 2006). In a computerized economic game, emotional responses to disdainfully unfair offers activated areas of the anterior insula specifically associated with core disgust (Sanfey et al., 2003).¹ Similarly, in contrast to a sad or neutral mood, disgust makes people more likely to reject an unfair offer (Moretti & di Pellegrino, 2010).

¹ The left anterior insula is also active during the observation of facial expressions of disgust (Phillips et al., 1997; Wicker et al., 2003). Stimulation of this area of the anterior insula leads not only to feelings of nausea and sickness (Penfield & Faulk, 1955) but unpleasant sensations in the mouth and throat (Krolak-Salmon et al., 2003).

Using facial EMG, Chapman et al. (2009) demonstrated that unfair treatment in an economic game activates the levator labii muscle involved in oral revulsion.

Social disgust also evokes an urge to get clean, a behavioral tendency associated with core disgust. Zhong and Liljenquist (2006) asked research participants to recall an ethical or unethical deed from their past and describe their emotional response. Following this activity, they asked participants to complete word fragments. Those who recalled an unethical deed were more likely to produce words associated with physical cleansing (e.g., W _ _ H as WASH as opposed to WISH). In their second study, participants hand-copied a short story written in the first person describing an ethical or unethical act. Those who copied the unethical act rated cleansing products (e.g., Dove shower soap) more highly than those who copied the ethical act. In the third study, participants were offered their choice of an antiseptic cleansing wipe or a pencil following the recollection of an ethical or unethical deed. Participants who recalled the unethical deed were more likely to choose the antiseptic wipe (67%) compared to participants who recalled an ethical deed (33%). In their final study, they found that physical cleansing mitigates the need to compensate for immoral behavior. Participants who cleaned their hands after recalling an unethical deed were less likely to volunteer for another study. They also felt less moral disgust.

Further support that social disgust involves physical disgust comes from the finding that core disgust makes social judgments more severe. Wheatley and Haidt (2005) gave research participants posthypnotic suggestions to feel nausea and core disgust upon seeing an arbitrary word. When participants were later asked to rate the moral wrongness of characters in short vignettes, the vignettes evoked harsher judgments when they included the arbitrary

word. If social judgments are influenced by one's emotional response, and the experience of core disgust is attributed to the social situation at hand, that core disgust might be experienced as social disgust, a perception reflected in the ensuing judgments. The presence of an ambient foul odor also leads people to judge social scenarios as more morally wrong (Schnall et al., 2008). This effect is stronger for those who score high on measures of bodily sensitivity.

Why Are Social Scenarios Disgusting?

The above evidence, while showing that social disgust involves physical disgust, leaves open the question of why. Why would a social scenario that has no real power to impact the physical body evoke a response designed to protect the body from disease and decay (Pinker, 1997)? How does an emotion like social disgust come to be?

Currently, there are three major hypotheses for social disgust: the intuitive explanation, evolutionary preadaptation, and cultural learning. Perhaps the first explanation for social disgust that comes to mind, or the implicit explanation that exists prior to curious inspection, is that disgust functions broadly to keep us away from things that might harm us either physically *or* abstractly (Kass, 2002; Miller, 1998). Both rotten food and excessive frivolity threaten our constitution, or who we are, and so they both evoke disgust. Perhaps the presence of a clown could penetrate and corrode one's heightened sense of exaltation. However, this begs the question. How do we know if something like frivolity poses a threat to the soul or psyche analogous to that of a molding pear or decaying carcass? Further, why does the equivalence seem so obvious?

The evolutionary explanation goes a step further, spelling out what the intuitive explanation takes for granted. In evolutionary preadaptation, a pre-existing response is co-

opted for a new situation. Essentially, according to this view, we are born with a genetic predisposition to find certain social behaviors, such as violent crime or incest, disgusting (Rozin et al., 2000; Haidt, 2003; Rozin, Haidt, & McCauley, 1993). Not all instances of social disgust necessarily owe their existence to evolution, however. In particular, scenarios that lack strong physical triggers (i.e., gratuitous exposure to bodily fluids) are not as elegantly accounted for by evolutionary preadaptation.

Cultural learning is another mechanism by which social disgust might arise. When others in society such as parents or peers demonstrate disgust with a certain social scenario, one learns that disgust is the appropriate response to that scenario (Rozin et al., 2000; Stevenson et al., 2010). Still unanswered, however, is why certain scenarios are originally deemed disgusting. The above explanations also focus little on individual differences regarding which scenarios evoke social disgust. If politics is any indication, individual differences may eclipse our commonalities. What appears as a threat to one person may not appear threatening to another. Witnessing dehumanizing behavior in a leader, for example, might evoke disgust in one person, sadness in another, and a giddy sense of determination in someone else.

A fourth explanation, the one explored here, is that social disgust reflects the considerable role of bodily experience in the development of abstract concepts. Through *embodied concept learning*, when a concept arises, the bodily experiences around which it was formed arises along with it.

Embodied Concept Learning

The embodied concept learning (ECL) hypothesis offers one possible developmental account of social disgust. According to this hypothesis, encounters with foul substances are accompanied by thoughts about the encounter or simple perceptions of the broader context, and these thoughts or perceptions are fused with the sensory experience of the foul substance to form a concept. The concept becomes a single unit joining both the sensory experience and one's thoughts about that experience. In an encounter with a bad smell or rotten taste, one might have thoughts about how the encounter came about, what caused the foul substance to appear, what the intentions were of those involved, and other evaluations of the meaning or significance of the experience. Perceptions might include, for example, mental comparisons between the smell and related memories, familiarity or perplexity, or the recognition of a match or mismatch between experience and expectation. The resulting concept is an amalgam of thoughts or perceptions and sensory-motor memories of the bad smell or rotten taste. The concept of abnormality, for instance, might form while eating a bowl of grapes. Noticing that some of the grapes are misshapen or discolored compared to the others, then eating one and discovering its bitter taste, the conflation of bitterness and atypical shape contributes to a concept of abnormality in which atypicality in any form is fundamentally something repugnant.

Later, when one encounters a new scenario that involves only the thoughts or perceptions from the original experience, the embodied concept is summoned, and the sensory-motor memories of the foul substance are summoned as well. For example, the perception of atypicality in someone's beliefs or mannerisms would evoke sensory memories

of the bitter grape and trigger oral revulsion, especially if the atypicality involved, like the bitter grape, a feeble version of the standard form. The result is a reenactment or simulation of core disgust in response to a new scenario that involves nothing physically disgusting.

In contrast to an evolutionary account, embodied concept learning concerns how concepts develop over the lifetime of an individual. ECL was proposed by Lindeman and Abramson (2008) as a causal mechanism for some cases of depression and more broadly for other emotions and mood states evoked by the conceptual rather than physical elements of a situation.² They suggested that ECL explains why concepts of psychological or social powerlessness and the ensuing inability to reach abstract goals lead to the somatic symptoms of depression consistent with a state of physical powerlessness (i.e., psychomotor retardation) and the inability to physically acquire a sensory reward (i.e., anhedonia, or a lack of anticipatory pleasure).

Research in embodied cognition is highly relevant to the study of emotion, because it offers an explanation for how situations with abstract significance evoke the bodily experiences we typically characterize as emotion. The basic tenet of embodiment is that we think with our bodies. Without the contribution of sensory experiences to conceptual thought, thoughts would be pale and skeletal (Lakoff & Johnson, 1999). They would pack less punch. Abstract concepts, in particular, owe much of their flesh to early sensory experiences (Lakoff & Johnson, 1999; Barsalou, 1999). In their theory of conceptual metaphor, Lakoff and Johnson (1980, 1999) proposed that abstract concepts originally develop in conjunction with sensory experience. For example, conceptualizing an increase in quantity as vertical

² In Lindeman and Abramson (2008), embodied concept learning was referred to as metaphor simulation.

elevation, they argue, is rooted in the visual perception of rising piles of objects as more objects are added. Later, increases in quantity are expressed in language in terms of vertical elevation (e.g., "rising prices"). The experiential basis of abstract concepts was further explored by Joseph Grady (1997) and Chris Johnson (1997) who traced the developmental pathways of specific conceptual metaphors, including affection as warmth and theories as physical structures. Thus, in the embryonic stage of an abstract concept, bodily sensations and motor impulses triggered by the situation and thoughts or perceptions about the situation are interdependent facets of the same experience.

Classical Conditioning

Embodied concept learning incorporates elements of classical conditioning, a similar paradigm employed primarily to understand relationships between two or more sensory experiences (as opposed to the relationship between a sensory experience and a thought). As in classical conditioning, the connection of two experiences leads the later recurrence of one to evoke a recurrence of the other. ECL might be considered a special type of conditioning that takes place not between two physical stimuli (e.g., the sound of a bell and the smell of food), as is prototypical in classical conditioning, but between a physical stimulus (a foul odor) and an introspective event (discerning broader aspects of the situation in which the foul odor occurs, a concept or meaning derived from the situation as a whole). The foul substance is akin to the unconditioned stimulus. The introspective event is akin to the conditioned stimulus. Later, recurrence of the introspective event evokes memories of the encounter with the foul substance, which is akin to a conditioned response.

One difference between ECL and classical conditioning lies in how the two experiences are connected. In ECL, the introspective event is a derivative of the sensory experience and its context, whereas in classical conditioning, the conditioned stimulus is not derived from the unconditioned stimulus. Whereas classical conditioning involves a conditioned response (e.g., salivation) to subsequent presentations of the conditioned stimulus (e.g., the bell), in ECL, the final result of the learning process is the formation of a concept that integrates both the physical experience (the encounter with the foul substance, akin to an unconditioned stimulus) and the introspective event (e.g., the notion of failing to meet a social standard, akin to a conditioned stimulus), and this concept can be used to think and reason. In ECL, the sensory experience is raw material for the concept.

Specific Aims

The goal of this research is to create a novel instance of social disgust by inducing embodied concept learning in the laboratory. If the necessary ingredients are present, will an ordinarily neutral social scenario come to evoke disgust? The hypothesized factors necessary to create social disgust using ECL are:

- (1) sensory contact with a foul substance,
- (2) a thought or perception about contact with the foul substance (any introspective event, such as recognition of the broader context, a causal attribution, or a supplied interpretation), particularly any thought about its reason for being, and
- (3) later presentation of a social scenario that does not involve a foul substance but evokes the same thought or perception (due to similar context, causal structure, or interpretation).

To illustrate, imagine a child coming into contact with smelly bodily fluids during a potty accident. The bodily fluids represent the first factor, exposure to a foul substance, and evoke core disgust. The parent chides the child for failing to reach the bathroom in time. The child recognizes disappointment in the parent, and this constitutes the second factor, the child's perception of or thought about the experience. The combination of exposure to the bodily fluids and the perception of disappointment leads to the formation of a new concept, failure to meet a social standard in which memories of disgust are a primary component. The sensory-motor experience of disgust becomes a building block for the concept, something concrete and tangible for the concept to form around. The concept, its fundamental quality or structure, is a combination of both the thoughts and perceptions and core disgust. What does the concept mean? What is it to fail to meet a social standard? After such an experience, it *means* having smelly bodily fluids all over oneself.

Later, his teacher indicates that he did not perform well on a puzzle, and the child perceives disappointment, which represents the third factor, a subsequent scenario that evokes the same thought or perception but has nothing to do with anything smelly. *With that thought, the child experiences disgust with himself.* Because he learned that failing to meet a social standard means being covered in smelly bodily fluids, his perception of social failure would *feel like* being covered with smelly fluids. If his concept of social failure had originated in a different context (e.g., falling from a bike while trying to emulate peers), his perception of social failure would feel different (e.g., aches and pain in his extremities), and arguably, his concept would be fundamentally different as well. His concept would carry different

implications, and instead of motivating him to clean himself, social failure might motivate him to seek rest.

As illustrated above, the prediction for the following two experiments is that the presence of the hypothesized factors for ECL will result in social disgust, demonstrating that those factors are sufficient to make an ordinarily neutral social situation disgusting. Further, social disgust was expected to arise more clearly in individuals with high disgust sensitivity in general. If an encounter with a foul substance evokes greater disgust in an individual, and that encounter involved embodied concept learning, that individual should also demonstrate greater social disgust upon the recurrence of the embodied concept. The hypothesis is that ECL is a *sufficient* pathway to social disgust but not a necessary one. The different theories for social disgust are not mutually exclusive. Therefore, the question is *not* which developmental pathway is the only pathway to social disgust, but rather, is ECL one of them? This approach is neither able nor intended to rule out other explanations for social disgust. Rather, the experiments are intended to offer a demonstration that such a pathway *can* occur under limited laboratory conditions. "Demonstration experiments" were endorsed by Mook (1983) as a method of showing a process *can* happen. Examples of well-known demonstration experiments include the obedience study by Milgram (1974), the Stanford prison experiment (Haney, Banks, & Zimbardo, 1973), and research on learned helplessness by Seligman (1975).

The primary limitation of demonstration experiments is that null results do not necessarily show that the hypothesized process cannot happen or does not happen. Rather, they merely show that the process is unlikely to happen when certain factors are present in the

form and manner in which they were presented in the particular study. A major advantage of demonstration experiments is that they have the potential to reveal new facets of human experience in ways that build theory, and they also serve as more concrete instantiations of the underlying theory that may facilitate further reasoning and future experimentation.

