FROM PERCEPTUAL SYMBOLS TO ABSTRACTION AND BACK AGAIN: THE BITTER TRUTH ABOUT MORALITY

by

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A dissertation submitted to the Graduate Faculty in Psychology in partial fulfillment of the requirements for the degree of Doctor of Philosophy,
The City University of New York

2011

This manuscript has been read and accepted by the
Graduate Faculty in Psychology in satisfaction of the
dissertation requirement for the degree of Doctor of Philosophy.

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ABSTRACT

From Perceptual Symbols to Abstraction and Back Again: The Bitter Truth about Morality

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The representation and processing of abstract concepts is a poorly understood and controversial area of research in the cognitive sciences. Some traditional and recent approaches argue that abstract concepts are represented in symbolic, amodal channels that are proposed to be distinct from the brain's perceptual centers (Burgess & Lund, 1997; Paivio, 1986, 1991; Pylyshyn, 1973; Schwanenflugel & Stowe, 1989). On the other hand, research in grounded and embodied cognition has shown that sensoriperceptual states can influence cognitive processing in numerous ways (Barsalou, 1999, 2008, 2010), even for abstract concepts like morality (e.g., Schnall, Haidt, Clore, & Jordan, 2008). The present research investigated a prototypical abstract concept (morality) and explored the extent to which perceptual information influences the processing of moral judgments. Although various studies have linked physical disgust to moral disgust, surprisingly little research has investigated morality in conjunction with taste. Across three experiments, it was found that gustatory disgust is indeed linked to moral disgust, and this effect is more pronounced in political conservatives than political liberals. Experiment 1 revealed that bitter tastes elicited significantly harsher moral judgments than sweet or control (i.e., water) tastes. Experiment 2 reversed the directionality of this effect and showed that reading about moral transgressions, virtuous, or control events instantiated gustatory disgust, delight, or neutral taste perceptions, respectively. Experiment 3 replicated the basic methodology of

the first experiment (but using a within-subjects design) and significantly reduced the effect by asking participants to suppress their perceptual and emotional experiences. Taken together, these taste perception experiments provide additional support for the idea that moral processing draws from perceptual and embodied information, specifically embodied disgust. A new theory is proposed (Distributed Embodied Network Theory) for explaining how perceptual symbols might ground abstract conceptual representations. According to this view, two classes of perceptual information (sensorimotor and affective) provide the foundation for abstract representations and can also be used to predict the abstractness and concreteness of diverse conceptual representations.

ACKNOWLEDGMENTS

To my advisor, Dr. Natalie A. Kacinik, who has taught me so much in so little time, and with great care.

To Dr. Jesse J. Prinz, for his contagious enthusiasm and inspiring mind.

To Dr. Elisabeth Brauner, for her complete warmth.

To my family for their continuous support and banana bread.

To my wife for her nurturance, love, and humor.

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Classical Views of Cognition

Over the last several decades cognitive scientists have advanced a variety of models to explain mental processes ranging from memory to language to attention (Atkinson & Shiffrin, 1968; Coltheart, Rastle, Perry, Langdon & Ziegler, 2001; Kahneman, 1973). In general, many of these box-and-arrow models represent the convergence of vast bodies of literature and sound empirical methodologies. However, despite these polished models, much remains unknown about the boxes' contents, the processes signified by arrows, and the nature of the representations themselves. This is especially true for abstract conceptual representations, whose construction, development, maintenance, and structure are somewhat mysterious. What exactly is being represented and processed in the human mind when one thinks about concepts such as TRUTH, JUSTICE, or MORALITY? The latter concept is perhaps one of the most pervasive social phenomena in human culture; yet, given its omnipresence in daily life, we know relatively little about *how* moral events are actually represented and processed in the human mind. Traditional theories of cognition have postulated that abstract concepts are represented in symbolic, amodal codes claimed to be divorced from sensorimotor and perceptual experience, and therefore processed separately as well (Newell & Simon, 1972). More recently, others have argued that perceptual information is necessarily intertwined with conceptual representation (Barsalou, 1999, 2008, 2010; Glenberg, 1997; Prinz, 2002). The latter approach has received much attention as of late and operates under several labels (e.g., embodied, grounded, embedded, dynamic, situated, extended, etc. cognition). Although these views differ slightly, they seem equally committed to the thesis that concepts are deeply intertwined with their perceptual and experiential properties.

The purpose of the present research was to determine the extent to which sensoriperceptual and emotional information influence the representation and processing of a complex abstract concept, specifically morality. In what follows, I will explore how our embodied experiences lend themselves to abstract conceptual development. My aims are threefold. First, I will describe classical accounts of cognition and their underlying assumptions. Second, using Barsalou's theory of Perceptual Symbol Systems (PSS) as a backdrop, I will defend a view of grounded cognition that focuses on the affective and dynamic nature of embodied experiences and how these experiences shape abstract conceptual representations, specifically MORALITY. Finally, I will report three experiments that show how embodied, perceptual information influences moral processing, discuss what these findings suggest about abstract conceptual representation, and lastly develop an approach for explaining how perceptual information becomes incorporated into abstract representations.

Models and Assumptions of Classical Cognitivism

We are representational beings, yet the details of this hidden architecture remain puzzling. Do we think in images, words, propositions, etc.? Are our moral conceptual representations processed as sets of propositional imperatives, or are they represented as category instances rich in perceptual and experiential details? According to classical views of cognition, it sometimes depends on a concept's concreteness or abstractness. For example, Paivio (1969) used paired-associate learning to test participants' memory for concrete and abstract nouns. In this method, participants are given word pairs to remember (cat-hat or truth-justice). When participants are later presented with one of the words in the pair, they are directed to recall the other word. Results showed that concrete

noun pairs were more easily recalled than abstract pairs. Paivio reasoned that imageability drove this effect such that it is much easier to imagine cat-hat pairs than truth-justice pairs, which makes these items easier to remember. Yet it is unclear *how* the abstract pairs are represented, if not via images. Consequently, Paivio (1986, 1991) proposed the Dual-Coding Theory, which posits two distinct channels for representing information: a verbal, symbolic channel and a visual, analogue channel. Concrete concepts can be represented visually *and* verbally, and hence receive more retrieval cues, whereas abstract concepts can only be represented by verbal, symbolic channels, and thus have less flexibility during retrieval. Additional support for the presence of visual and perceptual information in representation comes from research in mental imagery.

According to the mental imagery view, many concepts are represented in the form of mental images that are analogous to visual perceptual states. Although some concepts are harder to image than others (e.g., FLOWER vs. TIME), image theorists maintain that images are infused with thought (Bower, 1970; Paivio, 1969). For example, Kosslyn (1973) directed participants to memorize an object that contained different parts (a boat with an anchor set at its bow, a motor at its aft, and a windowed cabin in the middle). After memorizing and creating a mental image of this picture, participants were directed to start at a certain point on the boat, and then "look" for other parts of the boat. As predicted, parts that were physically farther from each other took longer for participants to identify. These results have been replicated using cognitive maps (Kosslyn, 1978) and mental rotations (Shepard & Metzler, 1971), which suggests that thinking about spatial concepts is consistent with the corresponding perceptual states. However, it could be argued that

maps and boats are naturally imageable concepts and that these kinds of findings do not transfer to or explain the representations that underlie abstract concepts like MORALITY.

Abstract concepts pose a challenge for imagists because they often lack perceptual content, which naturally accompanies concrete concepts. To this end, Boroditsky and Prinz (2008) define abstract concepts as those "whose category instances are not unified by a shared appearance" (p. 101). For example, moral transgressions manifest themselves in a variety of contexts, and the perceptual information that accompanies these events is typically viewed as distinct from the actual "moral" components of the events themselves. As a result, some theorists postulate a separate channel for processing abstract conceptual information.

In reaction to the image theories that were gaining popularity in the 60s and 70s, Pylyshyn (1973) argued that concepts are not represented in the form of images, but that all sensory codes for a concept dissolve into a single propositional representation. Propositions carry information about the relationship between concepts in a linguistic form. Thus when Marian sees that the bird is flying above the tree, she represents this relationship by reasoning BIRD: ABOVE: TREE. Pylyshyn further distinguishes between what one *experiences* and what one *represents* during concept activation. Although spatial experiences might be present when one thinks about boats, this does not mean that the underlying representation is spatial in nature. Similarly, context availability theorists have argued that both concrete and abstract concepts are stored in a single semantic code (Schwanenflugel & Stowe, 1989; Schwanenflugel, Harnishfeger, & Stowe, 1988). On this view, comprehension flows from the richness of the verbal context, cues, and discourse, as well as their semantic associations held in memory. In short, propositional and context

availability theorists argue that mental images are a byproduct (epiphenomenon) of the propositions on which representations are based.

Other cognitive scientists have proposed a variety of representational models for handling concrete and abstract concepts, including hierarchical semantic networks (Collins & Loftus, 1975; Collins & Quillian, 1969), feature comparison models (Smith, Shoben, & Rips, 1974), prototype models (Medin & Smith, 1984; Rosch & Mervis, 1975), exemplar models (Mervis, 1980), adaptive control of thought (ACT) models (Anderson, 1976, 2005), and connectionist models (McClelland, McNaughton, & O'Reilly, 1995; McClelland & Rumelhart, 1986; Rogers & McClelland, 2004). Although some of these models offer promising strategies for handling abstract concepts, many of them make similar assumptions about cognition and representation in general. First, many of these models are supported primarily by verbal labels and semantic networks. Second, these models treat conceptual representation as a set of symbolic computations performed on semantic nodes, units, or features (Fodor & Pylyshyn, 1988). Third, and most importantly, amodal symbols appear to be the vehicles of thought, such that any sensorimotor or perceptual information is virtually absent from their representations.[1] The classical view on abstract conceptual representation is clear: the representations of amodal symbols are extracted/abstracted from the original perceptual experiences and related to each other in propositional networks in relationship with other symbols. It should therefore be evident that the main

[1] According to Barsalou (1999) and Prinz (2002), amodal symbols are those which do not participate in a specific sensory code. In other words, amodal symbols are divorced from the original sensorimotor experiences that accompany perception during the acquisition of concepts.

difficulty with classical theories is that they do not really explain how abstract concepts become grounded, hence suffering from the symbol grounding problem.[2]

Some modern theories of semantic representation have approached the symbol grounding problem more directly (Burgess & Lund, 2000; Landauer & Dumais, 1997). The Hyperspace Analogue to Language (HAL) and Latent Semantic Analysis (LSA) accounts similarly propose that words can be acquired, induced, and represented by analyzing the covariation between words and the semantic spaces (texts) in which they occur. By tracking the relationship between words and text through mathematical techniques (singular value decomposition and multidimensional scaling), these models establish semantic meaning through brute linguistic experience with words. In particular, Burgess and Lund (1997) argued that HAL can account for the representation of abstract words. Using HAL to create vector representations for abstract terms, researchers compared HAL's representations to human raters' data on abstract word norms rated on a seven point Likert scale for concreteness, pleasantness, and imageability. Results showed that HAL's vector representations could reliably predict the variation in human responses. Burgess and Lund thus concluded, "that the global co-occurrence information carried in the word vectors can be used to predict…abstract semantic dimensions" (pp. 63).