EXPERIMENT 1

To determine whether embodied concept learning is one possible pathway to social disgust, the hypothesized necessary factors were presented in the following experiment.

The First Factor: A Bad Smell

The laboratory room was filled with a bad smell, representing the first necessary ingredient. Three groups of participants were exposed to the bad smell. A fourth group was not exposed to any odor.

The Second Factor: A Thought About the Smell

A simple explanation for the bad smell was provided to each study participant (in the three odor-exposed groups) in the form of an apology note. This was the second ingredient--a thought, perception, or other introspective event regarding the smell. Of course, the participant was not having this thought all on their own. The note explicitly supplied the thought. More precisely, the note gave the odor's reason for being.

Three different notes (i.e., notes A, B, and C) were written to explain the reason for the presence of the odor in the room (see Appendix). Each began with a courteous greeting and an apology for the odor followed by the explanation, which was about two sentences. Note A explained the odor as a consequence of adding something normally expected to help: "The janitor attempted to rid the room of the smell. However, the janitor applied an ineffective cleaning agent that made the odor smell even worse." Note B attributed the persistence of the odor to a lack of resources: "Due to a lack of sufficient resources or expertise, the building manager is unable to properly clean the room at this time." Note C attributed the persistence of the odor to ignorance of its origins: "We cannot determine what is

causing the odor. We have had difficulty identifying the odor or its source and so cannot yet eliminate it from the room." As noted above, a fourth group was not exposed to the bad smell. The remaining participants (exposed to an odor) were randomly assigned to one of three groups which differed according to which note they read.

Multiple notes were used for two reasons. First, it was hypothesized that some concepts would lead to embodied concept learning with an odor more easily than others. Generating explanations that had otherwise neutral emotional significance was difficult, and any existing emotional significance was expected to influence the effect. The idea was to cast a wide net. Embodied concept learning was not expected to occur in all cases with the rather brief, fleeting manipulation. Second, using more than one note made it possible to statistically examine judgment severity by using the non-matching notes as control groups.

The conflation of the bad smell with the explanation in the note was expected to induce the formation of an embodied concept. In this new embodied concept, abstract elements of the explanation would be equated with exposure to a bad smell, and the experience of the bad smell would provide some of the internal structure for the concept. In other words, the smell and the thought would form a conceptual unit that surface together when the concept is evoked later.

The Third Factor: A New Scenario

Finally, after reading the note while sitting in the room with the bad smell, participants were asked to judge the moral wrongness or unlikability of characters in various social scenarios (i.e., the Social Judgment Questionnaire; SJQ-I). Moral wrongness and unlikability were lumped together, because social disgust in this context was presumed to result in either

or both assessments. Either was considered an adequate probe for the hypothesized effect, and the mention of both indicated to the participant that the sought after judgment was not just moral repugnance but repugnance in general.

These social scenarios evoked the same thoughts and perceptions as those provided in the explanation notes. More specifically, they contained the same conceptual interpretation as those provided in the three explanation notes, except the context was entirely different. The scenarios had nothing to do with foul odors (or any other acute sensory experience), nor did they depict behaviors one would ordinarily find disgusting. Instead, the main idea of each scenario was abstract. The scenarios were the third necessary ingredient, later presentation of a scenario that evokes the same thoughts or perceptions.

In general, the presence of a bad smell makes moral judgments for a variety of scenarios more severe (Schnall et al., 2008). This finding provided a useful tool for the exploration of embodied concept learning. What would happen to those judgments if the bad smell were given meaning, a context, or conceptual interpretation? What if some of the scenarios being judged involved that same meaning?

Scenario A contained the same thought or perception as note A. Scenario B contained the same thought as note B, and scenario C matched note C. Each scenario was represented in two different items on the social judgment questionnaire for a total of six items. In one item depicting scenario A, a character makes a disagreement worse by interjecting what typically would be a helpful comment. Like the janitor in note A, the character tries to ameliorate the situation, but instead, the situation worsens. For scenario B, the characters lack the resources or expertise to accomplish a task, and the situation worsens. Similarly, in note B, a lack of

resources meant the persistence of a bad smell. While scenario B described no significant physical consequences to the characters, simply perceiving the lack of resources was expected to conjure up sensory memories of the bad smell. Scenario C involved characters behaving in ways with no apparent explanation.

Each participant received only one note. However, every participant was asked to judge the characters in all three scenarios (two items for each type of scenario for a total of six items). Thus, for each participant, one scenario (two items) matched the apology note while the other two scenarios (four items) did not match the note.

Predictions

The ambient odor was expected to make judgments for all social scenarios more harsh. In addition to this effect, however, the conflation of the odor with a thought or perception was expected to make judgments for certain scenarios even more harsh. If the scenario evoked the same thought or perception as that supplied in the explanation note for the odor (if the scenario *matched* the explanation note), the judgment was expected to be even more harsh than it would have been with the ambient odor alone.

The logic behind this prediction is that scenarios were expected to reactivate the concept previously formed around the ambient foul odor and the explanation for the odor. Reactivation of the concept would include sensory memories of the odor and the associated disgust response. As a result, participants were expected to experience greater core disgust for the characters in the matching scenarios over and above the core disgust evoked by the ambient odor alone and judge the matching scenarios more harshly.

Embodied concept learning following such a brief manipulation was expected to occur primarily in those with high disgust sensitivity or those who found the ambient odor particularly disgusting. Because women are more disgust sensitive than men (Druschel & Sherman, 1999; Haidt et al., 1994), the effect was also expected to differ by gender.

Methods

Participants

Two-hundred forty-seven undergraduate students (168 women) from the University of Wisconsin, Madison, participated for course credit in an introductory psychology class.

Materials

Bad Smell. A combination of limburger cheese, fermented shrimp paste, and clam juice was used to create the bad smell.

Explanation Notes. The explanation notes (A, B, and C) were printed on a half sheet of paper and stapled to the cover of the questionnaire packet supplied to each participant. The participant could not begin the questionnaires without looking at the note and lifting it away from the first page.

The specific explanations were carefully chosen based on several criteria. First, each concept needed to offer a sensible and realistic explanation for how an odor could come about. Incidentally, this represents a major distinction between ECL and conventional conditioning. An example of a concept that would not elegantly fulfill this criterion is gregariousness or taking another perspective. One would be hard pressed to come up with a believable scenario in which gregariousness was the cause of a foul odor (although any

attempts would almost certainly have comedic value). This criterion posed a significant constraint.

Second, concepts with existing moral implications were avoided by considering whether one could reasonably conceive of a situation in which the concept would be positive, admirable, or neutral. For example, adding too much of something can be positive or neutral in reference to work hours (in the United States). Being baffled can be positive or neutral when watching a mystery. Deferring attention can be positive or neutral when writing a manuscript (“sleep on it”).

Third, the concepts needed to be unrelated to one another to minimize conceptual overlap between them. This criterion also posed an enormous constraint. An example of two overlapping concepts would be (a) neglecting something and (b) allowing time for growth. In both situations, time passes in which something goes relatively undisturbed.

Finally, the explanations for each odor were phrased in an emotionally neutral way.

Social Judgment Questionnaire I. The SJQ-I consisted of six items. Each item presented a short character vignette approximately three sentences long. The first and fourth items depicted scenario A. An example of one item: "Kevin attempts to resolve a disagreement among friends. However, instead of helping, his comment only causes his friends to fight more." The second and fifth items depicted scenario B (e.g., "John leads a group discussion, but he does not have enough knowledge or experience to clarify the topic or keep the conversation on track. As a result, the discussion is often haphazard and disorganized."). The third and sixth items depicted scenario C (e.g., "Rick has a strange habit of putting things in the wrong place. He has never been able to understand why he does this.

He cannot remember anything that caused him to learn this bad habit, so it persists to this day."). The SJQ-I corresponds to the third factor discussed in the specific aims, new social scenarios that do not pertain to physical disgust yet evoke the concepts in factor two (i.e., the three explanation notes). The vignettes were written with the goal of simplicity and a minimal focus on tangential concepts. The questionnaire was kept short to avoid the influence that a long questionnaire might have had on the concepts under scrutiny.

Private Body Consciousness. Five items from the Body Consciousness Questionnaire (Miller et al., 1981) were presented. The PBC subscale gauges sensitivity to internal bodily sensations, a factor expected to distinguish those individuals for whom sensory memories of a foul odor would be more readily accessed and consulted in making social judgments. In the study by Schnall et al. (2008), participants who scored higher on the PBC subscale showed a greater effect of ambient odor on morality ratings than those with lower scores.

The items were: "I am sensitive to internal bodily tensions"; "I know immediately when my mouth or throat gets dry"; "I can often feel my heart beating"; "I am quick to sense the hunger contractions of my stomach"; and "I am very aware of changes in my body temperature."

The Disgust Scale-Revised. The 25-item DSR measures sensitivity to disgust (Haidt, McCauley, & Rozin, 1994, modified by Olatunji et al., 2007). Greater sensitivity in core disgust is correlated with greater sensitivity in social disgust. Rozin et al. found positive intercorrelations between different domains of elicitors using their Disgust Scale, which they interpreted as "evidence that the domains converge on a common dimension of sensitivity to

disgust." High sensitivity to disgust was expected to characterize those individuals for whom ECL would occur more readily in this experiment.

Examples of items on this scale include: "It bothers me to hear someone clear a throat full of mucus" and "I never let any part of my body touch the toilet seat in public restrooms."

Procedure

Figure 1 provides a graphic depiction of the design of the experiment by showing the three necessary factors as they occur along a timeline.

Creating a stink. Prior to the arrival of the participant, if the participant was assigned to one of the three groups exposed to the odor, the experimenter prepared the room by mixing the limburger cheese with the shrimp paste and clam juice in a small container. The experimenter hid the container in a filing cabinet adjacent to the table where participants sat during the experiment. Participants in the fourth group were not exposed to any odor.

Supplying the questionnaires. Upon arrival, participants were asked to fill out a series of questionnaires. Attached to the front sheet of the questionnaire packet was one of the three notes which explained the reason for the ambient odor. Participants in the fourth group (that were not exposed to the odor) received a questionnaire packet that was identical in every respect, except no note was attached to the packet.

Immediately after the note, the first full page of the questionnaire packet was a brief set of demographic questions (e.g., age, sex). The second page was the SJQ-I. The SJQ-I was positioned second in order to avoid making the connection between the note and the scenarios too obvious. However, participants encountered the scenarios in the SJQ-I within about a

minute of reading the explanation note, and the intervening questions required little contemplation.

Manipulation checks. After completing the questionnaires in the first packet, participants in the three odor-exposed groups were given questions regarding the odor in the room and the apology note. They were asked, "Did you read the entire note explaining the reason for the bad smell?" Thirty-five participants (9 men and 26 women) indicated that they did not read the note.

At the end of the experiment, participants were also asked, "How disgusting or revolting is the odor?" This variable is subsequently referred to as odor repulsiveness (OR). Responses were given on a scale of 0 to 5 with 0 indicating "not at all disgusting," 1 indicating "slightly disgusting," and 5 indicating "extremely disgusting." Twenty-nine participants indicated that the odor was "not at all disgusting." Experimenters reported, however, that the odor was always highly aversive and overpowering during the first several minutes of the experiment when participants were the reading the apology note, but habituation occurred rapidly. Thus, OR may have functioned more as an indicator of habituation or waning noticability than initial repulsiveness.

Results

Before examining the evidence for embodied concept learning, the first question was whether the bad smell in the room made judgments more severe regardless of which note participants received. The next question was whether judgments were even more severe, over and above the effect of smell, if the concept characterizing the scenario was first provided in

the note to explain the bad smell. This would suggest that social disgust was generated for the scenario as a result of embodied concept learning between the note and the bad smell.

Question 1: Did the bad smell make judgments more severe?

Judgments for items on the SJQ-I were more harsh in the presence of an ambient odor ($t = -2.004$, $df = 215$, $p < .025$, $M = 2$ vs. 1.4) (see Table 1), replicating the findings of Schnall et al. (2008) upon which the experiment was modeled.³ The perceived repulsiveness of the odor (OR) also influenced judgments, with OR ratings above the median (3 or above on a scale of 0 to 5) associated with more severe judgments ($t = -1.85$, $df = 217$, $p < .05$).

Although all participants exposed to a bad smell also received a note explaining it, the note itself was not responsible for the increase in judgment severity. The effect of odor was more dramatic when the non-odor group was compared to participants in the odor groups who indicated that they did *not* read the note ($t = -2.98$, $df = 60$, $p < .005$, $M = 2.5$ vs. 1.4), suggesting that the apology notes actually mitigated the effect of odor on judgment severity. Indeed, among those exposed to the bad smell, average judgments were significantly less harsh for those who indicated that they read the apology note ($t = 2.026$, $df = 217$, $p < .025$, $M = 1.9$ vs. 2.5).

Question 2: Did notes make judgments more severe for scenarios with the same concept?

If embodied concept learning was a pathway to social disgust in this experiment, judgments should also depend on the note for the scenarios matching the note. This would appear first as a statistical interaction between note and scenario. Next, an examination of

³ In this comparison, the three groups exposed to an odor were combined into one.

each scenario individually should reveal the most severe judgments following the matching note and least severe judgments following non-matching notes.

Table 2 presents the means and standard deviations for each scenario for those who received notes A, B, or C.

An interaction between note and scenario. A repeated measures multivariate analysis of variance was conducted with social judgments for the six items in the SJQ-I as the dependent variables. Within subjects factors were Scenario (involving concepts from note A, B, or C) and Item (2 for each scenario). Between subjects factors were Note, Sex, DSR (high or low), and OR (high or low). Following the approach of Schnall et al. (2008), the individual difference variables (in this case, DSR and OR) were split at the median and entered as factors to identify those in whom embodied concept learning was expected to occur more readily. Participants who indicated that they did not read the note were excluded. Participants from the fourth group who did not receive a note at all (or an ambient odor) were also excluded.

The interaction between scenario and note was not significant ($p = .145$). However, several three, four, and five way interactions were obtained. The note influenced judgments of the scenarios at different levels of OR, $F(4,318) = 4.24$, $p = .002$, as well as DSR, $F(4,318) = 2.32$, $p = .057$, and sex, $F(4,318) = 2.4$, $p = .05$, supporting the first statistical prediction. Of particular interest was a four way interaction between note, scenario, OR, and DSR, $F(4,318) = 2.59$, $p = .037$, which is explored in the simple effects analysis below.⁴

⁴ A five way interaction between note, scenario, OR, DSR, and sex was also significant ($p = .03$); however, too few men scoring high on DSR or OR (only 1 or 2 for some groups) prevented a meaningful exploration of the interaction.

Simple effects of note for each scenario. The interaction between note, scenario, OR, and DSR was explored further using independent samples t-tests. For each scenario, judgments following the matching note were compared to judgments following each non-matching note to find out if the scenario showed the hypothesized effect. Given the significant four way interaction involving DSR and OR, these comparisons were performed at each level of DSR and OR (and their possible combinations, e.g., high DSR and high OR, high DSR and low OR, etc.). The hypothesized effect was anticipated for high DSR and/or high OR.

If embodied concept learning took place, judgments for the scenario should be more severe following the matching note compared to non-matching notes. For example, judgments for scenario A for participants who read note A were compared to judgments for scenario A for participants who read note B, then compared to those who read note C. Judgments for scenario A should be more harsh for those who read note A than judgments by those who read either note B or C. Further, judgments for scenario A should not differ significantly between the groups that received notes B and C, because neither note contained the same concept as scenario A.

None of the simple effects comparisons reached significance for scenarios A or B, providing no evidence that embodied learning for the concept in note A (exacerbating a situation with a typically helpful thing) or note B (lacking the resources to remedy a situation) increased disgust for matching scenarios.

For scenario C, reading note C (not knowing the cause of a problem) led to increased judgment severity when the ambient odor was mildly to moderately repulsive (below the

median on OR), consistent with predictions (see Figures 4-6). Table 3 presents the means and standard deviations for judgments of scenario C by note, DSR, and OR. If the ambient odor was perceived as very repulsive (above the median on OR), however, judgments were less severe. This observation depended on disgust sensitivity. Specifically, for those high in disgust sensitivity who found the odor mildly repulsive, judgments were *most* severe following note C compared to note A (for the second item; $t = -2.4$, $df = 19$, $p = .027$), and more severe than note B (for both items; $t = -3.78$, $df = 20$, $p = .001$) (see Figure 7). For those high in disgust sensitivity who found the odor very repulsive, however, judgments did not differ significantly between the notes, failing to support predictions.

In contrast, for those low in disgust sensitivity, participants who found the odor mildly repulsive showed no significant differences, which was expected (see Figure 8). However, contrary to predictions, for those low in disgust sensitivity who found the odor very repulsive, judgments were *least* severe following note C compared to note A (for both items; $t = 3.01$, $df = 25$, $p = .006$) or note B (for both items; $t = 2.25$, $df = 25$, $p = .033$). As predicted, the differences between notes A and B were not significant ($p = .29$) at any level of OR or DSR.

Judgments for scenario C offer mixed evidence that embodied concept learning occurred between the bad smell and note C. Of relevance, scenario C differed from the other scenarios in one crucial way. The goal of the experiment was to evoke disgust for behaviors one would not ordinarily consider morally wrong or unlikeable. Otherwise, whatever learning takes place is compounding or muddling prior learning. Scenario C came closest to this ideal. For judgments by those in the fourth group who were not exposed to a bad smell or an

apology, a repeated measures MANOVA revealed a significant main effect of scenario, $F(2,22) = 6.43, p = .006$. Judgments for scenario C were less severe than either scenario A, $F(1,23) = 8, p = .01$, or scenario B, $F(1,23) = 12.62, p = .002$. In the multivariate test, the scenarios were not judged with equal severity regardless of which note the participant received, as evinced by a main effect of scenario, $F(2,158) = 26.4, p < .001$ (see Table 1). Scenario C was judged least severely, while scenarios A and B were judged most severely. Scenarios B and C were not significantly different from one another ($p = .171$).

Disgust Sensitivity as a Moderator

The influence of disgust sensitivity on the scenario by note interaction was in accord with its influence on judgments in general. There was also a main effect of DSR, $F(1,159) = 6.61, p = .011$, with higher disgust sensitivity associated with harsher judgments. In the presence of an ambient odor, average judgments were more harsh for those who scored above the median on the DSR ($t = -2.29, df = 216, p = .023, M = 2.26$ vs. 1.77). Of note, disgust sensitivity overlapped with gender. Women were more disgust sensitive than men, according to scores on the DSR ($M = 57.74$ vs. $45.92, t = -5.86, df = 244, p < .001$). Women also rated the ambient odor as more repulsive ($M = 2.64$ vs. $1.93, t = -3.43, df = 218, p = .001$). Not surprisingly, the effect of the bad smell on judgments was only significant in women. In women, average judgments for all scenarios were significantly more harsh in the presence of an odor ($t = -2.406, df = 150, p = .017$), while in men, the difference was not significant ($t = -.147, df = 63, p = .883$).

Discussion

With a bad smell in the room, a variety of behaviors were judged as more morally wrong and unlikeable, reproducing the findings of Schnall et al. with scenarios that were rather non-offensive. In addition to this effect, despite the fleeting nature of the concept learning manipulation and its competition with the main effect of the odor, one of the three scenarios showed evidence of social disgust arising as a result of embodied concept learning, providing partial support for the ECL hypothesis. Baffling behavior was judged more severely when, just prior to making their judgments, participants learned that bafflement can be the *raison d'etre* for a bad smell.

Disgust sensitivity and odor repulsiveness moderated this effect. For highly disgust sensitive individuals who found the odor mildly to moderately repulsive, judgments were *most* severe when the bad smell was conflated with bafflement. If, however, these highly disgust sensitive individuals found the odor highly repulsive, judgments were not significantly higher. An attribution effect might explain these results. The perceived repulsiveness of the odor, possibly an indication of waning salience or habituation to the smell, may have determined whether participants attributed feelings of disgust to the character in the scenario or the odor in the room, especially since the scenarios were rather non-offensive. If feelings of disgust were attributed to the odor as opposed to the scenario, those feelings would have guided judgments to a lesser degree. This phenomenon has been well documented in research on the misattribution effect (Murphy & Zajonc, 1993). Attitudes are influenced by extraneous factors primarily when the source of the influence goes unidentified (Schwarz & Clore, 1983; Jacoby, Kelley, & Dywan, 1989; Winkielman, Zajonc, & Schwarz, 1997).

According to the attribution literature, if people are aware of the extraneous influence on their attitudes, they tend to correct their judgments, often reversing them altogether (Strack, Schwarz, Bless, Kubler, & Wanke, 1993; for reviews, see Martin, Seta, & Crelia, 1990; Wegener & Petty, 1997; Wilson & Brekke, 1994). This was observed in individuals who found the odor very repulsive but were low in disgust sensitivity. Their judgments were the *least* severe, suggesting that they overcorrected for its influence.

One possible explanation for the effect of the bad smell on social judgments is a simple mood effect. Were participants more judgmental because they were feeling disgust or simply negative affect? This issue was addressed by Schnall et al., who found that sadness actually has the opposite effect and leads to judgments that are less harsh than either disgust or a neutral mood. A neutral mood also resulted in judgments that were less harsh than disgust. Based on this finding, a mood effect was not considered the most likely explanation for the influence of either the bad smell or embodied concept learning on judgments.

The remaining question is why the other two scenarios showed no effect. Embodied concept learning was not expected to occur with the same ease and strength for all concepts, hence the use of multiple concepts. Not all concepts make a sensible explanation of a bad smell. In particular, embodied concept learning was predicted to occur most strongly for scenarios with little pre-existing emotional meaning or aversiveness. The two scenarios showing no effect were both judged more harshly on average, while the scenario that did show an effect was rated very low on average.

Overall, results suggest that for certain behaviors, in those with sufficient sensitivity, embodied concept learning may be a pathway to social disgust.

Limitations

The primary limitation in this experiment is that the second hypothesized factor for embodied concept learning, the thought about the odor, was presented in the form of an apology. Judgments were not as severe when the individual read the apology note, an influence running counter to that of the ambient odor. This influence may have dimmed the very judgments that would have been more severe as a consequence of concept learning.

A related limitation in this experiment was the presence of the ambient odor *during* social judgments. While this constituted a powerful manipulation in the experiments by Schnall et al., the primary manipulation in this experiment occurred the moment the participant read the note explaining the ambient odor. The persistence of the odor during the social judgment phase may have influenced the sensitivity of judgments to prior concept learning.

Another limitation was the possibility of overlap between the concepts in the note in reference to the items under judgment. For example, the concept in note C involved not knowing the origins of an experience. However, the first item in scenario B, which was written with the intention of depicting a lack of resources, also involves not knowing. Conceptual overlap was investigated in the next experiment.

The demand characteristics of the experiment may have influenced judgments in certain ways. The effect of the apology may have represented participants' guess as to the desired or intended judgments. However, the increase in judgment severity for some scenarios and not others, based on the concept in the note, ran counter to this demand. Nevertheless, some participants may have responded with more severe judgments for scenario

C after reflecting on its conceptual relationship with note C and presuming that severity was the desired outcome.

Another limitation is that each participant was only exposed to one note, introducing a possible priming effect among those factors influencing judgments.

Participants in the no odor group all participated towards the end of the sampling period, because it would have been difficult to clear the room of the bad smell between the thirty minute sessions, which were often run contiguously.

Finally, although a short judgment questionnaire seemed ideal, with only two items depicting each scenario, if participants judged any one item more or less harshly based on tangential factors, the overall analysis would likely be sensitive to that.

EXPERIMENT 2

A second experiment addressed key limitations in the first. In this experiment, each participant was exposed to all three concepts, but only one of the concepts was conflated with a foul odor. Further, the concept was not presented in the form of an apology, and the bad smell was not an ambient odor, which meant that the bad smell was not present while the participant made their judgments. Finally, the number of items on the social judgment questionnaire representing each scenario was doubled.

The First Factor: A Bad Smell

A bad smell was delivered in a small glass jar placed on a table in the laboratory room. Two additional jars contained a neutral or slightly pleasant odor. All three groups of participants were asked to smell the contents of all three jars.

The Second Factor: A Thought About the Smell

Each jar was accompanied by one page of simple questions about the odor in the jar, such as "How disgusting or revolting is the odor?" At the top of this page was a short paragraph describing the contents of the jar which entailed a basic concept. This was the second ingredient—a thought, perception, or introspective event regarding the smell. Beyond a simple temporal pairing, the concept was *conflated* with the odor by explaining its reason for being. In this way, the concept was the context for the sensory experience.

The concepts were modified for this experiment in order to accommodate the different manner in which the odor was presented. The same criteria used to select conceptual explanations in experiment 1 were used for experiment 2 with the addition of one other. The explanation needed to be applicable to either a bad smell or a neutral or slightly pleasing

smell. Concept A involved adding too much of something that would normally ameliorate a situation (i.e., overdoing something). Concept B involved an inability to understand the situation (i.e., being baffled). Concept C involved setting something aside (i.e., deferring attention). Specifically, for the concept A, the paragraph read: "This jar contains substance Y. Normally, when substance X is added to substance Y, the odor of substance Y disappears. However, this odor resulted when way too much of substance X was added." For the concept B, the paragraph read: "Lab personnel did not know how this odor was created or where it came from. Although they attempted to find out, they could not determine the process that produced it. As a result, they could not eliminate the odor, and the odor persisted." For the concept C, the paragraph read: "This smell was purposely generated by placing a substance in an ordinary storage unit for just one week at room temperature."

In one group, the page with concept A was presented with the jar containing the bad smell. In the second group, concept B was presented with the bad smell. In the third group, concept C was presented with the bad smell. In all groups, the other two remaining concepts were presented with the other two jars whose contents were identical and non-offensive. Thus, the groups differed according to which concept was conflated with the bad smell.

The Third Factor: A New Scenario

As in the first experiment, participants were asked to judge the moral wrongness or unlikability of characters in various social scenarios. The scenarios evoked the same thoughts and perceptions as those provided in the odor descriptions, representing the third necessary ingredient for social disgust.

A new social judgment questionnaire was created with four items per scenario instead of just two (see Appendix).

Methods

Participants

One hundred and thirty-eight undergraduate students (97 female) from the University of Wisconsin, Madison, participated for course credit in the introductory psychology class.