Although elegant and informative, these models err in at least two ways. First, they lend themselves to an infinite regress in terms of word meaning. One might be able to use the covariation between words and text to discover meaning by comparing new words to

[2] The often discussed symbol grounding problem questions how symbols (e.g., words that require semantic interpretation) become embedded in cognitive systems so that symbolic meaning is intrinsic and internal to them (Harnad, 1990).

known words, but that does not explain how terms *first* acquire meaning. Second, people do not experience the world solely through text. They have phenomenal experiences that color their senses and leave lasting impressions. Although the principle of verbal co-occurrence could generalize to co-occurrences in other modalities, it is unclear what mechanisms would drive these processes and how perceptual information would be represented if not linguistically. If one accepts the claim that the aforementioned views do not sufficiently explain how symbols are grounded in abstract representations, and that the meaning of *first* concepts is poorly detailed, then one accepts that something is missing from these theories and that there may be more to moral processing than propositional, linguistic-based imperatives. One possibility is that a body is necessary for grounding cognition.

Grounded Cognition

Embodied cognition is a loaded term and has become a buzzword in contemporary cognitive science. Far from a new idea, versions of embodiment have been expressed throughout history (Hume, 1739/1978; Locke, 1690/1979; Uexküll, 1934/1992). In the empirical tradition, Locke and Hume contended that all concepts are stored copies (representations) of sensory and perceptual activity. Uexküll developed a theory of Umwelt (roughly translated as "environment"), which posited that the manner in which an organism acts and perceives its environment reflects its unique cognitive architecture. He reasoned that organisms and their environments cannot be studied in isolation because they are functionally interdependent. Thus, an organism's body *type* is as informative as its environmental responses.

Today, most embodiment researchers claim that sensorimotor and perceptual experiences are fundamental to cognitive processing. In other words, one's bodily interactions with physical and cultural environments provide the raw materials for cognition in terms of both representation and processing (Clark, 1997; Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005; Varela, Thompson, and Rosch, 1991). If this view is accurate, then moral processing might be deeply intertwined with perceptual and embodied experiences, which challenges the classical view that moral judgments are strictly rational and rooted in amodal symbols.

Following Barsalou (2008), it might be more constructive to use the term "grounded" rather than "embodied" because the former stresses the importance of *perceptual* information in conceptual processing rather than the "mistaken assumption that…bodily states are necessary for cognition" (p. 619). To date, Barsalou's Perceptual Symbol Systems (PSS) (1999, 2008) is the most sophisticated theory of cognition that uses perceptual information to explain conceptual processing.

Perceptual Symbol Systems

According to PSS, concepts are represented by modality specific symbols. Both Barsalou (1999, 2003, 2008, 2010) and Prinz (2002, 2005) explain modal representations as those which carry information through specific sensory codes (e.g., the visual code). In every experience of a category exemplar, one's perceptual state is naturally accompanied by unique patterns of sensory activation, which are later stored in long-term memory as perceptual symbols. When concepts are activated during cognition, perceptual symbols accrued through lived experiences are stimulated. These stimulations generate neural patterns of activity that simulate the original physical, perceptual experiences, which

provides the foundation for conceptual representation, which emerges from the interaction of perceptual symbol systems. Barsalou (1999, 2010) argues that all concepts are couched in perceptual centers, and simulation is an essential property of representation. S*imulators* are patterns of activity that span perceptual and associative brain areas. The instantiation of a concept is realized to the degree that a simulator accurately excites a perceptual pattern of activity that mimics the original experiences.

At its core, PSS is a multimodal representational system. One's representational system *combines* properties of the perceptual regions that are aroused by one's experiences with category exemplars. Barsalou (1999) holds that simulations are not run *precisely* as the original instantiation; instead, they are variable constructions formed in working memory. However, if a concrete concept's representation is variable, then what determines which properties will be represented (simulated) in any particular instance? A thoughtful objection to the PSS account is that it remains unclear which aspects of a concept are simulated and represented during its instantiation. Representing one's entire gamut of perceptual experience for any given concept seems like an uneconomical use of cognitive resources. Thus, using amodal symbols that abstract meaning from experience might be a more parsimonious alternative to perceptual symbols.

Perhaps paradoxically, one of the principle benefits of a perceptual symbol system is that it *is* parsimonious because conceptual representations run on the *same* information provided during perception. Rather than positing additional amodal symbols to represent concepts, perceptual symbols *are* the concepts themselves, and they have the flexibility to instantiate a variety of sub-categories as a function of their various simulators. On this view, the diverse experiences that accompany abstract concepts could be carried by

simulators. Thus, according to this view there is no single representation for MORALITY; it is a variable representation that contains vast information about specific moral experiences, which will be discussed later in more detail. Like Barsalou, Prinz (2002) notes that an important feature of PSS is that concepts are not represented by *individual* simulations but rather by the properties taken from a *set* of simulators relevant to a concept. The relevance of simulators is determined by the associative strength between them and the overall conceptual frame, the unique demands of the task, and the state of the cognizer. Simply put, every representation deals only with portions of one's experiences, which are selected by the environmental context and the specific needs of the target task in question.

Empirical evidence for perceptual symbol systems. In sum, PSS offers a unique view into cognitive processing that is economical and flexible. But is there experimental evidence to support this model? If PSS underlies conceptual representations and cognitive processing, then they should be manifested in many cognitive research domains.[3] Researchers in conceptual processing showed that switching modalities when verifying properties about concepts resulted in cognitive costs (Pecher, Zeelenberg, & Barsalou, 2003). Participants were directed to verify facts about a concept in a particular modality. When participants verified facts in an auditory modality (rustling leaves) they were faster to verify properties in that same modality (noisy blenders) than other modalities like taste (tart cranberries). Further, research in linguistic processing found participants processed pictures faster when their orientation was the same orientation as that of the item

[3] See Barsalou (2008) for an extensive review of the empirical literature supporting PSS and grounded cognition in general.

mentioned in the sentences they previously read (Stanfield & Zwann, 2001). Therefore, after reading that *John put the pencil in the cup*, participants were faster to respond to a vertical rather than a horizontal picture of a pencil, congruent with that action. The results suggest that implicit perceptual simulations prime participants to recognize context-specific vertical orientations over horizontal orientations. Zwann and Madden (2005) tested participants' RTs to pictures containing images regarding recently processed sentences. They found that participants were biased to respond to perceptually appropriate pictures consistent with the meaning of the sentence. For example, after reading "The ranger saw the eagle in the sky," participants were faster to name a congruent picture showing an eagle with outstretched wings as opposed to an incongruent image of an eagle with folded wings.

Perhaps some of the strongest evidence for PSS comes from neuropsychology and cognitive neuroscience more generally. Adolphs, Damasio, Tranel, Cooper, and Damasio (2000) showed that damage to the right somatosensory cortices, which are important for producing facial expressions, was also correlated with an impaired ability to recognize the facial expressions of others. Participants were directed to rate 36 pictures of facial expressions on six basic emotions (happiness, surprise, fear, anger, disgust, and sadness). Those with damage to the right somatosensory cortex showed the weakest correlations with the mean ratings. Two additional studies were designed to distinguish between the lexical and conceptual processes implicated in the first study. In a forced-choice lexical task, participants had to label the same faces with one of the six provided emotions. Lexical impairment for applying verbal labels to emotions was associated with lesions in the right temporal lobe, left frontal operculum, and supramarginal gyrus. Finally, participants had to

sort 18 of the 36 pictures according to the depicted emotion. Performance on this task was negatively affected by damage to the right insula, which is responsible for the retrieval of emotion-related conceptual knowledge independent of language. Taken together, the researchers argue that emotion recognition requires intact regions (right somatosensory cortices) associated with both emotion production and emotion-related conceptual knowledge, which are distinct from emotion labeling. It appears that simulation is implicated in emotion recognition. However, emotional expressions are important for inter-personal communications, so it should also be shown that non-communicative representations also require simulation.

Chao and Martin (2000) used fMRI to explore whether motor areas of the brain would become excited after viewing pictures of tools (commonly associated with hand movements) as opposed to pictures of animals, faces, or houses. They found that only tool pictures elicited greater activation in the left ventral premotor cortex. However, the objection could be raised that pictures of tools are better candidates for perceptual representation in that they contain more sensory information. Since words do not have such properties, Hauk, Johnsrude, and Pulvermüller (2004) conducted an fMRI study to investigate whether simply reading action words referring to the face, arms, and legs (lick, pick, or kick) would similarly excite the corresponding regions in the motor cortex unique to each body part responsible for those actions. Their results did indeed demonstrate somatotopic activation in the motor and premotor cortex.

If grounded theories of cognition are ultimately viable and accurate accounts of conceptual representation and processing, then they should be evidenced from multiple research programs. The described studies represent only a portion of the existing studies;

in particular, there is much research in social cognition that is beyond the scope of this review (Duclos et al., 1989; Meier & Robinson, 2004, 2006; Moeller, Robinson, & Zabelina, 2008; Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005; Semin & Smith, 2002; Wells & Petty, 1980). Despite the influx of grounded and embodied cognition research, it is not absolved of skepticism and concern. Some of the strongest and best defended reactions to the grounded thesis comes from Dove (2009) and Mahon and Caramazza (2008). Their objections can be condensed into two claims, each of which raises critical issues regarding the representation and processing of moral concepts.

Underlying Amodal Mechanisms and Abstract Concepts

The first objection is that the grounded cognition evidence does not necessarily dismiss amodal symbol systems. According to Mahon and Caramazza (2008), the aforementioned results show that the "motor and sensory systems are activated but they do not demonstrate that activation of motor or sensory information constitutes the semantic analysis of the sentence – and that is the critical issue at stake" (p. 63). This is perhaps the strongest argument, and, in some respects, it highlights a traditional question in the sciences about whether a phenomenon is really causal or just correlational. The evidence does not indubitably show that sensorimotor simulation is the driving force behind conceptual representation and processing simply because corresponding areas become activated in various cognitive tasks. Mahon and Caramazza outline four potential pathways to represent the relationship between concepts and senses: (1) concepts immediately activate sensorimotor systems without accessing an intervening 'abstract' conceptual system; (2) concepts simultaneously activate both sensory and abstract systems; (3) concepts first activate sensorimotor systems and subsequently abstract

systems; (4) concepts first activate abstract systems and subsequently sensorimotor systems. Mahon and Caramazza privilege (4), referring to it as the "disembodied hypothesis."

While the disembodied view is possible, I find no overwhelming evidence or strong reasons to adopt this stance. One can posit additional abstract systems (i.e., amodal symbols or "hidden units" in connectionist models) to handle representation, but doing so seems unnecessary given the available information already housed in modal symbols. Adducing extra abstract layers accommodates traditional theories of representation well, but its necessity has not been sufficiently empirically demonstrated. The grounded view is reasonable, parsimonious, can explain classic findings, and is supported by various experimental findings.[4] However, absolutist positions occasionally lend themselves to myopia. If amodal symbols are useful for some representational processes, then they might have a circumscribed niche in cognitive systems. It seems that modal symbols subtend most cognitive processes, but amodal symbols might still play a supplemental role, albeit smaller than traditional cognitive theories would hold. An intermediate approach may have the most explanatory power, especially for the representation and processing of complex concepts like MORALITY, which is often described as being an abstract concept on the one hand, yet linked to experience on the other (e.g., actual moral vs. immoral behaviors).

In response to the surge of evidence for embodiment, Mahon and Caramazza endorse a more neutral theory, "grounding by interaction," which is the thesis that although amodal symbols are required for conceptual processing, "sensory and motor

[4] It should be noted that parsimony alone provides no reason to endorse one view over another. Naturally, it must be juxtaposed with empirical evidence.

information contribute to a full representation of a concept" (p.68). Hence, this implies that amodal symbols alone are impoverished. Similarly, Dove (2009) advances a pluralistic theory of representation, such that both amodal and modality-specific symbols work together to generate full and rich concepts. In addition to the earlier criticism, Dove also argues that amodal symbols are a possible solution to the problem of multisensory integration. This problem is evident in instances of abstract concepts that contain information from diverse sensory codes. Amodal symbols might aid these cases by consolidating sensory information into propositional forms. This criticism, while insightful and itself quite parsimonious, can be accommodated by Barsalou's (1999) earlier defense. Recall that he argued that all simulations are *partial*, involving only the relevant aspects of a concept, triggered by the introspective, environmental, and initial cognizer state cues in addition to the associative strength between the task demands and the conceptual frame.

The second objection is that the grounded cognition evidence does not explain how abstract concepts are represented. If we take PSS to account for all concepts, then how can perceptual symbols explain abstract concepts, which do not participate in a particular sense or universal perceptual experience? For example, moral and immoral behaviors take various perceptual and experiential forms, yet they all represent various aspects of the concept of MORALITY in general. Prinz (2002) offers a few perceptual-based strategies to explain abstract concepts. For example, his *mental operations* approach suggests that the debate over the primacy of perceptual symbols often confuses mental *representations* with mental *operations,* with the latter referring to the "rules used in combining concepts and the processes used to adjust feature weights" as opposed to the representation itself (Prinz, 2002, p. 171). Admittedly, mental operations may involve amodal symbols, but the central

argument remains that representations *themselves* are perceptual in nature. Barsalou (1999) advanced a similar view to accommodate abstract concepts like morality.

Barsalou (1999) suggests that abstract representation occurs in two stages: First, the content (or *meaning*, as one might say) of the abstract concept is activated, and, second, perceptual representations are generated to specify the conceptual content. This stage is realized through three distinct mechanisms: framing, selectivity, and introspective symbols. As Barsalou explains (1999, p. 600-601) one must:

> First, identify an event sequence that frames the abstract concept. Second, characterize the multimodal symbols that represent not only the physical events in the sequence but also the introspective and proprioceptive events. Third, identify the focal elements of the simulation that constitute the core representation of the abstract concept against the event background. Finally, repeat the above process for any other event sequences that may be relevant to representing the concept (abstract concepts often refer to multiple events, such as *marriage* referring to a ceremony, interpersonal relations, domestic activities, etc.).

Barsalou's account provides a glimpse into the representational process. Comparing the situational instances of abstract concepts to their core content helps concept bearers run, abstract from, and unify multiple simulations under the appropriate conceptual umbrella, so to speak. If Barsalou is correct that simulation and multimodal activation are required for abstract conceptual representation, this would provide evidence that perceptual symbols ground conceptual knowledge. Dove (2009) insists that concepts' situatedness alone does not establish that they are represented by perceptual symbols. He argues that the introspective nature of Barsalou's third stage, which helps distinguish core conceptual representations against background noise, is itself non-perceptual. With respect to the present research, deciding which simulations to run and compare to represent MORALITY does not seem to be well suited as a perceptual task. More specifically, although moral experiences could be represented using PSS and coded into a network of simulators for

one's MORALITY concept, it is unclear exactly how one might *abstract* from those diverse perceptual experiences the "moral" components and build a functional conceptual representation out of them.

Barsalou (2003, 2008) agrees, and, in more recent versions of the theory, he develops and defends a view that seems to incorporate amodal symbols in linguistic forms (Barsalou, Santos, Simmons, & Wilson, 2009). Similar to Dual-Coding Theory (Paivio, 1986, 1991), they postulate the Language and Situated Simulation Theory (LASS), which integrates both linguistic forms and modal symbols into the human conceptual system. According to this view, when one encounters a word, the linguistic and simulation systems are activated simultaneously. The linguistic system peaks first in activity and is responsible for categorization, spreading activation, and other shallow, word association based processes (consistent with statistical models like HAL and LSA). The simulation system peaks later and is responsible for developing concepts more deeply, which is accomplished through modality-specific simulations. Prima facie, it appears that Barsalou et al. endorse a pluralistic view of representations; however, it is important to stress that their basic thesis remains constant: the representation of conceptual meaning is fundamentally grounded in perceptual symbol systems.

Barsalou's (1999, 2003, 2008, 2010) approach to explaining abstract conceptual representations with perceptual symbols relies heavily on introspective processes. Although the exact mechanisms underlying these processes require more specification, introspective information seems like an important candidate for understanding abstract concepts because it highlights an important kind of perceptual and embodied information: emotional and affective states.

The Role of Affect in Abstract Conceptual Representations

From psycholinguistics to social cognition and cognitive neuroscience to moral psychology, researchers are finding that affective information plays an important role in the representation and processing of abstract concepts (Clore, 2009; Damasio, 1994; Kousta, Vigliocco, Vinson, Andrews, & Del Campo, 2011; Schwarz & Clore, 1983, 1998), even in moral reasoning (Haidt, 2001), which will be reviewed in greater detail later. For example, Kousta et al. (2011) found that emotional valence plays a critical role in the processing and representation of abstract words. After controlling for imageability, concreteness, context availability ratings, and a host of other linguistic factors, participants were given a standard lexical decision task. After being presented with a letter string for 2000 milliseconds, participants were instructed to decide whether the string was a real word or not and respond as quickly and accurately as possible using a serial response box. Three hundred and twenty words and non-words were presented to each participant.

Results showed that abstract words were processed faster than concrete words, which contradicts much of the previous research in cognitive psycholinguistics showing that concrete words are processed faster because there are more "cues" and perceptual information to facilitate retrieval and processing. To show that emotion drives this effect, they conducted another study with a large set of emotionally "neutral" rated words that ranged from low to high concreteness and imageability. They predicted and found that concreteness and imageability did *not* significantly predict reaction times and thus there were no differences in reaction times between words. This finding is taken as evidence that the lack of emotional information in the words created a null effect in terms of processing speed. Finally, using a set of words that span the entire range of emotional valence,

concreteness, and imageability in words with moderate to high frequency, Kousta and colleagues showed that emotion was the only significant predictor of reaction time, providing support for what they call the "abstractness effect". Following the work of Vigliocco, Meteyard, Andrews and Kousta (2009), the researchers argue that affective information is a crucial type of sensorimotor information that plays an important role in abstract embodied semantics.

The above research provides evidence that internal affective states are rich information channels that can help support abstract conceptual representations. Although treating affect as a *type* of embodied information opens up doors for new research, the extent to which embodied information can explain the representations underlying abstract concepts is still a matter of contention. For example, is embodied information the absolute foundation for abstract conceptual development and subsequent representations or does it simply help shape pre-linguistic conceptual domains? Clearly, these are the deep and challenging questions that are not easily answered. However, research in social cognition suggests that higher-order cognitions (e.g., interpersonal judgments) also have foundations in affect, which offers additional support for its significance.

Clore's (2009) *affect-as-information* view is described as "more of an approach than a theory" (p. 123). Of its several principles, the one most relevant to the present research is the *Information Principle*. According to this principle, emotions are thought to inform judgments, decision making, and information processing strategies in general at a very basic level, as input arrows in a cognitive model, so to speak. For example, Schwarz and Clore (1983) found that participants rated their life satisfaction as higher when they were interviewed on sunny spring days (when moods were positive) as opposed to rainy spring

days (when moods were negative). In another experiment, they similarly showed that after being primed with happiness or sadness (via a writing exercise about a personal life experience), "happy" primed participants reported greater life satisfaction than "sad" primed participants.

This approach assumes that emotions act as types of information designed to guide cognition, both implicitly and explicitly. On this view, emotions that are acquired experientially and linked to various stimuli such as other agents, objects, events, locations, etc. becomes instrumental to cognitive processing when these emotions again arise in the presence of the same (or similar) stimuli. In this way emotional states can serve as input arrows to direct the flow of judgments and decision making. This view is consistent with the research of Damasio (1994), who draws from neuropsychological findings to advance an emotional approach to cognition.

According to Damasio's (1994) influential *somatic marker hypothesis*, emotions refer to a unique family of representations that carry information about various homeostatic changes in the brain and body across a broad array of contexts, where the contextual features are also represented as forms of external stimuli with corresponding response options. This embodied, emotional information is encoded and stored so that similar subsequent situations and decision-inducing contexts will re-activate one's "somatic markers" to facilitate decision making. This process also helps make highly complex problems more tractable by increasing the strength of the somatic marker's signal, and thus one's reliance on "gut feelings," so to speak. The feelings associated with the positive or negative outcomes are linked to corresponding contexts to increase motivation and happy emotions or avoidance and sad emotions, respectively, in appropriate situations. In

sum, one's internal, emotional, and somatic representations become linked with one's representations of external stimuli and their contexts to enable the brain to determine (1) to degree to which various external stimuli are beneficial or harmful and (2) the most appropriate response option in a quick and adaptive manner.

Much of the support for the claim that decision making is carried by emotional signals comes from research using the Iowa Gambling Task (Bechara, Tranel, & Damasio, 2000). In this procedure participants are directed to choose from one of four different decks of cards that vary to the extent that some produce high immediate gains but greater future loss – leading to long term loss- and other that produce low immediate gains but smaller future loss – leading to long term gain. Participants are tasked with trying to maximize their profit, and they are free to switch between the four decks as much as they like, although they can only pick one card at a time. Unknown to participants, they were stopped after they pick 100 cards, at which point their net amount was totaled. Participants were patients with amygdala damage (the emotional center in the limbic system), patients with damage to their ventromedial prefrontal cortex (VMPFC), and normal healthy controls. Patients with damage to VMPFC have shown various deficits in their social and personal decision making and judgment abilities, often leading to severe financial loss, an inability to maintain personal and romantic relationships, and a compromised ability to express and experience their own emotions, despite having otherwise normal intellectual capacities.

Results showed that normal participants showed preference for the long term gain decks, whereas both patients with amygdala and VMPFC damaged preferred the long term loss decks, suggesting that emotional systems play an important role in decision making.

Similar findings were shown using skin conductivity response (SCR), which is a physiological index of one's current emotional and somatic states (Bechara, Damasio, Damasio, & Lee, 1999). While playing the same gambling task, patients with amygdala damage, VMPFC damage, and normal participants' SCRs were measured. Results indicated that normal participants produced SCRs when they received rewards or punishments after picking cards *and*, after experience, they produced SCRs *before* picking cards, with more pronounced activation before picking from "risky" decks. Patients with VMPFC damage also produced SCRs after picking cards, although slightly lower than normal participants. However, patients with amygdala damage failed to produce SCRs to rewards or punishments. The most critical finding was that neither the VMPFC nor amygdala patients generated SCRs *prior* to picking cards. Together, these results suggest that emotional information guides decision making in a critical way and that gut feelings might be more crucial than previously thought.

In sum, it seems that affect plays an important role in abstract conceptual representations and processes. Emotional valence significantly predicts the manner in which people process abstract words and also their judgments about abstract domains such as life satisfaction. Furthermore, even abstract computational processes like decision making seem to rely on emotional and somatic states to provide information about previous experiences and to help predict future outcomes. Perhaps most striking, however, is the extent to which emotions are used in the processing and representation of one of our most abstract and complex conceptual domains: morality.