Materials

Odors. Three jars contained substances for the participant to smell. One jar contained a mixture of limburger cheese, fermented shrimp paste, and clam juice (a mixture identical to that used in experiment one). The other two jars contained vanilla extract. The jars were wrapped in opaque, blank, white labels, and a small, white coffee filter was placed in the top of the jar to hide the substance from view.

Odor Questionnaire. Each jar was accompanied by a single page of questions which began with a few sentences explaining how the odor came to be. Immediately after the odor description were instructions for the participant to (1) "open the jar," (2) "sniff the odor in the jar," and (3) "read the above paragraph as you are smelling the odor, then answer the questions that follow." The participant was asked to check a box to indicate that they read the paragraph while smelling the odor.

The participant was also asked, "How disgusting or repulsive is the odor?" Responses were given on a scale of 0 to 5 with 0 indicating "not at all disgusting," 1 indicating "slightly disgusting," and 5 indicating "extremely disgusting." Responses associated with the jar

containing the bad smell, split at the median, provided a measure of odor repulsiveness (OR) akin to that in the first experiment.

Social Judgment Questionnaire II. After exposure to the odors, participants were given a questionnaire in which they were asked to judge 13 short descriptions of someone behaving in a particular manner. The first item held no relation to any of the three concepts. The remaining 12 items depicted the three scenarios. In scenario A, characters performed a behavior characterized by concept A (e.g., "He attempts to resolve a disagreement between two people. However, instead of helping, his comments only cause his friends to disagree more."). In scenario B, characters performed a behavior characterized by concept B (e.g., "He cannot determine how his habit originated. Consequently, he is having trouble breaking the habit."), and in scenario C, characters performed a behavior characterized by concept C (e.g., "He intentionally created the tricky situation after he set aside the project for some time.").

The order in which items were presented did not vary across subjects. However, no consecutive items presented the same scenario. For each scenario, two items involved a male character, and two items involved a female character.

Questionnaire Upon Mental Imagery. Participants were given the shortened form of Bett's Questionnaire Upon Mental Imagery (QMI; Sheehan, 1967), which asks respondents to gauge their vividness of imagery for items in each of the five sensory modalities as well as internal sensations using a rating scale from 1 to 7, with 1 indicating "perfectly clear and as vivid as the actual experience" and 7 indicating "no image present at all, you're only 'knowing' that you are thinking of the object." Examples of rated items include "an ill-ventilated room," "roast beef," and "hunger."

Eysenck Personality Questionnaire. Participants completed the Neuroticism subscale of the Eysenck Personality Questionnaire (EPQN; Eysenck & Eysenck, 1968).

Conceptual Relatedness Questionnaire. In the Conceptual Relatedness Questionnaire (CRQ), participants were asked to rate the degree to which each item was an example of each concept. Specifically, they were asked to read each paragraph originally provided with the three jars and "indicate the degree to which the scenario is related to the paragraph" and "consider how the BEHAVIOR OR TRAIT described is CONCEPTUALLY RELATED TO or REPRESENTATIVE OF the ideas in the paragraph. In other words, to what degree is the scenario an example or instance of the idea in the paragraph?" Possible responses ranged from 0 for "not at all related" or 1 for "very slightly related" to 10 for "extremely related, a perfect example." An example paragraph with responses to two items was provided to illustrate.

Additional questionnaires. Participants also completed the DSR (see Experiment 1).

Procedure

Participants were randomly assigned to one of the three groups. The study had two parts: (1) an embodied concept learning experience involving the three jars and (2) social judgments. Participants were told that each part of the experiment represented two consecutive research experiments conjoined for the convenience of the researcher. In part one, the experimenter paired the three odor question sheets with the appropriate jars and asked the participants to follow the instructions supplied with each sheet. In part two, participants completed a questionnaire packet which began with brief demographic questions, followed by

the SJQ-II and the additional questionnaires, and ending with the conceptual relatedness questionnaire.

Figure 9 provides a graphic depiction of the experimental design. Of note, all participants encountered all three concepts, but groups differed based on which concept was provided with the bad smell. For each group, one concept was provided with the bad smell, and the other two were paired with the vanilla extract.

Results

Judgments for the three scenarios in the SJQ-II were explored in order to answer one primary question. For each scenario, were judgments more severe when the concept in the scenario was first encountered as the reason for a bad smell?

Perceptions of Conceptual Relatedness

Before gauging the effect of conceptual learning, whether participants perceived a relationship between the concepts describing the odors and the scenarios was a vital concern. If participants were able to see a relationship, the scenarios would function adequately as the third hypothesized factor for embodied concept learning (a new scenario involving the same thought or perception as that conflated with the bad smell). If, however, the participants were not able to see a relationship, the scenarios were not expected to evoke the appropriate concepts with their associated smell memories, and any effects of embodied learning would go undetected.

On a scale from 0 to 10, with 0 indicating "not at all related" and 10 indicating "extremely related, a perfect example," the average rating of relatedness between concept A and items in scenario A was high ($M = 7.95$). The average for scenario B and concept B was

8.33, and the average for scenario C was 7.9. The overall average rating of relatedness between matching concepts and scenarios was 8.06 ($SD = 1.42$). In contrast, the average rating of relatedness between concepts and non-matching scenarios (that were not written to depict that concept) was 2.85 ($SD = 1.56$). These ratings were accepted as sufficient indication that the concepts and scenarios served their intended roles.

Were judgments more severe when the concept in the scenario first explained a bad smell?

A repeated measures MANOVA was conducted with judgments on the SJQ-II as the dependent variables. Within-subjects factors were Scenario (A, B, or C) and Trial (participants encountered each scenario four times). Between-subjects factors were Concept (A, B, and C), Sex, DSR (high or low), OR (high or low), QMI (high or low), and EPQN (high or low). Following the approach of Schnall et al. (2008), the individual difference variables (in this case, DSR, OR, QMI, and EPQN) were split at the median and entered as factors to identify those in whom embodied concept learning was expected to occur more readily. Twenty-two participants were excluded for failing to indicate that they read the concept in the paragraph supplied with the foul odor.

Table 4 presents the means and standard deviations for each scenario for the three concept groups. Judgments for the three scenarios were influenced by which concept described the bad smell. Numerous significant three, four, and five way interactions were obtained involving concept and scenario. For example, the effect of concept on judgments by scenario varied as a function of disgust sensitivity and reported vividness of imagery (QMI), $F(4,112) = 2.92$, $p = .025$. Neuroticism (EPQN) also influenced judgments in a five way interaction between concept, scenario, DSR, and OR, $F(2,55) = 5.47$, $p = .007$.

The number of times the scenario was encountered (four times each) heavily affected judgments. This was evident in a main effect of trial, $F(2,54) = 8.23, p < .0001$. Judgments were low to moderate for the first encounter of each scenario (with no significant difference between the first and second encounters), peaked in severity on the third encounter, and dropped on the fourth, according to the within-subjects contrast, $F(1,56) = 17.09, p < .0001$. The effect of trial arose in several five and six way interactions involving concept and scenario. Of particular interest was an interaction between concept, scenario, trial, DSR, and OR, $F(12,104) = 2.67, p = .004$, which is explored further in the simple effects analysis below, as well as an interaction between concept, scenario, trial, DSR, and sex, $F(6,51) = 2.67, p = .025$.

As in experiment 1, the scenarios were not judged with equal severity regardless of condition. There was a main effect of scenario, $F(2,55) = 44.23, p < .0001$. Average judgments were highest for scenario C ($M = 3.9$ vs. 2.38 for scenario A and 2.09 for scenario B) which depicted concept C, the deferral of attention, a behavior that could be construed as negligence. Thus, scenario C did not involve ordinarily non-offensive behavior. There was no main effect of concept.

Simple effects. Each scenario was examined individually using independent samples t-tests to explore the interaction between concept, scenario, trial, and DSR with OR (Figure 10) and sex (Figure 11). The following analyses focused on participants at those levels of DSR, OR, and sex for which embodied concept learning was expected to occur: high DSR, high OR,⁵ and women. Embodied concept learning was expected to be more evident in women

⁵ Because the odor was not ambient, the attribution effect observed in experiment 1 was not anticipated.

than in men for a variety of reasons. Women perceived a stronger relationship between concepts describing the smell and their matching scenarios ($t = -2.37$, $df = 136$, $p = .019$) but not for non-matching scenarios ($p = .38$). Women also scored higher on the DSR ($M = 58$ vs. 47 , $t = -3.91$, $df = 134$, $p < .0001$), the EPQN ($M = 11$ vs. 9.4 ; $t = -1.88$, $df = 136$, $p = .06$), and the QMI ($t = -2.71$, $df = 136$, $p = .008$), and rated the foul odor as more disgusting and unpleasant ($t = -2.25$, $df = 136$, $p = .03$).

For the sake of clarity, groups are referred to as group A, B, or C, indicating which concept was provided with the bad smell. For group A, for instance, concept A described the bad smell, and concepts B and C described the vanilla extract in the other two jars. Table 5 presents the group means and standard deviations for each item in each scenario for those who scored high on DSR and OR.

For scenario A, for those who scored high on the DSR and OR, judgments were more severe for the third trial for group A compared to group B ($t = 1.82$, $df = 35$, $p = .04$, one tailed) or compared to group C (for all trials; $t = 2.09$, $df = 24$, $p = .02$, one tailed), supporting predictions (see Figure 10). Also consistent with predictions, judgments did not differ significantly between groups B and C except for the fourth trial. On the fourth trial, judgments for group C were below groups A and B.

For scenario B, for those who scored high on the DSR and OR, judgments were more severe on the fourth trial for group B compared to group C ($t = 2.14$, $df = 27$, $p = .02$, one tailed). This was also true of women who scored high on the DSR, with a marginal difference on the third trial ($p = .12$). Collapsing across all trials, judgments were more severe for scenario B for group B compared to C ($t = 1.72$, $df = 26$, $p = .05$), supporting predictions.

Judgments were also more severe for the third and fourth trials for group B compared to group A (for women who scored high on the DSR; $M = 3.6$ vs. 2.68 and 3 vs. 2.68 respectively; see Figure 11). However, this trend was not statistically significant ($p = .14$ and $.31$ respectively). In comparing groups A and C, no difference was predicted, because neither concept A nor C characterize scenario B; however, for the second and fourth trials, judgments for group C were below A ($t = 1.72$, $df = 28$, $p = .05$, and $t = 1.67$, $p = .05$).

For scenario C, for those who scored high on the DSR and OR, judgments were least severe for group C compared to groups A and B (for the second and fourth trial), contrary to predictions. However, judgments among all three scenarios were less severe for group C, making interpretation difficult in this case. For a better understanding, the interaction between concept, scenario, DSR, OR, and EPQN ($p = .007$) is revealing. For those who scored high in disgust sensitivity, odor repulsiveness, and neuroticism, average judgments for *all* items on the SJQ-II were less severe for group C (A vs. C: $t = 2.7$, $df = 12$, $p = .009$; B vs. C: $t = 2.12$, $df = 17$, $p = .02$).⁶ This relationship was true for all scenarios, with the greatest mean differences occurring for scenario C. In other words, although scenario C led to the most severe judgments, group C made the least severe judgments across all scenarios, especially scenario C (for the high DSR, high OR participants), suggesting that whatever effect concept C had on judgments in general was magnified for judgments of scenario C. Returning to the simple effects analysis for scenario C, there were no significant differences between groups A and B.

⁶ The differences remained significant when those low in neuroticism were included.

Discussion

The evidence for embodied concept learning in this experiment is slight and mixed. The number of encounters with the scenario under scrutiny mattered considerably with judgments generally increasing in severity. The increase in severity may represent a repeated exposure effect. Although repeated exposure to a stimulus, including people or faces, generally increases positive regard (c.f., mere exposure effect), merely thinking about an attitude tends to make that attitude more extreme (see Tesser, 1978 and Tesser, Martin, & Mendolia, 1995, for reviews) and repeated expressions of attitudes in group discussions can lead to attitude polarization (Brauer, Judd, & Gliner, 1995). This same process may have led to the strong trial effect.

Judgments were most severe on the third encounter of each scenario. Here, concept learning was evident for two scenarios in those with high disgust sensitivity who found the odor very repulsive. The act of adding too much of something typically mitigating was judged as more morally wrong and unlikable after adding too much of a typically mitigating substance was explained as the cause of a bad smell. A weak trend towards more severe judgments arose in women with high disgust sensitivity for behaviors involving bafflement, or an inability to determine the origins of a problem, when the bad smell was attributed to an inability to determine the process that produced it.

When the bad smell was said to result from setting the substance aside, the effect on judgments was unusual. In this group, for those high in disgust sensitivity, all judgments were less severe. One possible explanation lies in the fact that the odor was "purposely generated," according to this description. The recognition of intention may have reduced

negative affect for the odor and ameliorated any tendencies towards condemnation.

Nevertheless, behaviors that involved setting something aside were judged most severely on average regardless of which concept described the bad smell.

Limitations

Unlike the apology notes in experiment 1, the jars and their corresponding descriptions in this second experiment lacked the same real world, personal significance for participants. Personal significance is central to how situations evoke emotion (Lazarus, 1991).