Affect in Moral Processing

According to traditional views of morality, moral processing is often described as a higher-order cognition that is divorced from emotional and bodily experiences, which are typically thought to inhibit and interfere with reason (Descartes, 1649/1989; Kohlberg, 1973; Wilson, 1998). It follows from this view that making sound moral judgments requires an act of stripping away one's passions in order to gain a clear view of the target moral event. To ensure clarity on this topic, I will use Haidt's (2001) definitions of moral judgment and moral reasoning, which are as follows:

> *Moral judgment:* evaluations (good vs. bad) of the actions or character of a person that are made with respect to a set of virtues held to be obligatory by a culture or subculture (p. 817).
>
> *Moral reasoning*: conscious mental activity that consists of transforming given information about people in order to reach a moral judgment (p. 818).

Traditional Rationalist Theories of Moral Representation

Following in the Piagetian tradition, Kohlberg's view of moral processing is one of the most influential and powerful approaches in psychology. His approach is developmental in nature, and he is recognized for having used detailed interviewing methods to determine how both children and adults reason about specific moral dilemmas. For example, Kohlberg (1963, p. 19) famously put forth the following event:

> In Europe, a woman was near death from a special kind of cancer. There was one drug that the doctors thought might save her. It was a form of radium that a druggist in the same town had recently discovered. The drug was expensive to make, but the druggist was charging ten times what the drug cost him to make. He paid $200 for the radium and charged $2,000 for a small dose of the drug. The sick woman's husband, Heinz, went to everyone he knew to borrow the money, but he could only get together about $ 1,000 which is half of what it cost. He told the druggist that his wife was dying and asked him to sell it cheaper or let him pay later. But the druggist said: "No, I discovered the drug and I'm going to make money from it." So Heinz got desperate and broke into the man's store to steal the drug-for his wife. Should the husband have done that?

According to Kohlberg, there are six stages through which one passes developmentally as his/her reasoning abilities mature. For example, in stage one (obedience and punishment orientation) a child might report that the man was wrong to steal because it is against the law and therefore he will be punished, while in stage three (good interpersonal relationship) one might report that it was okay to steal because it is important take care of close others. In stage six (universal principles) one would report that the highest moral good means working towards the benefit and improvement of society at large while also protecting individual rights. The utilitarian calculus involved in this last stage is reminiscent of what the moral philosopher John Rawls (1971) referred to as the "veil of ignorance," a perspective taking method during which individuals suspend all social roles and identities of the parties involved in a moral issue and decide what is morally right based on principles alone.

In a similar vein, Turiel's (1983, 1998) *social interactionist* model privileges conscious reasoning as the driving force behind moral processing. Also drawing from real-time interviews, this approach contends that moral development emerges through social interactions (perspective taking, sharing, imagining, responding to harm, etc.), which are argued to guide deliberate moral thinking. Thus, a child makes harsher moral judgments about injustice after experiencing it personally or imagining another experiencing it. Although this approach has grounded components and elements of embodiment, the central claim is that these social interactions merely *facilitate* the development of moral processing more broadly, whereas *reason* is ultimately the faculty responsible for *making* actual moral judgments.

Although it is a reasonable view that conscious deliberation is involved with moral judgments, much of the traditional research focuses *only* on rational thought as the primary vehicle for making moral judgments. However, a variety of diverse thinkers have argued the opposite- namely, that moral processing is *not* necessarily consciously motivated (Freud, 1900/1976; Skinner, 1971). Most notably, in the 18th century, Hume (1772/2004) made the startling suggestion that moral judgments are based on emotions rather than pure reason. On this view, moral judgments are comparable to judgments of taste, and, for Hume, the notion of taste can be understood quite literally: an action is assessed as morally wrong when it elicits emotional disgust.

Perceptual and Emotional Theories of Moral Representation

More recently, some morality researchers have also argued that emotions serve as the foundation for moral development (Blair, 1995; Turiel & Killen, 2010) and moral judgment (Haidt, 2001, 2007; Prinz, 2007). According to this approach, the wrongness of an action is determined by introspecting how that action makes us feel, and Haidt's (2001) *social intuitionist model* is one of the clearest articulations of this stance, stating that "the central claim of the social intuitionist model is that moral judgment is caused by quick moral intuitions, and is followed (when needed) by slow, ex-post facto moral reasoning" (p. 817). This two-stage model predicts that emotional states influence moral judgments in a direct and automatic manner, whereas reason-driven states are supported by controlled processes, which are not always required and/or motivated. If this model is correct, then moral judgments are (generally) more akin to automatic processes rather than controlled ones, which is a striking claim. One possible prediction of this view is that inhibiting or

controlling one's emotional/perceptual states should neutralize one's moral judgments in a compatible manner.

Not everyone agrees with this stance (Huebner, Dwyer, & Hauser, 2009), but a lot of empirical research supports a link between moral judgments and emotion, especially disgust (Borg, Lieberman, Kiehl, 2008; Haidt, 2003; Rozin, Haidt, & McCauley, 2009; Schnall, Benton, & Harvey, 2008; Schnall, Haidt, Clore, & Jordan, 2008). For example, Liljenquist, Zhong, and Galinsky (2010) showed that participants were more likely to engage in charity and reciprocity of trust in a clean-scented room compared to a baseline room. They found that in a trust game, during which participants had to decide whether to return money to an unknown investor, those in a clean-scented room returned significantly more money than those in the baseline room. Further, participants in a clean-scented room expressed more interest in volunteer work and monetary donations relative to those in the baseline room. Similarly, Zhong and Liljenquist (2006) demonstrated that threats to one's moral purity (recalling unethical past actions or writing about another's misdeeds) increased participants need for physical cleansing as revealed by faster lexical access to cleansing-related concepts and a stronger desire for cleansing products (e.g., soap, toothpaste, etc.). These studies suggest a link between morality and cleanliness, but what about disgust?

A clever manipulation by Schnall, Haidt, Clore, and Jordan (2008) used commercially available "fart sprays" to induce disgust in their participants by spraying a nearby trashcan. Participants exposed to strong or mild stink conditions made harsher judgments on a variety of moral vignettes (e.g., sex between first cousins) than those in the no-spray condition. Similar effects were found using dirty (versus clean) desks and the recalling of

disgusting experiences. Inbar, Pizarro, and Bloom (in press) recently replicated the smell manipulation and showed that disgust can lead to stronger disapprobation of gay men. Finally, to further demonstrate that perceptual information is linked to morality in a modality-specific format, Lee and Schwarz (2010) took inspiration from our common moral vernacular with expressions like "dirty hands" and "dirty mouths". Participants completed a role-playing scenario during which they committed a moral transgression (a lie) either via email (with their hands) or voicemail (with their mouths). They then completed a seemingly unrelated consumer research task where they rated various products such as hand-sanitizer and mouthwash. Results showed that participants who lied with their mouths indicated stronger preference for the mouthwash than other products, whereas participants who lied with their hands indicated stronger preference for hand-sanitizer.

Although these results suggest that emotional disgust and cleanliness are highly associated with morality, such claims would be even stronger if these domains were found to recruit similar brain regions. Chapman, Kim, Susskind, and Anderson (2009) investigated the physiological overlap between oral and moral disgust. Similar facial motor activity occurred across three different kinds of disgust in gustatory, visual (via disgusting pictures), and moral domains, such that all three types of disgust activated the levator labii muscle of the face, which has evolutionary origins in taste preference. Other studies also provide evidence for partially overlapping brain regions during physical and moral disgust, particularly in temporal and frontal cortices (Moll et al., 2005; see also Borg et al. (2008) for additional neural correlates). This research suggests that physical disgust is linked to moral disgust, and it follows that individuals who are more sensitive to physical disgust

should make harsher moral judgments than those who are less sensitive to physical disgust. To this point, recent findings in political psychology have shown that political orientation can predict sensitivity to disgust, and that conservatives and liberals differ in more ways than just their political ideologies.

For example, recent research has revealed that political conservatives and political liberals show physical differences in their brains. Conservatives, in particular, appear to have significantly more gray matter volume in their left insula and amygdala, both of which play important roles in processing emotions like fear and disgust, whereas liberals seem to have significantly more gray matter in their anterior cingulate cortex, which monitors uncertainty and conflicts (Kanai, Feilden, Firth, & Rees, 2011). Further evidence from Inbar, Pizarro, and Bloom (2009) has shown that conservatives are more easily disgusted than liberals, as revealed through questionnaires assessing disgust sensitivity and political orientation. This research provides further support for the view that emotions are involved with morality, and that they might even be sensitive enough to predict individual differences like political orientation. Furthermore, it suggests that conservatives might be more influenced by their sensoriperceptual and emotional states than liberals, which is an interesting proposition that warrants more thorough investigation.

Physical and moral disgust thus appear to be linked through cognitive, behavioral, and physiological processes. Although the extant research highlights this relationship in various ways, no existing studies appear to have specifically targeted taste perception. If morality is indeed processed through perceptual and emotional channels, then inducing gustatory disgust should elicit harsher moral judgments than gustatory delight or a control condition.

Brief Review and Introduction to the Present Experiments

The purpose of the present research was to determine the extent to which sensoriperceptual and emotional information influence the representation and processing of a complex abstract concept, specifically morality. According to the grounded account of cognition, sensoriperceptual information is fundamentally intertwined with all varieties of conceptual representations, both concrete and abstract. Put simply, perceptual information accrued through experience is stored as symbols and later activated during the processing of concepts (Barsalou, 1999, 2003, 2008, 2010). Along somewhat similar lines, Damasio (1994) and other affective science researchers have argued that emotional and somatic information are stored and used during the processing and representation of concepts, even in abstract cases (Kousta, 2009). Therefore, it follows from this view that perceptual and emotional information play critical roles in representation and their presence (or absence) should influence the manner in which concepts are processed.

On the other hand, amodal accounts of cognition hold that abstract concepts do not operate on perceptual symbols, but there is some variation in these views. For example, dual-coding theory maintains that concrete concepts are processed in a perceptual, visual channel during activation, while abstract concepts are processed in a separate "verbal" channel (Paivio, 1986, 1991). Alternatively, propositional models contend that both types of concepts are represented in a single semantic channel that focuses on the relationships between concepts (Pylyshyn, 1981). Similarly, context availability theorists have argued that both concrete and abstract concepts are stored in a single semantic code (Schwanenflugel & Stowe, 1989; Schwanenflugel, Harnishfeger, & Stowe, 1988). The

variations between these accounts are informative, yet their basic thesis is similar- namely, that abstract concepts are neither processed nor represented with perceptual symbols.

To determine the extent to which perceptual information affects high-level abstract cognitive processes involved with morality, the following experiments tested the effects of gustatory taste perception on moral judgment. It is worth stressing here that morality is indeed a highly complex domain, such that one's sense of right, wrong, virtue, and vice stem from interactions between neurobiological, cultural, evolutionary, anthropological, and religious factors, etc. (Churchland, 2011; Hauser, 2007). Some researchers even maintain that moral judgments are specific to certain kinds of emotions, which are in turn specific to certain types of moral events (Rozin, Lowery, Imada, & Haidt, 1999). For example, contempt is linked to violations of communal codes, whereas anger is linked to violations of individual rights. The following research involved making moral judgments about several different kinds of moral issues in order to survey a greater range of moral events.

If grounded views of cognition are accurate, then the perceptual and emotional experiences of disgust should influence how individuals process moral issues and make subsequent moral judgments. However, if amodal views are accurate, then such perceptual experiences should be processed in a separate perceptual channel and have no effect on moral representation and processing, which is theorized to be in a distinct semantic channel. Individual hypotheses will be specified within each experiment, but the general hypothesis guiding these experiments is that perceptual and emotional states are critical components of the conceptual representation of MORALITY such that perceptions of physical disgust are intertwined with judgments of moral disgust. Further, it is expected

that these effects will be stronger for political conservatives than liberals given the physiological and social cognitive evidence outlined earlier.

Experiment 1: The Effects of Gustatory Disgust on Moral Judgments

To determine whether exposure to gustatory disgust elicits moral disgust, participants were randomly assigned to consume one of three different beverages (bitter, sweet, or water-control) while making moral judgments about characters in a variety of vignettes. It was hypothesized that participants in the bitter condition would make significantly harsher moral judgments than participants in the sweet or control conditions, and that participants in the sweet condition would make significantly kinder moral judgments compared to the control and bitter conditions.

Method

Participants and procedure. Fifty-seven (41 females) undergraduates were recruited from the Brooklyn College Psychology participant pool and received course credit for their participation. They were told that the present experiment was designed to explore the effects of motor interference (specifically arm-hand movements) on cognitive processing and were therefore directed to drink a beverage during a moral judgment task to instantiate this movement in a natural way. They received informed consents and were randomly assigned to one of three different taste conditions.

Taste manipulation. Participants in the sweet (n = 21), bitter (n = 15), and control (n = 18) conditions were given Minute Maid Berry Punch, Swedish Bitters, or water, respectively, which was treated as a between-subjects factor. They were not told the identity of the beverages, although an ingredient list was provided to check for potential allergies. Beverages were administered in two one-teaspoon doses in a small cup, with the

first dose given at the onset of the moral judgment task, and second one administered at the halfway point to ensure that the taste lingered throughout the task. Participants were instructed to drink each dose in its entirety in a single swift motion, "as if they were drinking a shot."

Moral vignettes. Moral judgments were assessed using Wheatley and Haidt's (2005) moral vignettes, which portray various moral transgressions (consensual second cousin incest, a man eating his already dead dog, a bribe-accepting congressman, a lawyer prowling hospitals for victims, a shoplifter, and a student who steals library books- see Appendix A). All participants received the same six moral vignettes, counterbalanced to control for order effects. Each vignette was followed by a scale for rating "how morally wrong" the offense was consisting of a 14-cm line representing a continuum from *not at all morally wrong* to *extremely morally wrong*. Participants were asked to make a slash at the point on the continuum corresponding to their impressions. These marks were then converted to scores ranging from 0 to 100, with higher scores indicating harsher moral judgments.

***Distracter task and demographics*.** Following the moral judgment task, participants were given an unrelated language distracter task, where they described their language background. They were also asked to provide some basic demographic information and indicate their political orientation by checking either conservative or liberal. This variable was of interest because there is evidence to suggest that politically conservative individuals seem to rely more on sensory information (Haidt & Hersh, 2001) and show greater sensitivity to disgust (Inbar, Pizarro, & Bloom, 2009) than those with liberal views and hence we wanted to test this claim using the taste manipulation. If

conservatives are indeed more sensitive to disgust, then the taste manipulation should affect their moral processing more strongly than liberals.

Beverage ratings and manipulation check. Participants also rated their beverage with respect to how sweet, bitter, neutral, and disgusting they found it on a 7 point Likert scale ranging from *not at all* (1) to *very much* (7), to check whether the taste manipulation was successful- see Appendix B. Finally, they were asked to write down what they thought the study was about.

Results

Three out of the 57 participants correctly guessed the hypothesis and were therefore excluded from all analyses. For the remaining 54, an overall moral judgment score was obtained for each participant by averaging his/her ratings of the six vignettes, where higher scores indicate harsher moral judgments. Self-report ratings of the beverages shown in Table 1 confirmed that participants actually perceived the Swedish Bitters to be disgusting, the Minute Maid Berry Punch as sweet, and the water as neutral, with higher numbers indicating stronger endorsement of a particular taste.

To determine the effects of the beverage manipulation, a one-way ANOVA of the moral judgments was conducted. Results revealed a significant effect of beverage type, $F(2, 51) = 7.368$, $p = .002$, $\eta_p^2 = .224$. Planned contrasts on the data in Figure 1 showed that participants' moral judgments in the bitter condition ($M = 78.34$, $SD = 10.83$, $n = 15$) were significantly harsher than those in the water ($M = 61.58$, $SD = 16.88$, $n = 18$), $t(51) = 3.117$, $p = .003$, $d = 1.09$, and sweet ($M = 59.58$, $SD = 16.70$, $n = 21$), $t(51) = 3.609$, $p = .001$, $d = 1.22$, conditions, which did not differ significantly, $t(51) = .405$, *n.s*. A regression was also performed to test whether moral judgments could be predicted by feelings of physical

disgust. Results indicated that 27.5% of the variance in moral judgment was accounted for by participants' self-reported disgust ratings, $t(52) = 4.445$, $p < .001$, $\beta = .525$. These results confirm the primary hypothesis that disgust (at least partially) underlies moral processing. Regarding the secondary hypothesis, conservatives were expected to be more sensitive to disgust and therefore make harsher moral judgments than liberals, particularly in the bitter condition. Ten participants, who failed to identify themselves as liberal or conservative, were removed from these analyses. Of the remaining 44 participants, 19 identified themselves as politically conservative and 25 identified themselves as politically liberal. Although a few participants identified as libertarian, the sample was too small for statistical analysis.

A 2 (conservative, liberal) X 3 (Taste: bitter, sweet, control) between-subjects ANOVA was conducted on moral judgment to determine if political orientation influenced judgments within each taste condition. There was a significant main effect of taste, $F(2, 38) = 9.741$, $p < .001$, $\eta_p^2 = .339$, reflecting the difference between the bitter relative to water and sweet conditions described earlier. Simple effects analyses of political orientation at each taste condition, depicted in Figure 2, showed that conservatives ($M = 51.81$, $SD = 15.83$) were marginally different from liberals ($M = 66.74$, $SD = 17.49$) only in the water condition, $F(1, 38) = 3.979$, $p = .053$, $\eta_p^2 = .095$.

To further test the hypothesis about whether disgust affected conservatives' and liberals' judgments differently, two contrast analyses were conducted to directly compare the disgust group (bitter condition) and non-disgust group (sweet and control conditions combined) for both conservatives and liberals. Conservatives' judgments were significantly harsher in the disgust ($M = 84.94$, $SD = 4.69$) condition compared to both the sweet ($M =$

56.60, *SD* = 17.00) and control (*M* = 51.81, *SD* = 15.83) conditions combined, *t*(16) = 4.473, *p* <.001, *d* = 2.21 , whereas liberals' judgments did not significantly differ as a function of disgust (*M* = 76.67, *SD* = 9.47) compared to the sweet (*M* = 64.72, *SD* = 14.07) and control (*M* = 66.74, *SD* = 17.49) conditions combined, *t*(22) = 1.703, *n.s.* (This suggests that liberals are less likely to recruit extraneous sensoriperceptual information during moral processing than conservatives.) Taken together, these results suggest that physical disgust helps instantiate moral disgust, and that these effects are more salient in individuals with politically conservative relative to liberal views.

Discussion

The purpose of the present experiment was to determine the extent to which perceptual and emotional information influence the representation and processing of morality. It was hypothesized that gustatory disgust would elicit harsher moral judgments than gustatory pleasure (sweet) and control groups. It was also predicted that sweet taste perceptions would elicit significantly kinder moral judgments than the bitter or control groups. Finally, it was expected that political conservatives show stronger effects in the predicted directions when compared to political liberals.

Results showed that disgust-induced perceptional and emotional experiences instantiated harsher moral judgments than sweet or control experiences, and this effect was more pronounced in political conservatives when compared with liberals. Overall, conservatives were significantly more affected by disgusting experiences than non-disgusting experiences, whereas there was no significance difference between liberals' judgments as a function of perceptual experience. Yet, it is important to note that conservatives and liberals did not significantly differ in their judgments in the bitter

condition alone. Thus it cannot be concluded that conservatives are more sensitive to bitter tastes than liberals, although a case can be made that conservatives are more sensitive to disgust overall. To this end, conservatives' moral judgments were significantly harsher in the disgust group (bitter) when compared to the non-disgust group (sweet *and* control conditions combined), and there were no differences in liberals' judgments between the disgust and non-disgust conditions. Therefore, it appears that sensitivity to disgust, *not* bitterness per se, is the principal factor here.

One explanation for these findings is that both liberals and conservatives could be using "affect-as-information" (Schwarz & Clore, 1983, 1998) in moral decision-making, but differ in their reliance on disgust. Disgust has been associated with violations of purity norms (Rozin et al., 1999), and these are more prevalent in conservative morality (Haidt, 2007). An alternative hypothesis might suggest that moral judgments are normally made using a non-emotional system, but this system can be influenced by extraneous emotions, and conservatives may be more vulnerable to that influence. The former hypothesis that emotions guide both liberals and conservatives is more parsimonious, and consistent with the finding that people generally have difficulty articulating reasons for their moral judgments (Haidt, 2001) as well as the grounded account of cognition (specifically Barsalou's introspective stage on abstraction) and Damasio's (1994) somatic marker view.

The sweet perception hypothesis was not supported- that is to say, participants in the sweet condition did not make significantly kinder judgments than participants in the control condition. While these results fail to support the idea that sweet perceptual states yield "sweet" judgments, participants' self-reported taste perceptions for each beverage revealed that participants did not rate the sweet beverage as strongly as they did the bitter

and water beverages, which could explain why this finding was not obtained. Further, the berry punch was somewhat tart and tangy, so perhaps a more *explicitly* sweet beverage (like sugar water) would produce the predicted effect.

Experiment 2: The Effects of Moral Judgments on Gustatory Perception

Experiment 1 showed that taste significantly influenced moral judgments such that participants exposed to disgusting tastes formed harsher moral judgments than participants exposed to non-disgusting tastes. These results supported the primary hypothesis that perceptual states of gustatory disgust can instantiate states of moral disgust. However, to further demonstrate the relationship between perceptual states and morality, Experiment 2 was designed to investigate the directionality of this effect and determine whether the reverse also holds true. In other words, will processing different types of moral events in turn affect one's subsequent gustatory perceptual experience? It was hypothesized that participants who read moral transgressions will perceive a beverage to be significantly more disgusting than participants who read about events depicting moral virtue (e.g., an altruistic act) or a control event (e.g., choosing a college major). As in Experiment 1, these effects were predicted to be stronger in conservatives when compared to liberals. Finally, to delve deeper into the relationship between political orientation and taste that was found in Experiment 1, a questionnaire was developed to determine if there were any reliable correlations between political orientation and taste preferences, which assessed the extent to which conservatives and liberals reported preferences for various tastes (sweet, bitter, sour, salty, savory, spicy, etc.).

Method

Participants and procedure. Sixty (29 females) undergraduates were recruited from the Brooklyn College Psychology participant pool. They were told that the present experiment was a two-part study designed to explore moral judgments in part one and participate in a taste perception survey as part of our collaboration with a market research/consumer interest company in part two. Those who participated in Experiment 1 were not eligible for Experiments 2 and 3.