The mode of presentation for the bad smell also introduced an element of scientific inquisitiveness, which may have affected the disgust response in unusual ways. Consider, for example, the following quote from *The Lost World*, by Arthur Conan Doyle, in which scientific curiosity is conflated with exposure to a tick:

My trouser had slipped up, exposing a few inches of my skin above my sock. On this there rested a large, purplish grape. Astonished at the sight, I leaned forward to pick it off, when, to my horror, it burst between my finger and thumb, squirting blood in every direction. My cry of disgust had brought the two professors to my side.

"Most interesting," said Summerlee, bending over my shin. "An enormous blood-tick, as yet, I believe, unclassified."

In this scene, scientific curiosity is conflated with the calm visual examination of something ordinarily repugnant. The ECL hypothesis predicts that later occurrences of objective curiosity for mildly aversive situations, even those that lack physical substance (e.g.,

contemplating the psychological motivations of a criminal) will evoke sensory memories of such physical encounters. However, if the objectivity afforded by scientific curiosity originally allayed a powerful disgust response, the sensory memory entails not just disgust but the ensuing relief.

GENERAL DISCUSSION

How the personal significance of a situation gives rise to emotion is intuitive yet extraordinary. A situation with no physical consequences may nevertheless evoke physical pain, perceptions of warmth or heaviness, crippling fatigue, or nausea in virtue of its abstract meaning, which often seems intrinsic to the situation itself (Zhong & Leonardelli, 2008; Williams & Bargh, 2008; Eisenberger et al., 2006; Zhong & Liljenquist, 2006; Lindeman & Abramson, 2008). To explore this process more deeply, the goal of this research was to make a thought or interpretation of a given situation evoke a bodily response that would be experienced as an emotion. To clarify, the idea was *not* to make a situation evoke a different emotion in virtue of having a different interpretation but for the same thought or interpretation to actually feel differently. According to embodied concept learning, this happens when the concept characterizing a new situation was originally formed in conjunction with a physical experience that evoked that bodily response. As the new situation evokes the concept, the bodily response contributing to its internal structure is also evoked, and this bodily response *is* the emotion.

Results from both experiments faintly suggested that embodied concept learning could be a pathway to social disgust for certain otherwise non-offensive behaviors. In the first experiment, for individuals with high disgust sensitivity, social disgust was generated for baffling behavior when bafflement was given as the reason for the bad smell in the room. However, if the odor was considered very repulsive by the conclusion of the experiment, this effect was not observed, and for those low in disgust sensitivity who found the odor very repulsive, the reverse was actually true, suggesting that judgments were toned down when the

odor was identified as an influence, a result consistent with the misattribution literature. In the second experiment, social disgust may have been generated for two behaviors as a consequence of embodied concept learning, but the effects were faint, apparent only in those with high disgust sensitivity who found the odor very repulsive or in women with high disgust sensitivity, and depended greatly on increasing encounters with the scenario. In both experiments, the hypothesized effect was most evident in those scenarios which were viewed as less morally wrong, suggesting that brief concept learning is more influential for situations that have no pre-existing emotional significance.

As an early demonstration experiment aiming to illuminate the intricacies of an uncharted process, these results, though meek, met expectations. Multiple odor descriptions were employed in the hopes that at least one would induce the formation of an odor-embodied concept potent enough to generate disgust for a behavior with little existing aversiveness and translate into harsher judgments despite a variety of other influences. Partial support in this context is encouraging.

Limitations

The experimental manipulation in both experiments was relatively weak and fleeting. Furthermore, neither experiment required the participant to process the description of the bad smell on a deep level. Embodied concept learning may require more than a cursory observation of the abstract elements of bodily experience, although intense experiences may make a lasting impression.

Another limitation of both experiments was that judgments could not be compared to an individual's baseline (e.g., before concept learning and after). How a particular individual

would have judged a given scenario in the absence of a learning experience cannot be determined, making it impossible to know whether judgment severity actually increased as a result of learning or remained the same while all other judgments decreased in severity. This becomes most problematic if the concept learning manipulation exerts any main effects, which occurred for one concept in the second experiment.

Finally, those sub-groups in whom embodied concept learning was expected to occur most easily and strongly (e.g., those high in disgust sensitivity, bodily imagery, and neuroticism) were small in both experiments, reducing the power to detect the hypothesized effects.

Future Research

The most basic next step for future studies would be to increase the power of the experimental design to induce and detect the hypothesized effects through (1) learning experiences that carry genuine personal significance or inspire deeper conceptual processing; (2) the use of a wider variety of concept-stimulus pairs to hone in on effective combinations; (3) measuring responses to new scenarios both before and after a concept learning experience for a completely within-subjects design; and (4) including more participants in the sensitive groups expected to respond.

Despite the delicacy of the results, the potential implications of embodiment for psychotherapies and social policies aimed at alleviating emotional suffering are profound and merit continued exploration. For example, cognitive psychotherapy relieves suffering primarily by divorcing painful or maladaptive emotional responses from the situations that trigger them so that those situations no longer lead to the same response. This is

accomplished by changing which concepts are applied to a situation (e.g., reappraisal or correcting cognitive distortions) or by changing the situation itself (e.g., behaving differently). Both tactics require an implicit presumption that one's concept is inaccurate or unproductive or that the situation must be amenable to change. However, if embodied concept learning is a pathway to certain emotions, another way to allay emotional suffering that does not require using a different concept or resisting the unfolding of events is to alter the internal structure of the concept by conflating it with a different bodily experience. One might continue to perceive rejection from a peer, for example, without experiencing physical pain, leaving one free to assess the situation realistically and honor the situation in a different way.

Mindfulness meditation, yoga, zazen, and other practices that align bodily experience with mental activity may achieve their benefit in part by decoupling the physical and abstract elements composing painful concepts.

Research on the bodily components of social disgust highlights our sensitivity to physical factors, both past and present, in how we regard and care for others. Specifically, it suggests that the emotion does not necessarily originate in ways that pertain directly or legitimately to the behaviors we come to find repugnant. Leon Kass, a conservative bioethicist, argues that social disgust can be "the emotional expression of deep wisdom, beyond wisdom's power completely to articulate it" (Kass, 2001). This "wisdom of repugnance," as he calls it, may motivate actions against those who prey on the weak or bans against practices that cause suffering. However, social disgust can also motivate neglect of the poor or mentally ill, justify the denial of civil rights, and fuel prejudice (Hodson & Costello, 2007; Harris & Fiske, 2006). The emotion itself is not necessarily negative. Rather,

how the emotion is triggered determines whether life is liberated or oppressed, safeguarded or wounded, and embodiment is directly relevant in this regard.

In the cultivation of positive social emotions, such as compassion and lovingkindness, the role of the body in social disgust becomes central. While we often think of crime and politics as typical sources of social disgust, other common triggers are weakness, illness, abnormality, and helplessness, conditions associated with those most in need of compassion. Disgust motivates distance and disconnection from the source of offense. Yet, contemplative practices designed to cultivate lovingkindness employ mental imagery involving physical proximity and warmth (e.g., imagining a warm light extending from oneself to another; Salzberg, 1995) to produce social warmth, an emotion in direct conflict with disgust. An important question and an area for future research is whether such imagery reduces social disgust or actually exacerbates it and how it affects behavior towards others. Is there a way to experience compassion in which our personal gut reactions to the plight of others become not only absent but irrelevant and inconsequential?

One all encompassing ambition of emotion research is to reduce emotional suffering, particularly in those facing unyielding adversity. Embodiment may reveal new and deeper pathways to relief unfettered by circumstance. Through greater awareness of how the body participates in thought, the strong ties between situation and emotion might be loosened and allow for fewer constraints on compassion, more enduring happiness, and greater wisdom in our disgust.

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APPENDIX

Experiment 1: Explanation Notes

NOTE A

Dear Research Participant:

We apologize for the smell. The janitor attempted to rid the room of the smell. However, the janitor applied an ineffective cleaning agent that made the odor smell even worse. We are working to solve the problem.

Sincerely,
Lab Supervisor

NOTE B

Dear Research Participant:

We apologize for the smell. Due to a lack of sufficient resources or expertise, the building manager is unable to properly clean the room at this time.

Sincerely,
Lab Supervisor

NOTE C

Dear Research Participant:

We apologize for the smell. We cannot determine what is causing the odor. We have had difficulty identifying the odor or its source and so cannot yet eliminate it from the room.

Sincerely,
Lab Supervisor

Social Judgment Questionnaire I

In each of the following scenarios, indicate how morally wrong or unlikeable the person is. Base your response on your own personal feelings regarding the situation. Please enter a number between 0 and 10 where:

- 0 = not at all morally wrong or unlikeable
- 1 = very slightly morally wrong or unlikeable
- 10 = extremely morally wrong or unlikeable

- _____ 1. Susan must complete a paper for class by tomorrow morning, but she is too sleepy to write a good paper. To solve the problem, she drinks many cups of coffee. However, the excess coffee is causing her to write a bad paper.

- _____ 2. John leads a group discussion, but he does not have enough knowledge or experience to clarify the topic or keep the conversation on track. As a result, the discussion is often haphazard and disorganized.

- _____ 3. Jason asks you a question. His thinking behind the question is a mystery. You cannot figure out what is motivating his question or what he means exactly.

- _____ 4. Kevin attempts to resolve a disagreement among friends. However, instead of helping, his comment only causes his friends to fight more.

- _____ 5. Jessica has numerous friends with whom she would like to maintain a strong relationship. However, she does not use any of the internet resources for keeping in touch and keeping up-to-date with her friends' lives.

- _____ 6. Rick has a strange habit of putting things in the wrong place. He has never been able to understand why he does this. He cannot remember anything that caused him to learn this bad habit, so it persists to this day.

Experiment 2: Odor Descriptions

A

This jar contains substance Y. Normally, when substance X is added to substance Y, the odor of substance Y disappears. However, this odor resulted when way too much of substance X was added.

B

Lab personnel did not know how this odor was created or where it came from. Although they attempted to find out, they could not determine the process that produced it. As a result, they could not eliminate the odor, and the odor persisted.

C

This smell was purposely generated by placing a substance in an ordinary storage unit for just one week at room temperature.

Social Judgment Questionnaire II

In each of the following scenarios, indicate the degree to which the BEHAVIOR OR TRAIT described is MORALLY WRONG OR UNLIKABLE. Base your response on YOUR OWN PERSONAL FEELINGS regarding the situation. Please enter a number between 0 and 10 where:

0 = not at all morally wrong or unlikable
 1 = very slightly morally wrong or unlikable
 10 = extremely morally wrong or unlikable

- _____ 1. He has a habit of skipping classes he does not enjoy.
- _____ 2. She tries to fix her friend's problem by providing suggestions, but she says too much and makes things worse.
- _____ 3. He cannot figure out how his friend became sad, and therefore he cannot come up with a way to help.
- _____ 4. He intentionally created the tricky situation after he set aside the project for some time.
- _____ 5. She does not know why the plan is not working, and so the plan continues to fail.
- _____ 6. He drinks many cups of coffee so that he can write a class paper. However, the excess coffee is causing him to write more poorly.
- _____ 7. He cannot determine how his habit originated. Consequently, he is having trouble breaking the habit.
- _____ 8. She decided to put the problem behind her for a little while, although she knew this would make things difficult later on.
- _____ 9. He attempts to resolve a disagreement between two people. However, instead of helping, his comments only cause his friends to disagree more.
- _____ 10. She is unable to understand why the situation developed. Her lack of understanding is preventing her from improving the situation.
- _____ 11. He turned his attention away from the friendship for awhile. He knew this would be hard on the friendship.
- _____ 12. She prepared a speech, but she practiced for too long, and as a result, her delivery was terrible.
- _____ 13. She put her concerns aside for the time being. Later, when she returned to the situation, she found that things had gotten worse.

TABLES

Table 1. Mean Judgments for the no odor and odor groups, by Scenario, Experiment 1

	<i>No Odor</i>		<i>Odor</i>	
	M	(SD)	M	(SD)
Scenario A	1.52	(1.47)	2.19	(1.81)
Scenario B	1.89	(1.65)	2.52	(2.02)
Scenario C	0.80	(1.07)	1.47	(1.65)
Overall	1.40	(1.21)	2.04	(1.60)

Note: $n = 27$ for the no odor condition and 191 for the odor condition. Participants who rated the odor as "not at all disgusting" were excluded from the odor condition.

Table 2. Mean Judgments for the Scenarios according to Note, Experiment 1

	<i>Note A</i>		<i>Note B</i>		<i>Note C</i>	
	M	(SD)	M	(SD)	M	(SD)
Scenario A	1.98	(1.88)	2.08	(1.65)	2.12	(1.86)
Scenario B	2.42	(1.97)	2.33	(2.12)	2.37	(1.92)
Scenario C	1.45	(1.51)	1.43	(1.84)	1.23	(1.57)

Note: $n = 61$ for Note A, 64 for Note B, and 60 for Note C.