Moral vignette manipulation. As a between-subjects factor, participants were given two vignettes to read that depicted moral transgressions (n = 20), moral virtues (n = 20), or control scenarios (n = 20)- see Appendix C. The two moral transgression vignettes were taken from Wheatley and Haidt (2005), specifically the bribe-accepting congressman and the shoplifter. These two vignettes were chosen because the results from participants in the control condition of Experiment 1 revealed that these two vignettes were judged harshest of the six vignettes. The basis for this decision was limited to the control condition in order to avoid the effects of bitter and sweet tastes. The moral virtue vignettes were developed to describe two altruistic acts (a generous gift to a homeless family and a Good Samaritan preventing a mugging). The two control vignettes were developed to reflect non-moral events (a student choosing a major and a waiter interacting with co-workers).

All vignettes were presented in counterbalanced order and were followed by a scale for rating how moral each offense was on a 14-cm line representing a continuum from *extremely morally bad* to *extremely morally good.* Participants were asked to make a slash at the point on the continuum corresponding to their impressions. These marks were then

converted to scores ranging from 0 to 100, with lower scores indicating harsher moral judgments.

Taste perception. Following the moral judgment task, participants began part two of the experiment with everyone receiving the same beverage to taste (blue Gatorade diluted with water, 1 part Gatorade to 10 parts water), which was chosen because it is not particularly sweet, bitter, or domineering in any other taste. They were not told the identity of the beverage they received, although an ingredient list was provided to check for potential allergies. Beverages were administered in a single one-teaspoon dose in a small cup. Participants were instructed to drink each dose in its entirety in a single swift motion, "as if they were drinking a shot." They rated the beverage on another 14-cm line representing a continuum from *very disgusting* to *very delicious*. Participants were asked to make a slash at the point on the continuum corresponding to their impressions. These marks were then converted to scores ranging from 0 to 100, with lower scores indicating stronger perceptual disgust.

Demographics. Participants then completed a questionnaire about their taste preferences, political orientation, and other standard demographics- see Appendix D). They were directed to rate how much they liked sweet, bitter, salty, sour, savory, and spicy foods and indicate how open they were to trying new foods on a 7 point Likert scale ranging from *not at all* (1) to *very much* (7). They also rated the beverage they tasted on the same scale in terms of how bitter and sweet they found it. As opposed to the checklist used in Experiment 1, political orientation was assessed with a more sensitive measure, a 7 point scale ranging from *strong liberal/democrat* (1) to *strong conservative/republican*(7). Finally, they were asked to write down what they thought the study was about.

Results

None of the participants correctly guessed the hypothesis and thus all 60 participants were used in the primary analyses. Table 2 confirmed that participants actually perceived the moral transgression vignettes as morally wrong, the moral virtue transgressions as morally right, and the control vignettes as morally neutral, with higher numbers indicating morally right events and lower numbers indicating morally wrong events.

To determine the effects of the moral vignette manipulation, a one-way ANOVA of taste perception was conducted. Results revealed a significant effect of vignette type, $F(2, 57) = 16.43$, $p < .001$, $\eta_p^2 = .366$. Planned contrasts on the data in Figure 3 showed that participants perceived the beverage to be significantly more disgusting in the transgression condition ($M = 33.10$, $SD = 19.72$, $n = 20$) than in the control condition ($M = 45.40$, $SD = 21.05$, $n = 20$), $t(57) = 2.221$, $p = .030$, $d = -0.603$. The other contrast revealed that participants perceived the beverage to be more delicious in the virtue condition ($M = 64.60$, $SD = 9.41$, $n = 20$), than in the control condition, $t(57) = 3.466$, $p = .001$, $d = 1.261$. A post hoc Tukey test confirmed that the transgression and virtue conditions yielded significantly different taste perceptions, $p < .001$. In addition to rating how disgusting/delicious the target beverage was, participants also rated how sweet and bitter they perceived it to be. To determine whether vignette type affected participants' sweetness and bitterness ratings of the target beverage, a MANOVA was conducted on *both* sweetness and bitterness ratings (with vignette type as the between-Ss factor) and revealed no significant differences in either the sweetness or bitterness ratings as a function of vignette type, Fs < 1.

A regression was also performed to test whether taste perception could be predicted by moral judgments. Results showed that 46.2% of the variance in taste perception was accounted for by participants' moral judgments, $t(58) = 7.063$, $p < .001$, $\beta = .680$. Together, these results confirm the primary hypothesis that abstract moral processing can influence embodied gustatory experiences in both directions (disgust and delight).

According to the secondary hypothesis, conservatives were expected to show more pronounced effects in the predicted direction than liberals. Again, political orientation was assessed using a 7 point scale ranging from *strong liberal/democrat* (1) to *strong conservative/republican* (7). In order to best test the interaction effects of vignette type and political orientation on taste perception, political orientation ratings were grouped into three categories, with scores ranging from 1-2 being liberals (n = 18), scores ranging from 3-5 being moderates (n = 23), and scores 6-7 being conservatives (n = 19). Although this method might be criticized on the grounds that information is lost by grouping political orientation this way, it is unlikely to be an issue here. First, it is highly unlikely that the reliability of this scale is so exact that that each participant's score is *exactly* correct. Second, it is also highly unlikely that the intervals between these point values are so miniscule that such a categorical assignment would result in any significant or meaningful loss of data. For the reasons articulated here and elsewhere (Nunnally, 1978), collapsing the political orientation variable into the aforementioned categories is the best approach to answering this particular interaction hypothesis.

A 3 (vignette type: transgression, virtue, control) X 2 (political orientation: conservatives, liberals) between-subjects ANOVA was conducted on taste perception to

determine if conservatives' exposure to different moral valences influenced their taste perceptions significantly more than liberals. Hence, the political moderates were excluded from these specific analyses. There was no significant interaction between vignette type and political orientation on taste perception, $F(2, 31) = 1.667$, *n.s.*, nor was there a main effect of political orientation, $F(1, 31) = 1.122$, *n.s.* There was a main effect of vignette type but this was redundant with the previously described one-way ANOVA. However, as shown in Figure 4, simple effects analyses on political orientation revealed that conservatives rated the beverage as significantly more disgusting ($M = 23.75$, $SD = 6.37$) than liberals ($M = 45.00$, $SD = 7.36$) in the moral transgression condition, $p = .037$, which is consistent with Experiment 1's finding that participants' moral judgments were only significantly affected by the bitter beverage condition, with no real differences in moral judgments between the control and sweet conditions. Again, since participants also rated the target beverage in terms of its sweetness and bitterness, a MANOVA was conducted on *both* sweetness and bitterness ratings (with vignette type and political orientation as between-Ss factors) and indicated no significant main effects or an interaction, all p_s = *n.s.*, which is also consistent with the above findings.

To further explore the relationship between political orientation and taste preferences, an exploratory correlational analysis was conducted comparing participants' self-reported political orientations and their preferences for sweet, sour, salty, bitter, savory, and spicy foods, as well as how "open" they are to trying new foods. For this analysis, *all* of the participants were included (i.e., the political moderates). Results are presented in Table 3, showing specifically that political conservatism is significantly positively associated with stronger preferences for bitter foods, $r = .289$, $p < .05$.

Discussion

The purpose of the present experiment was to investigate the strength of the connection between moral processing and embodied experience by reversing the directionality of Experiment 1's primary finding. After presenting participants with moral transgressions, virtues, or control events, they were all asked to rate the same target beverage in terms of how disgusting, delicious, bitter, and sweet they found it. It was hypothesized that that those exposed to moral transgressions, virtues, or control events would perceive the beverage as disgusting, delicious, or neutral tasting, respectively, and that this trend would be stronger in political conservatives when compared to politically liberal individuals.

Results showed that exposure to different moral (or non-moral) events did indeed elicit the predicted taste perceptions. These findings not only bolster the link between moral transgressions and embodied states of disgust (as also found in Experiment 1), but additionally show that the opposite is true- namely, that moral virtue is connected to embodied delight, which appears to be a novel finding morality research. Together, these results both replicate and extend the findings of Experiment 1.

The secondary hypothesis pertaining to political orientation was not supported overall; conservatives and liberals rated the beverage similarly in most cases. However, conservatives *did* perceive the beverage to be significantly more disgusting than liberals in the moral transgression condition. This is an important result because it further demonstrates that conservatives and liberals seem to differ only in their sensitivity to disgust. Experiment 1 found that conservatives made harsher moral judgments than liberals when they were in a state of gustatory disgust, and Experiment 2 found that

conservatives experienced greater gustatory disgust than liberals when they were in a state of moral disgust. Together, these findings show that disgust is a crucial component with respect to political orientation and morality, a conclusion that has been made elsewhere (Inbar, Pizarro, & Bloom, 2009).

Although there was a significant positive correlation between conservatism and bitter-taste preferences, the overall results from the present research would suggest that this finding needs to be replicated before any serious conclusions can be drawn. Thus far, it seems as though disgust, *not* bitterness per se, is the underlying mechanism connecting political orientations and moral judgments. Although it would be a striking claim to say that conservatives do actually *prefer* bitter tastes, it would force opposite predictions; specifically, that conservatives take *delight* in bitterness and therefore would make *kinder* moral judgments in these instances, which would contradict the present findings.

Experiment 3: The Effects of Controlled Emotions on Moral Judgments

Experiments 1 and 2 revealed that taste perception and morality seem to share in the same conceptual space. Specifically, they suggest that interoceptive perceptions (i.e., emotional states and affective information) are a fundamental part of how we represent and process MORALITY. This line of reasoning has been taken up elsewhere (Schwarz & Clore, 1998), and in morality research it is often referred to as *moral intuitionism* (Haidt, 2001, 2003, 2007). This two-stage model predicts that emotional states influence moral judgments in a direct and automatic manner, whereas reason-driven states are supported by controlled processes, which are not always required and/or motivated. If this model is correct, then moral judgments are (generally) more akin to automatic processes rather than controlled ones, which is a striking claim. If emotional information is so critical for

moral processing, then inhibiting emotional systems should inhibit moral judgments. The present experiment replicated the general approach of Experiment 1 but with a critical added instruction: Participants were informed of the true hypothesis at the onset of the experiment- namely, that it was expected that different tastes would influence their moral judgments. They were directed to overcome these perceptual effects and engage in a "conscious, controlled, and deliberate approach to moral thinking." It was hypothesized that their controlled emotional inhibitions would lead to less severe moral judgments (in both positive and negative directions). In short, no significant differences in moral judgments as a function of taste were expected.

Method

Participants and procedure. Twenty-seven (16 female) undergraduates were recruited from the Brooklyn College Psychology participant pool. They were told that the present experiment was designed to explore the effects of taste perception on moral judgments and that they should do their best to control and inhibit their emotions as they taste different beverages and make moral judgments.

Taste manipulation and moral vignettes. As a within-subjects variable, participants were administered the sweet, bitter, and control beverages used in Experiment 1 in counterbalanced order. They were not told the identity of the beverages, although an ingredient list was provided to check for potential allergies. Beverages were administered in three one-teaspoon doses in a small cup, with the first dose given at the onset of the moral judgment task, the second one administered after two vignettes were judged, and the third after two more vignettes were judged. Participants were instructed to drink each dose in its entirety in a single swift motion, "as if they were drinking a shot" as

they made moral judgments using the same 14-cm line on the six vignettes from Wheatley and Haidt (2005) used in Experiment 1, which were also counterbalanced to control for order effects.

***Demographics and beverage ratings*.** Following the moral judgment task, participants were given the same political orientation measure used in Experiment 2, as well as the other basic demographic questions. It was hypothesized that conservatives would have more difficulty inhibiting their emotions than liberals, which would be reflected in their greater range of judgments*.* Participants also rated each beverage with respect to how sweet, bitter, neutral, disgusting, and delicious they found it on a 7 point Likert scale ranging from *not at all* (1) to *very much* (7).