Table 3. Mean Judgments for Scenario C according to Note, disgust sensitivity (DSR) and odor repulsiveness (OR), Experiment 1

	<i>Low OR</i>				<i>High OR</i>			
	<i>Low DSR</i>		<i>High DSR</i>		<i>Low DSR</i>		<i>High DSR</i>	
	M	(SD)	M	(SD)	M	(SD)	M	(SD)
Note A	1.26	(1.03)	1.00	(1.40)	1.77	(1.72)	1.71	(1.79)
Note B	0.75	(0.81)	0.60	(0.39)	1.46	(1.98)	2.27	(2.33)
Note C	0.98	(1.21)	3.50	(1.91)	0.36	(0.78)	1.50	(1.75)

Table 4. Mean Judgments for each Scenario by group and overall, Experiment 2

	<i>Overall</i>		<i>Group A</i>		<i>Group B</i>		<i>Group C</i>	
	M	(SD)	M	(SD)	M	(SD)	M	(SD)
Scenario A	2.43	(2.03)	2.67	(2.02)	2.12	(1.84)	2.54	(2.34)
Scenario B	2.12	(1.88)	2.31	(2.09)	2.06	(1.83)	1.91	(1.62)
Scenario C	3.94	(2.17)	4.15	(2.15)	3.73	(2.10)	3.94	(2.36)

Table 5. Mean Judgments for each item by group for those who scored high on DSR and OR, Experiment 2.

		<i>Group A</i>		<i>Group B</i>		<i>Group C</i>	
		M	(SD)	M	(SD)	M	(SD)
Scenario A	Item 1	2.53	(2.35)	2.90	(2.13)	2.00	(2.87)
	Item 2	3.59	(3.10)	2.70	(1.98)	1.56	(2.65)
	Item 3	4.94	(2.79)	3.40	(2.35)	2.44	(2.13)
	Item 4	2.71	(2.91)	2.25	(2.51)	0.78	(0.97)
Scenario B	Item 1	1.88	(2.06)	1.50	(2.04)	0.89	(1.17)
	Item 2	3.00	(2.00)	2.10	(2.15)	1.22	(1.30)
	Item 3	2.82	(2.77)	2.95	(2.54)	2.00	(2.96)
	Item 4	2.82	(2.32)	2.90	(2.17)	1.22	(1.30)
Scenario C	Item 1	5.59	(2.50)	3.75	(3.14)	4.56	(3.28)
	Item 2	4.29	(2.80)	4.55	(2.74)	2.00	(2.50)
	Item 3	5.29	(2.59)	5.50	(2.56)	4.33	(3.32)
	Item 4	4.35	(2.94)	3.80	(2.46)	1.89	(2.09)

FIGURES

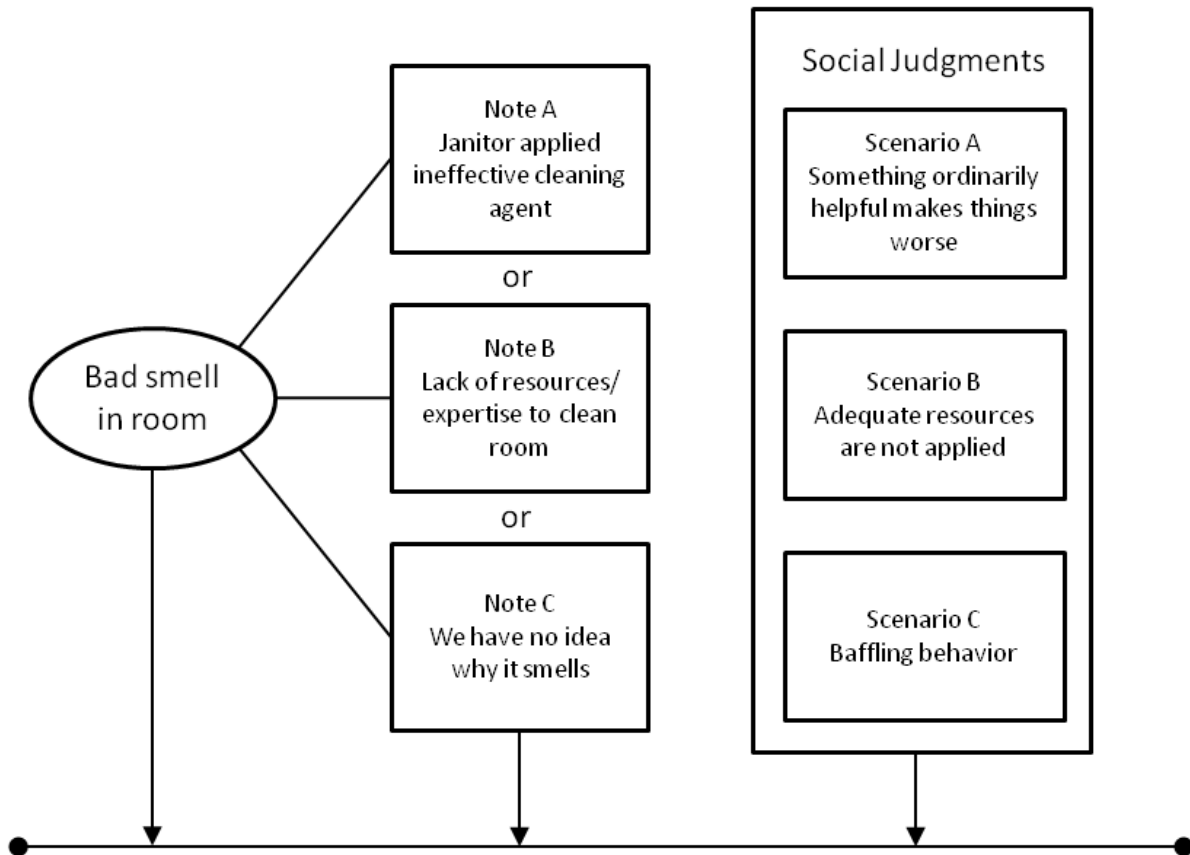
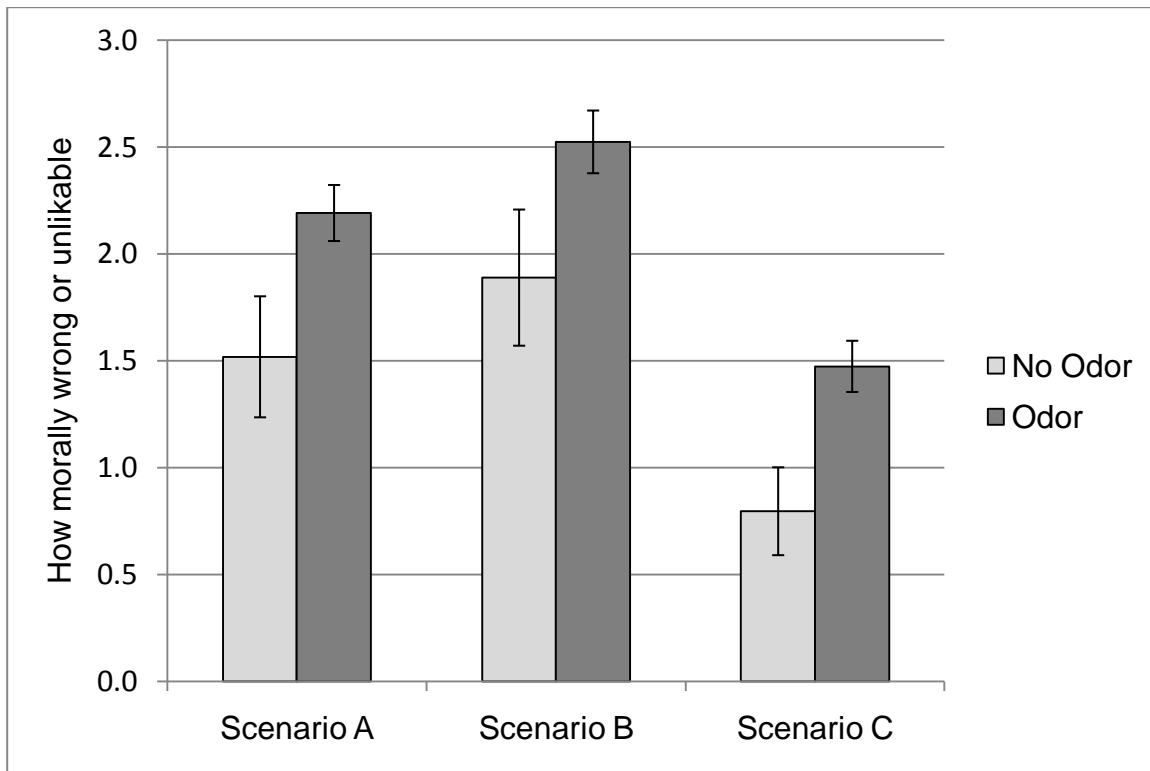
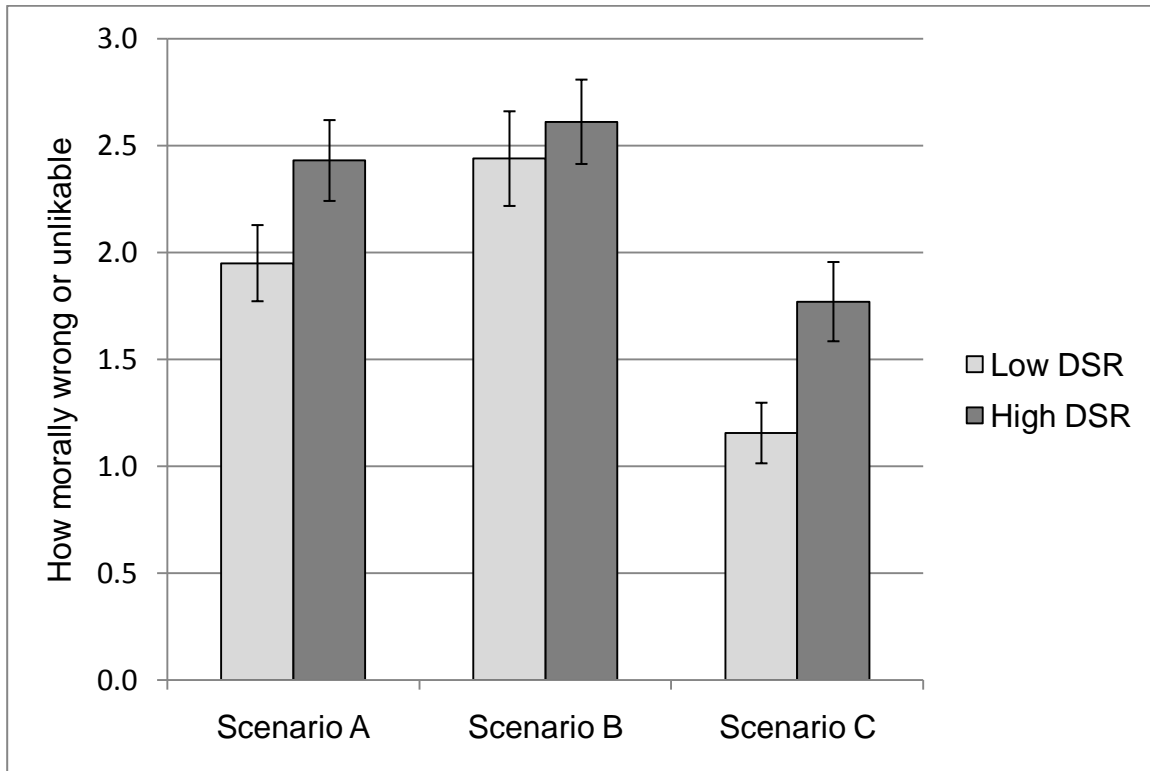
Figure 1. Timeline illustrating the design of experiment 1.

Figure 2. Effect of ambient odor on judgments in Experiment 1.



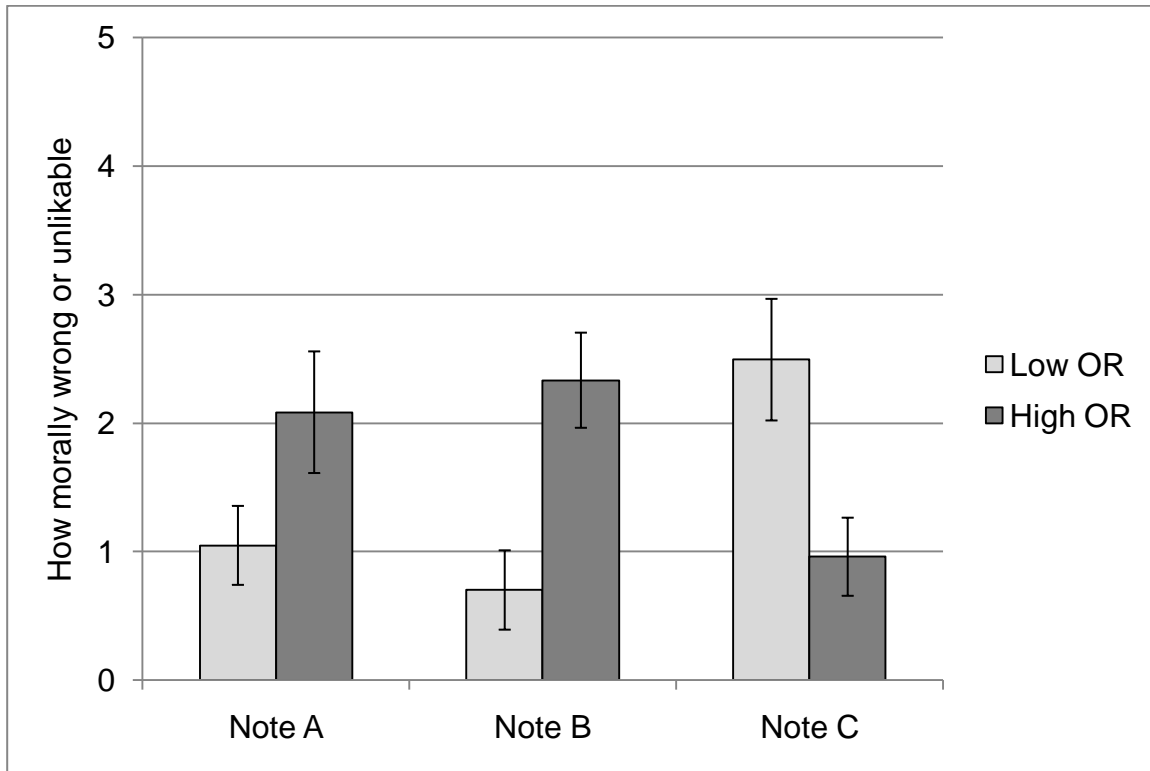
Note: $n = 27$ for the no odor condition and 191 for the odor condition.

Figure 3. Differences in social judgments in the odor condition according to high or low disgust sensitivity (DSR).



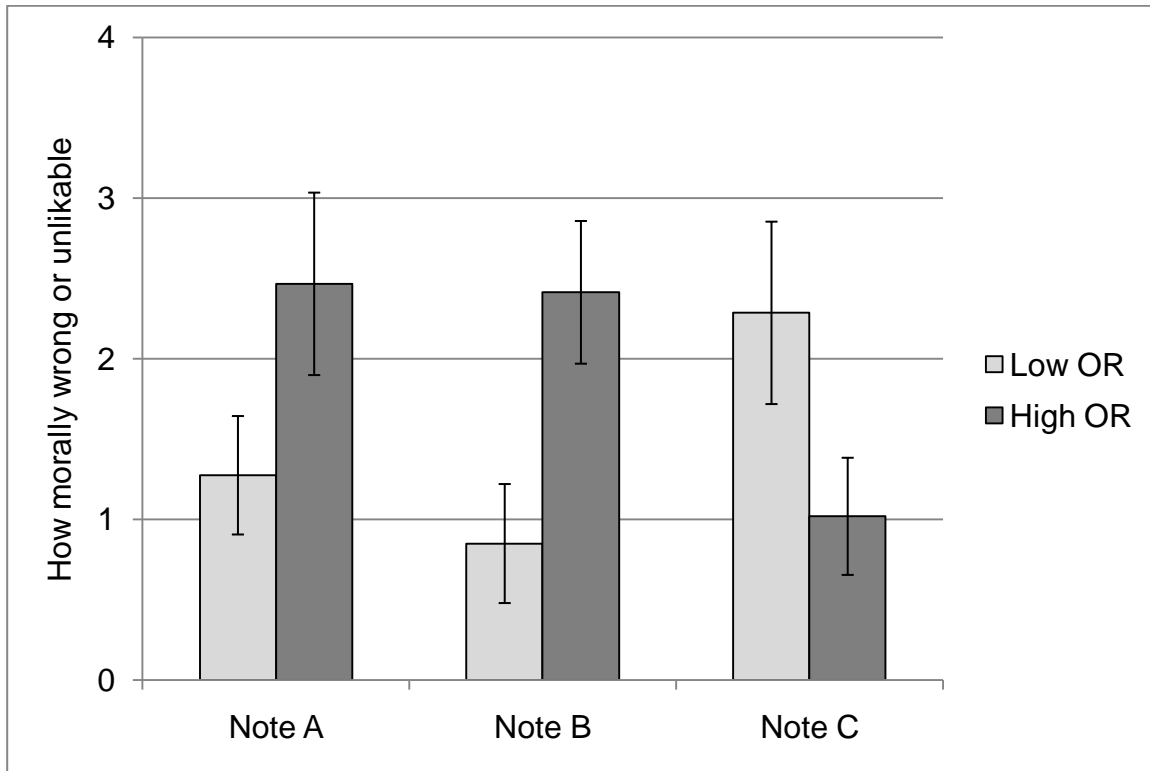
Note: $n = 61$ for Note A, 64 for Note B, and 60 for Note C.

Figure 4. Effect of odor repulsiveness (OR) on judgments for both items in Scenario C in Experiment 1.



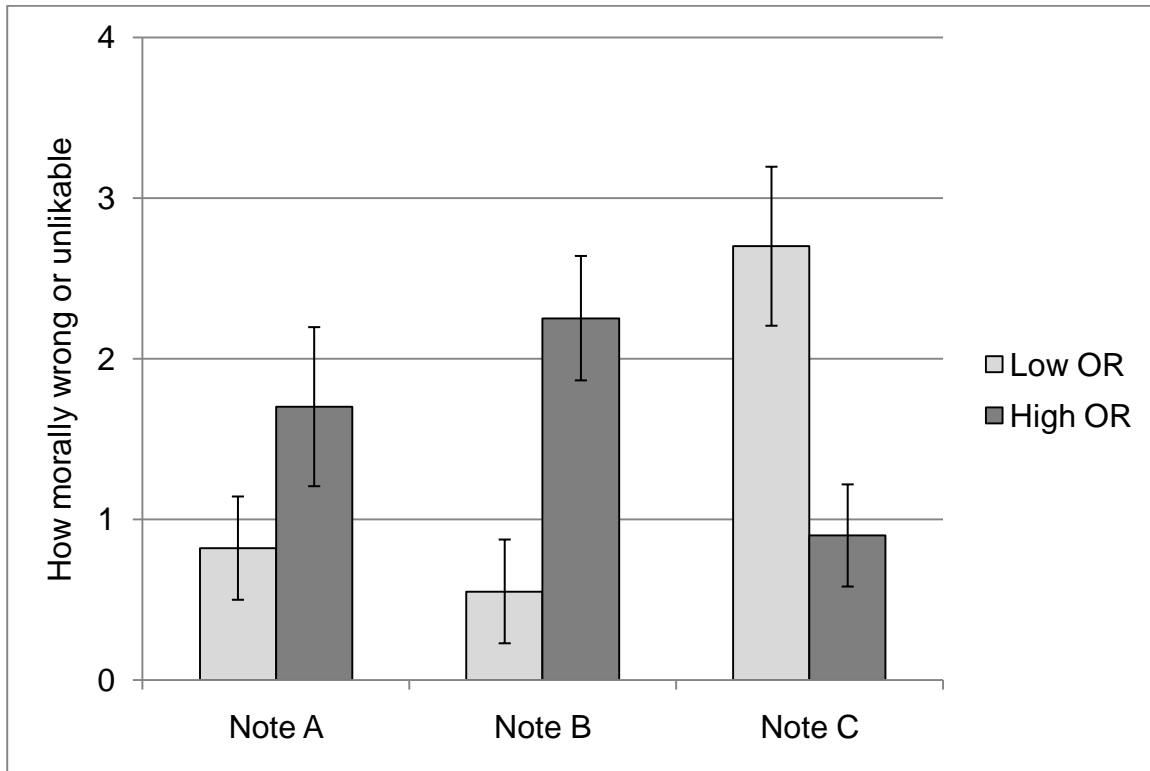
Note: $n = 61$ for Note A, 64 for Note B, and 60 for Note C.

Figure 5. Effect of odor repulsiveness (OR) on judgments for Scenario C, Item 1 in experiment 1.



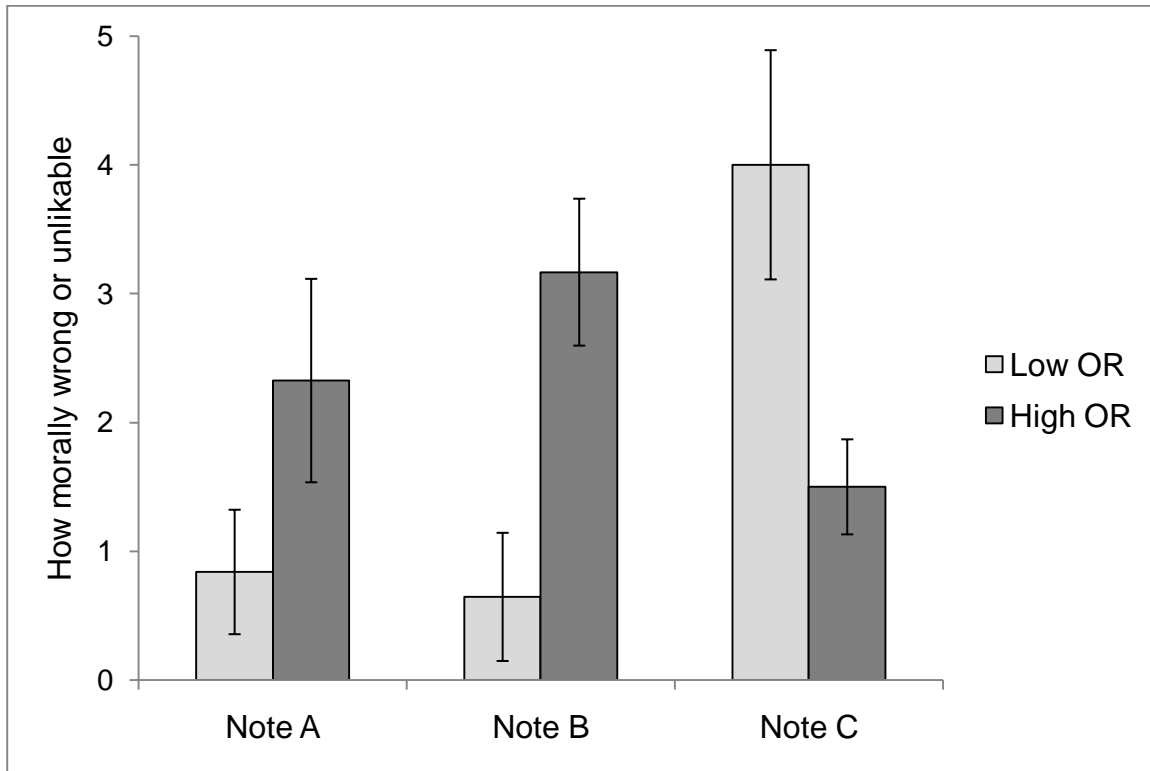
Note: $n = 61$ for Note A, 64 for Note B, and 60 for Note C.

Figure 6. Effect of odor repulsiveness (OR) on judgments for Scenario C, Item 2 in experiment 1.



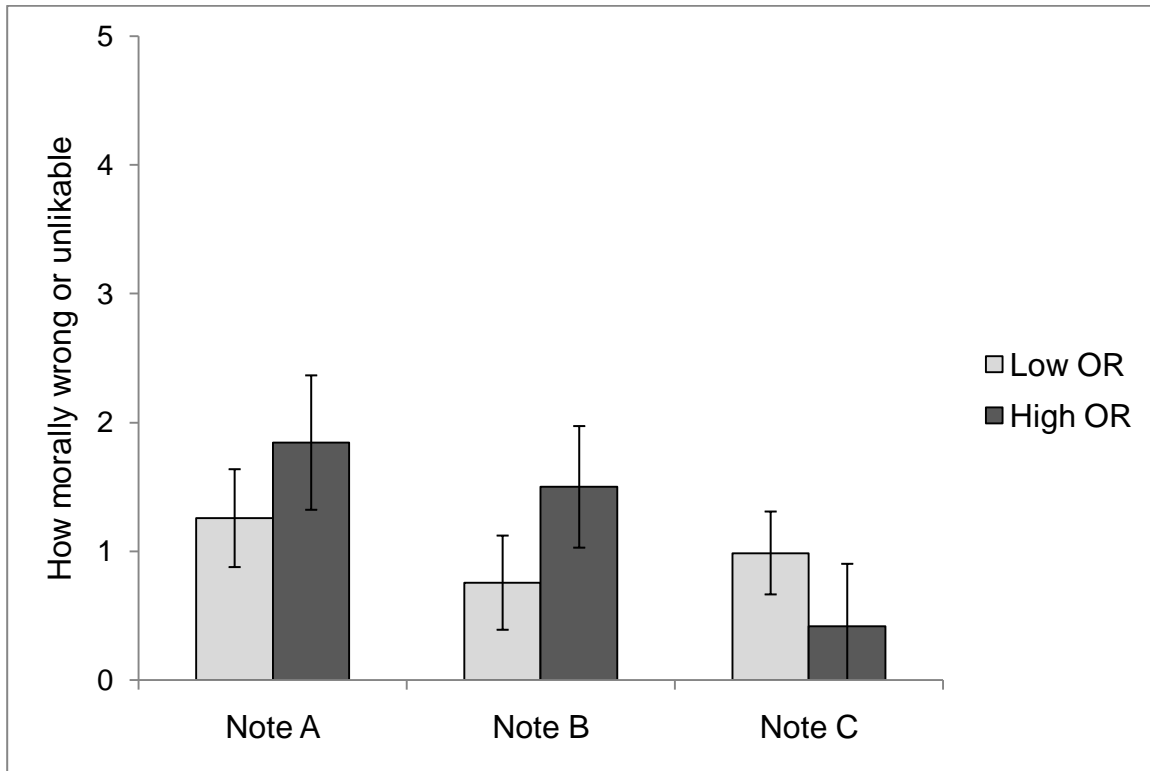
Note: $n = 61$ for Note A, 64 for Note B, and 60 for Note C.