Results

Since the hypothesis was revealed at the onset on the experiment, all participants were used in the primary analyses. Table 4 showed participants' ratings of each beverage, with higher numbers indicating stronger endorsement of a particular taste. Overall, ratings confirmed that they perceived the Swedish Bitters to be bitter and disgusting, the berry punch to be sweet and non-disgusting, and the water to be neutral and non-disgusting. However, participants did not rate the Bitters *as* bitter and disgusting as the participants from Experiment 1, and they also perceived the Bitters and berry punch to be more neutral tasting than the participants from Experiment 1. These results provide evidence that participants were in fact "controlling" their emotional and perceptual experiences.

To determine whether the instructions (i.e., use a "conscious, controlled, and deliberate approach to moral thinking") helped participants inhibit their emotional and perceptual experiences and focus on the moral events, a within-subjects ANOVA of moral

judgment was conducted with taste (bitter, sweet, and water) as the repeated-measure. Results showed that taste did *not* significantly affect moral judgments, $F(2,52) = 1.526$, $p = .227$, as indicated in Figure 5. Furthermore, across all conditions moral judgments hovered around the neutral range, with the bitter taste judgments ($M = 63.06$, $SD = 17.87$), sweet taste judgments ($M = 57.30$, $SD = 16.87$), and water taste judgments ($M = 65.44$, $SD = 16.02$) signifying somewhat "neutral" moral judgments.

To further show that participants' perceptual states were not influencing their moral judgments, three regression analyses were performed: (1) treating participants' disgust taste ratings of the Bitters to predict moral judgments while they were drinking Bitters, (2) treating participants' sweet taste ratings of the berry punch to predict moral judgments while they were drinking punch, and (3) a final analysis treating participants' sweet, disgust, and neutral taste ratings on water to predict moral judgments while they were drinking water. Results confirmed that perceptual (1) disgust was *not* a significant predictor of participants' judgments while they drank the Bitters, $t < 1$, perceptual (2) sweetness was *not* a significant predictor of participants' judgments while they drank berry punch, $t < 1$, and none of the perceptual (3) disgust, sweet, and neutral taste ratings were significant predictors of participants' judgments while they drank water, all $t_s < 1$. Together, these results provide support for the primary hypothesis that emotional and perceptual states play fundamental roles in moral judgments and specifically that *inhibiting* or *controlling* those states similarly inhibits one's moral judgments.

According to the secondary hypothesis, conservatives were expected to have more difficulty inhibiting their perceptual and emotional states than liberals, and this would be reflected in their moral judgments. Specifically, it was hypothesized that conservatives

would be affected by the taste experiences and form moral judgment patterns consistent with Experiments 1 and that liberals would show no differences in their judgments as a function of taste. In order to best answer this interaction hypothesis, political orientation ratings were again grouped into the three categories used in Experiment 2 for the previously stated reasons. In this sample, there were 10 liberals, 10 moderates, and 7 conservatives.

To determine whether conservatives' moral judgments were more influenced by their emotional and perceptual experiences than liberals' moral judgments, a 3 (Taste: bitter, sweet, control) X 2 (Political orientation: conservative, liberal) mixed model ANOVA was conducted, with political orientation treated as a between-Ss factor. The moderates were excluded from the following analyses because predictions were not made for them. Results now showed a significant main effect of taste yielding the following moral judgment averages for the bitter condition (M = 67.50, SD = 3.39), sweet condition (M = 53.75, SD = 3.10), and control condition (M = 62.76, SD = 3.78), $F(2,30) = 3.711$, p =.036, η_p^2= .198, where only judgments in the bitter and sweet conditions significantly differed, p =.009. There was also significant interaction between taste and political orientation, $F(2,30)$ = 4.673, p =.017, η_p^2= .228, and simple effects analyses on political orientation indicated that conservatives made significantly harsher judgments (M = 78.86, SD = 5.19) than liberals (M = 56.15, SD = 4.35) but *only* in the bitter condition, p =.004, as shown in Figure 6. These two results are consistent with the findings from Experiment 1, which revealed that moral judgments are affected more by bitter disgust than sweetness, and also that disgust influences conservatives' judgments more than liberals' judgments.

Finally, simple effects on taste revealed that conservatives made significantly harsher judgments in the bitter condition than in the sweet condition (M = 59.14, SD = 4.76), p =.013, and in the water condition (M = 58.57, SD = 5.80), p =.037. Conservatives judgments did *not* significantly differ between the sweet and water conditions, which is consistent with the previous experimental findings that disgust is what drives conservatives' moral judgments. Liberals' judgments only significantly differed between the sweet condition (M = 48.35, SD = 3.98) and the water condition (M = 66.98, SD = 4.86), p =.011. Unlike Experiment 1's findings, the present experiment provides evidence that liberals *do* recruit emotional and perceptual information into their moral judgments. This result is consistent with previous findings reported here and elsewhere that liberals' moral judgments do *not* seem to rely on disgust in the way conservatives' judgments do. However, given this new and theoretically unanticipated finding, replication is required before claims are made regarding the potential mechanisms underlying this effect.

To further explore the relationship between political orientation and taste preferences and also provide a replication for the findings in Experiment 2, a correlational analysis was conducted comparing participants' self-reported political orientations and their preferences for sweet, sour, salty, bitter, savory, and spicy foods, as well as how "open" they are to trying new foods. For this analysis, *all* of the participants were included (i.e., the political moderates). Results are presented in Table 5, showing specifically that political liberalism was significantly positively associated with stronger preferences for savory foods, r =-.468, p <.05. Conservatives' bitter taste preference found in Experiment 2 was *not* replicated, although there was a similar trend, r =.322, *n.s.*

Discussion

The purpose of the present experiment was to determine whether conscious emotional regulation would inhibit moral processing. In particular, participants were directed to control and inhibit their emotional and perceptual states and engage in a "conscious, controlled, and deliberate approach to moral thinking". If emotional regulation diminishes the severity of moral judgments, then it follows that emotions are a fundamental part of moral processing.

Results revealed that the emotional regulation directions significantly reduced the effects of the taste manipulation on moral judgments, which were also more neutral than Experiment 1. Furthermore, participants' taste ratings (disgust, sweet, bitter, etc.) of each beverage failed to predict moral judgments, providing additional support that perceptual taste was indeed suppressed. Together, these findings appear to confirm the primary hypothesis that emotional regulation diminishes the severity of moral judgments. There are some caveats that temper this conclusion and the extent to which emotional regulation/inhibition really drove this effect, but a discussion of these issues will be postponed until the general discussion.

To what extent does this effect hold true for both conservatives and liberals? Experiments 1 and 2 found that conservatives were more likely to be influenced by their perceptual and emotional states of disgust than liberals. Accordingly, it was hypothesized that conservatives would have more difficulty inhibiting their emotional and perceptual experiences and this would be reflected in a greater range of moral judgments, specifically in the bitter condition. Results showed that conservatives were significantly affected by their emotional experiences; specifically, their moral judgments were significantly harsher in the disgust group (bitter condition) when compared to each non-disgust group (sweet

and water conditions). However, liberals' judgments *also* differed as a function of taste; they made significantly kinder moral judgments in the sweet condition when compared to the water condition. Their judgments did not differ from the disgust and non-disgust groups. Finally, when comparing political orientation at each level of taste, conservatives' and liberals' judgments only significantly differed in the bitter condition, with conservatives making harsher judgments. Together, these findings replicate previous results showing that conservatives are influenced by perceptual and emotional disgust more than liberals (Inbar, Pizarro, & Bloom, 2009). While the present study revealed a novel finding that liberals are *also* influenced by their perceptual and emotional states, specifically with respect to the sweet and water conditions, this unexpected result was not found in the previous two experiments and requires replication before serious consideration is given to its potential underlying mechanisms. Nevertheless, a potential account will be provided later to explain this effect. These results suggest that political orientation, affect, and morality share a more complex relationship than previous thought, which warrants further investigation.

To replicate Experiment 2's positive correlation between conservatism and bitter-taste preferences, a similar correlational analysis was conducted with Experiment 3's sample. The results did *not* replicate for this specific relationship, although a trend in the same direction was found. A new finding emerged indicating that liberalism was significantly positively related with savory-taste preferences. Given the failed replication, this new and theoretically unanticipated finding, and relatively small sample size of the present experiment, the liberalism-savory finding should be replicated before any serious conclusions are drawn, although a tentative account will be provided.

General Discussion

The purpose of the present research was to determine the extent to which sensoriperceptual and emotional information influenced the representation and processing of a complex abstract concept, specifically morality. According to grounded and embodied accounts of cognition, sensoriperceptual information is fundamentally intertwined with all varieties of conceptual representations, even abstract concepts (Barsalou, 1999, 2003, 2008, 2010). On the other hand, amodal accounts of cognition hold that abstract concepts do not operate on perceptual symbols and are instead supported by symbolic, verbal channels (Paivio, 1986, 1991, Pylyshyn, 1981; Schwanenflugel & Stowe, 1989). To determine the extent to which perceptual information affected high-level abstract cognitive processes involved with morality, the experiments reported here tested the effects of gustatory taste perception on moral judgment.

If grounded views of cognition are accurate, then the perceptual and emotional experiences of gustatory disgust should influence how individuals process moral issues and yield harsher subsequent moral judgments than gustatory states of non-disgust. Furthermore, drawing from the physiological findings in political psychology, political conservatives should be more affected by their sensoriperceptual and emotional experiences than political liberals (Kanai, Feilden, Firth, & Rees, 2011). Such differential findings would further strengthen the grounded view by showing how *physically* different bodies result in corresponding different higher-order judgments. However, if amodal views are accurate, then such embodied differences and their corresponding perceptual states should be processed in a separate perceptual domain and have no effect on moral representation and processing, which is theorized to be a distinct cognitive process.

The results of the present three experiments provide support for a grounded view of cognition. In Experiment 1, participants were directed to drink one of three different beverages types (bitter-tasting, sweet-tasting, *or* water-control) and subsequently make moral judgments. The overall results showed that the bitter beverage elicited significantly harsher judgments than either the sweet beverage or water conditions, with the latter two conditions not significantly differing. As predicted, political conservatives were more sensitive to disgust and made harsher moral judgments in the bitter condition when compared to the sweet and water conditions (combined), whereas liberals' judgments did not significantly differ as a function of taste.

Experiment 2 showed that the direction of the effect could be reversed. Participants were exposed to scenarios reflecting one of three kinds of moral events (virtue, transgression, *or* control) and then subsequently rated the *same* beverage in terms of how disgusting or delicious they perceived it. Results replicated Experiment 1, showing specifically that reading about moral transgressions caused a neutral-tasting beverage to be perceived as significantly more disgusting than after reading about morally neutral events. Additionally, reading about moral virtues caused that same beverage to be rated as significantly more delicious than after reading about neutral events. This is a particularly novel finding in morality research, which has focused almost exclusively on disgust/moral transgressions, and it shows that positively valenced moral events also share a relationship with positively valenced gustatory experiences. It was also predicted that conservatives would be more sensitive to disgust than liberals, and pairwise comparisons confirmed that after reading about moral transgressions, conservatives perceived the beverage to be significantly more disgusting than liberals. Finally, stronger political conservatism was

significantly associated with stronger bitter-taste preferences. Although conservatism and bitterness seem to have a special relationship with respect to moral processing, this finding challenges the present research. If conservatives do actually *prefer* bitter tastes, then they should make *kinder* judgments when they drink bitter beverages because they should *not* be in states of disgust. Alternatively, another possibility is that participants were simply rating their more general *reactions* to the various presented tastes and not their actual *preferences* for each taste. In other words, conservatives might be responding strongly to the bitter taste and rating it highly because they react strongly to bitter tastes in general, but do not necessarily enjoy those tastes. This view would be more consistent with the present evidence and other research. Either way, this finding requires replication before any conclusions are drawn.