Figure 7. Mean judgments for Scenario C in experiment 1 for participants with high disgust sensitivity.



Note: $n = 32$ for Note A, 34 for Note B, and 26 for Note C.

Figure 8. Mean judgments for Scenario C in experiment 1 for participants with low disgust sensitivity.



Note: $n = 28$ for Note A, 30 for Note B, and 34 for Note C.

Figure 9. Timeline illustrating the design of experiment 2.

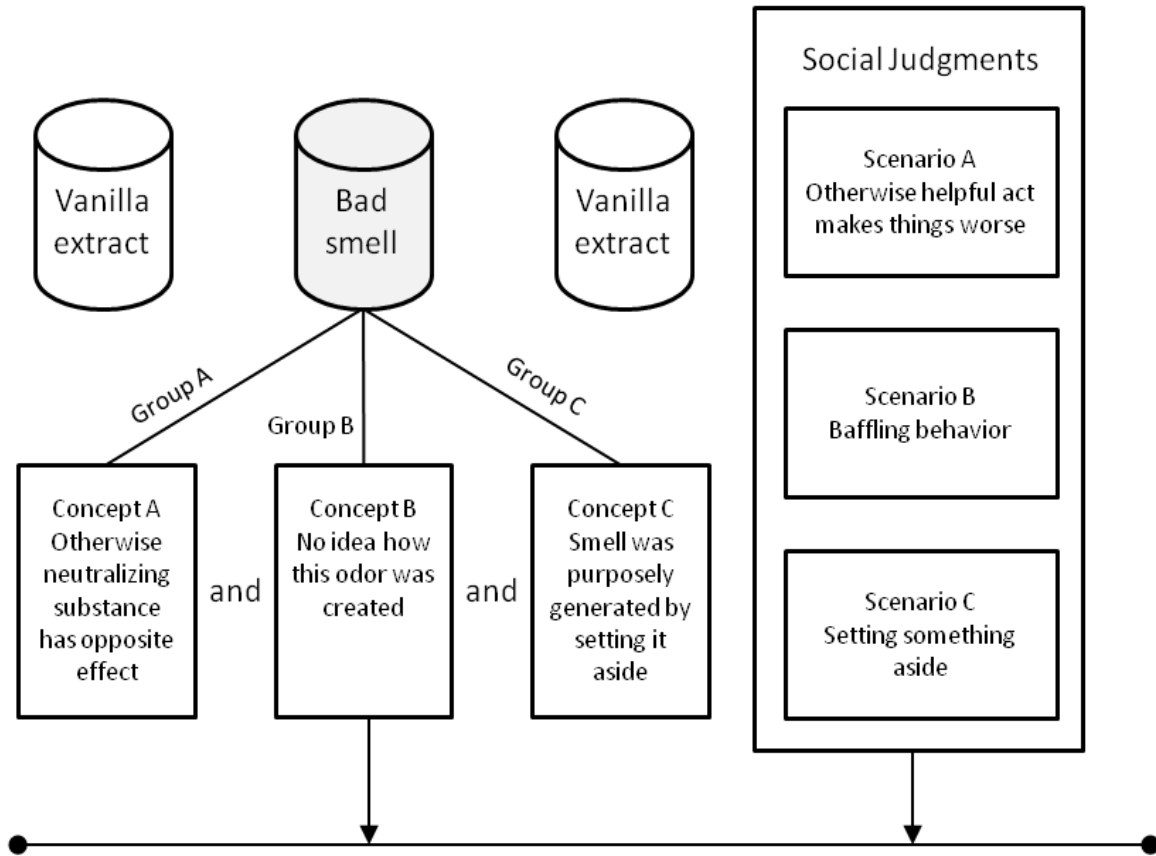
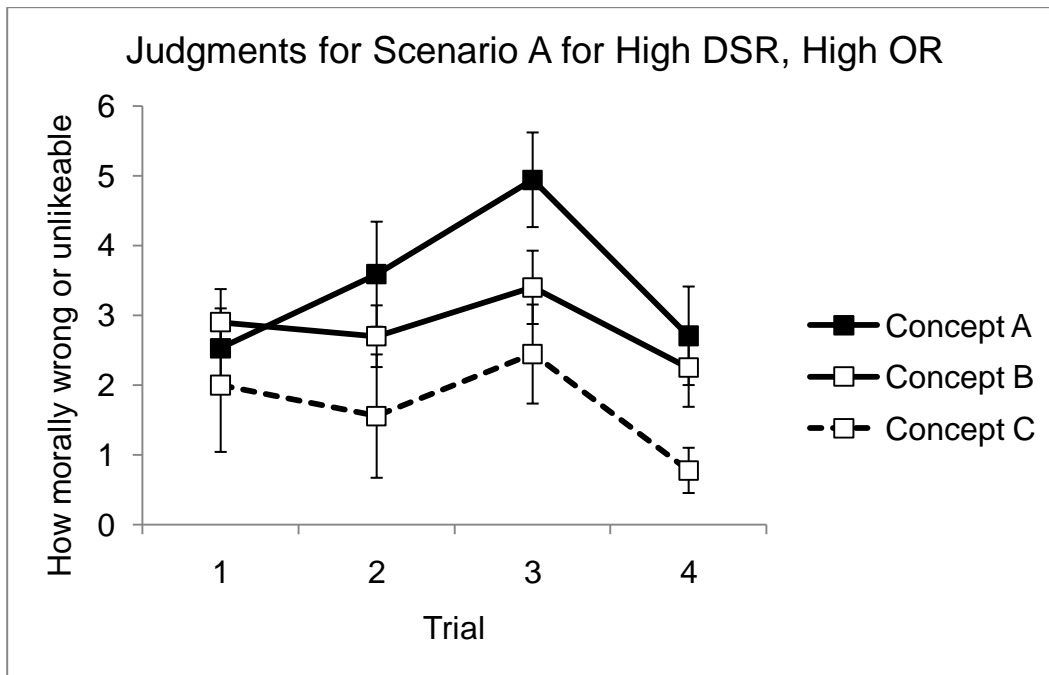
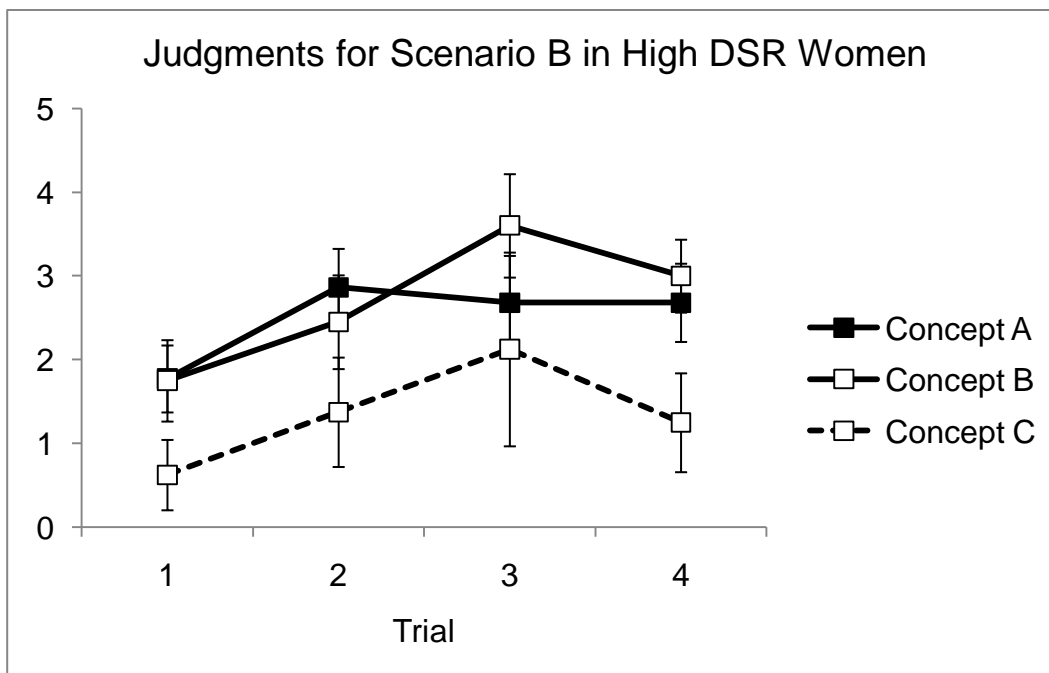
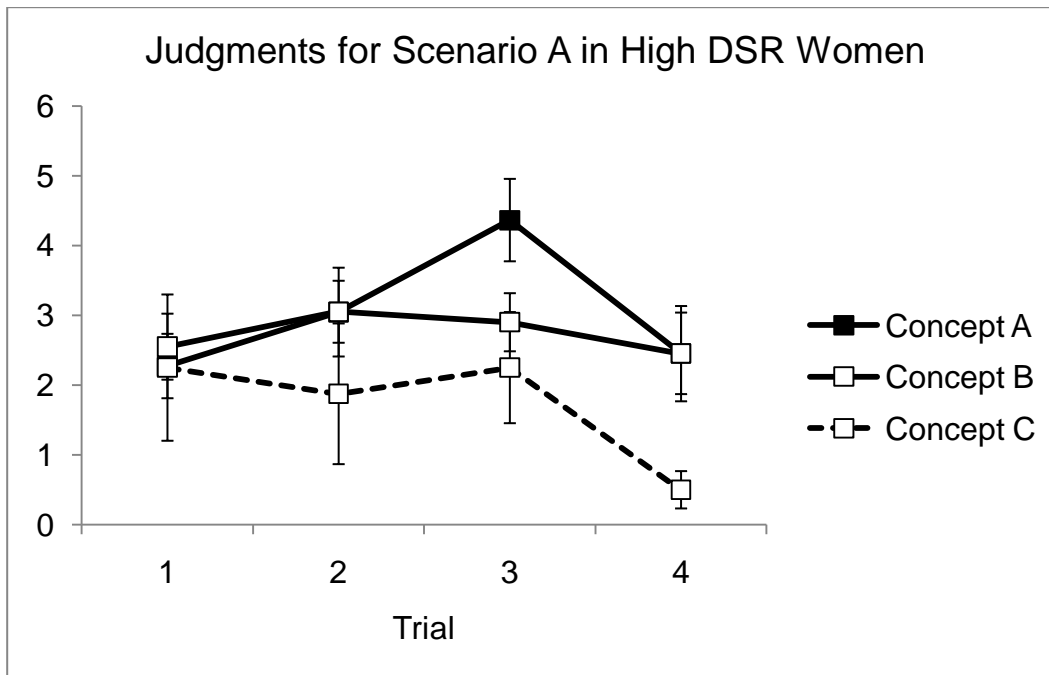


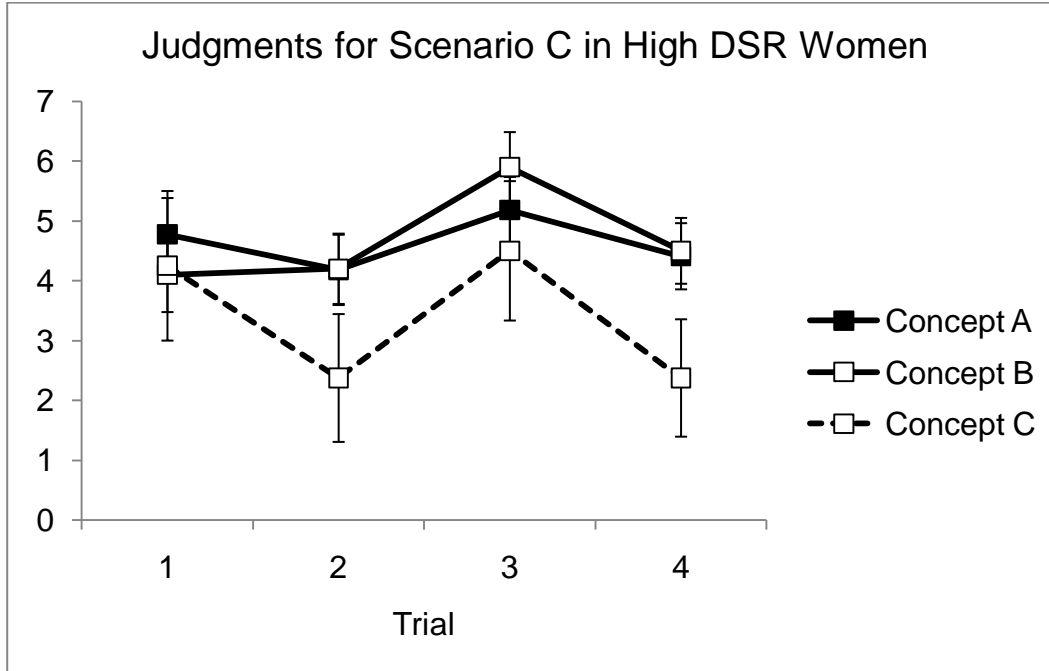
Figure 10. Mean judgments for Scenario A in Experiment 2



Note: $n = 17$ for Concept (Group) A, 20 for Concept B, and 9 for Concept C.

Figure 11. Mean judgments for women in Experiment 2 scoring high in disgust sensitivity.





Note: $n = 22$ for Concept (Group) A, 20 for Concept B, and 8 for Concept C.