Experiment 3 was designed to reduce the effects of perceptual experience and emotion on moral judgments. This design was motivated in part by Haidt's (2001) two-stage model of moral processing, which argues that perceptual/emotional information is processed in an implicit, automatic route that is distinct from rational-based information, which is proposed to be supported by more explicit, controlled routes. More specifically, Haidt (2001, p. 818) says that moral judgments "appear in consciousness automatically and effortlessly as the result of moral intuitions," which are rooted in emotional states. Moral *reasoning*, on the other hand, only occurs- when necessary- *after* the moral judgment has already been made. From Haidt's description it seems like there is little if any interaction between these two routes since moral judgments are thought to be formed prior to activation of the reasoning process. It can therefore be assumed from this model that

attempting to control or inhibit the emotional route would result in weakening those processes, thereby neutralizing subsequent moral judgments.

This possibility represents the strongest case for the importance of perceptual/emotional information in moral processing, and would predict that inhibiting perceptual/emotional states should similarly inhibit moral judgments, resulting in more "neutral" judgments. If perceptual/emotional states are really automatic, it could be argued that they should be immune to any sort of controlled process[5]. However, research has shown that the top-down regulation of emotion is possible and specifically activates the right ventral lateral prefrontal cortex, the dorsal medial prefrontal cortex, and the anterior cingulate cortex (Oshner & Gross, 2005). It therefore stands to reason that any attempts at inhibiting emotional states should degrade their effects and neutralize moral judgments in a corresponding manner.

Following the general design of Experiment 1, participants were given *all three* of the beverages (bitter, sweet, and water) to taste while they made moral judgments. They were told at the onset of the experiment to engage in a "conscious, controlled, and deliberate approach to moral thinking" and that they should try to inhibit their perceptual/emotional experiences of the beverages. Results showed that there was *no*

[5] Regardless of the debate about whether automatic and controlled processes are really qualitatively different rather than just the ends of the same continuum (Cohen, Dunbar, & McClelland, 1990; Logan, Taylor, & Etherton, 1999; Merikle, 1998; Shiffrin & Schneider, 1977), a truly automatic process according to a classical definition like Posner and Snyder (1975) appears to be rare if not impossible (e.g., Kiefer, 2007; Robidoux & Besner, 2011; Stolz & Besner, 1999).

effect of taste perception on moral judgments and that all judgments, regardless of taste, hovered around the "neutral" judgment mark. These results suggest that inhibiting one's perceptual/emotional states also inhibits the severity of one's moral judgments, but there are a few caveats to this interpretation.

First, the extent to which participants were actually inhibiting their emotional states or strategically shifting their processing to rely mainly or exclusively on a more rational process in making their moral judgment is unclear. Participants were instructed to use a "conscious, controlled, and deliberate approach" for their judgments, so it is indeed possible that this rational process *was* in fact interacting with the (most likely neutralized) emotional channel. Haidt's (2001) model does not specifically acknowledge this possibility. Hence, it is unclear what pathway should be the most activated in this case. Would the neutralized emotional channel still be the primary input into moral judgments, or were participants really just using their rational channels above and beyond, or instead of, their emotional channels, which is a reversal of the basic premise of Haidt's model? Demand characteristics may also have played a role here. More specifically, since the experiment used a within-subjects design, participants could have simply relied on a response strategy of keeping their ratings relatively neutral and in close range to each other. Although this possibility cannot be ruled out, participants' ratings of how they perceived the beverages and nature of their moral judgments does suggest that they were inhibiting their emotional responses. However, the extent to which rational processes actually interacted with emotional states, if at all, is difficult to really determine. Regardless of the exact underlying processes that participants used, their moral judgments were degraded in their severity, and this finding differed for conservatives and liberals.

With respect to political orientation, a second caveat of this experiment is that the conservatism-bitterness correlation found in Experiment 2 was not replicated here, although there was evidence of a similar trend. It therefore seems likely that conservatives do have a slight preference for bitter tastes, but this conclusion is not definitive. Overall, conservatives made harsher moral judgments than liberals while they were drinking the bitter beverage, which is consistent with the findings from Experiments 1 and 2. Conservatives continued to make significantly harsher judgments while drinking the bitter beverage when compared to the sweet beverage and water, which is also consistent with findings from the first two experiments. However, liberals made significantly kinder judgments while drinking the sweet beverage when compared to water. This is the first evidence that liberals also recruit perceptual/emotional information into their judgments. Although it seems firmly established that liberals do *not* rely on disgust as part of their processing of moral events, it is difficult to determine whether this specific finding is really meaningful or not, particularly since there was no evidence of this in the prior two experiments. Moreover, the correlational evidence from Experiment 3 revealed that stronger liberalism was significantly associated with stronger savory-taste preferences, which is an additional new and theoretically unanticipated finding. Any conclusions based on this single experiment's findings should be interpreted cautiously prior to replication, but, taken together, the sweet and savory liberalism results could be made into a tenable claim.

Research suggests that conservatives and liberals differ in a least a few important ways (Federico, Jost, Pierro, & Kruglanski, 2007; Jost, Glaser, Kruglanski, & Sulloway, 2003). Of these, it appears that conservatism is significantly predicted by a need for

cognitive order, structure, closure, intolerance for ambiguity and uncertainty, and fear of threat and loss, among others. On this view, disgust can be treated as a response to and marker of a *threatening* stimulus that will likely yield uncertain consequences (e.g., states ranging from discomfort to death), which provides a reason why conservatives are more sensitive to disgust. Liberalism, on the other hand, appears to be predicted by openness to experience, a tolerance for uncertainty/complexity, and a tendency to endorse non-status-quo (i.e., progressive) attitudes. Compared to conservatives, liberals prefer new and complex experiences, which require openness and willingness for exploration (Federico, Jost, Pierro, & Kruglanski, 2007; Jost, Glaser, Kruglanski, & Sulloway, 2003). This type of exploration could be likened to energy seeking behaviors that are best accommodated by sweet (energy rich) and savory (protein rich) foods, which also activate the same taste receptors (Bachmanov & Beauchamp, 2007). Similarly, openness and willingness for exploration might also be related to a weaker disgust response, which normally has a protective function by virtue of withdrawing one from bodily engagement. Thus, one potential explanation for why conservatives and liberals differ in their specific taste preferences is that each taste functions as a marker for events that are particularly relevant to their ideology (fear and threats for conservatives and openness and exploration for liberals).

Regardless of the liberalism findings and the post-hoc explanations for them, the results from the overall trends for political orientation support the view that these individual differences stem from the specific effects of different perceptual states on the

higher-order cognitive processing of certain individuals, like conservatives[6]. After looking at the overall trends for *all* participants, regardless of political orientation, it is clear that perceptual information significantly predicts their moral judgments such that perceptual disgust and moral disgust are linked (Experiments 1, 2, & 3) and that perceptual delight and moral virtue are linked (Experiment 2), with the latter being a particularly novel finding. The central claim of grounded and embodied accounts of cognition is that sensoriperceptual states are fundamentally intertwined with all conceptual representations. The evidence from the present research supports this view and shows specifically that abstract concepts like morality are processed (at least in part) by perceptual symbols. While it seems clear that the representation and processing of an abstract concept like morality *is* supported by perceptual symbols, the mechanism that incorporates perceptual symbols into abstract conceptual representations remains mysterious. More specifically, how exactly does one's experience with gustatory disgust become part of one's representation of MORALITY?

Potential Theoretical Accounts

Recall that Barsalou's framing method is his principle way of explaining how perceptual symbols become incorporated into and provide the foundation for abstract conceptual representations. Put simply, it consists of (1) recalling perceptual scenes that "frame" the target abstract concept, (2) identifying relevant introspective and proprioceptive states as well, such as emotions, and finally (3) targeting the "core"

[6] Since the causal nature of this relationship is still unclear, the opposite could also be true: Different political orientations could yield different perceptual and embodied states, which would in turn influence higher-order cognitions.

perceptual and introspective symbols that represent the abstract concept against the background noise, so to speak. While promising in many respects, it is unclear what mechanism recalls, identifies, targets, and abstracts the perceptual information from these event sequences and builds an abstract representation out of them. Prinz (2002) has offered a few alternative strategies to incorporate perceptual symbols into abstract representations: mental operations, labeling, sign-tracking, and metaphorical projection. The last of strategies, i.e., metaphorical projection, seems to have the strongest potential, and it is reminiscent of research in cognitive linguistics, most notably Conceptual Metaphor Theory (Gibbs, 2006; Lakoff, 1993; Lakoff & Johnson, 1980, 1999).

Conceptual metaphor theory. According to Prinz (2002), abstract concepts can be represented through metaphorical projection, which consists of dissolving concepts into meaningful components that are represented perceptually. For example, MORALITY can be broken into TASTE and FEELING, with TASTE being perceptually instantiated through experiences with physical substances whose properties are disgusting, savory, warm, cold, etc. and with FEELING being perceptually instantiated by the emotions that give individuals specific states of approbation and disapprobation. These two domains converge so that moral actions can be cold or warm and disgusting or unsavory. Thus, these two grounded perceptual experiences are projected onto MORALITY to shape its meaning. Further, relevant exemplars of MORALITY might be simulated during processing (e.g., a child unwrapping an altruistic gift from a friend), and such experiences can be used to modify this complex representation. In sum, this view predicts that MORALITY comes to refer to an evolving concept that is rooted in basic perceptual instances and modified by experiential exemplars.

Similar strategies have been proposed by others (Boroditsky, 2000; Gibbs, 2006; Lakoff & Johnson, 1980; Ritchie, 2008). In particular, Casasanto (2009) coined the term "mental metaphors" to refer to the way in which nonlinguistic associations from perceptual source domains are mapped onto abstract target domains. Each of these accounts uses Conceptual Metaphor Theory (CMT) as the springboard for their proposals in some capacity or another (Gibbs, 1992; Lakoff, 1993). In general, metaphor expresses how seemingly unrelated concepts are compared using source and target domains (Glucksberg, 2003). For example, to say that *life is a journey* takes the source domain (journey) to explain the target domain (life). This metaphor suggests that life takes paths that can be long, arduous, unexpected, exciting, goal-driven, etc. Metaphor research is typically couched in linguistics and other language related fields, which implies that it is strictly a happening of the linguistic mind. In contrast, CMT can be taken as the thesis that metaphor is not just a happening of the linguistic mind, nor is it reserved only for language related phenomena (e.g., metaphorical usage in creative writing). Instead, proponents of CMT champion metaphor as a basic aspect of thought itself. On this view, language represents an outward manifestation of the deeper mental happenings, during which phenomenal experiences (embodied and otherwise) are mapped onto appropriate conceptual target domains. As Ritchie (2008, p. 176) notes, "Metaphor is primarily conceptual, and the linguistic expressions we usually think of as 'metaphors' are expressions or manifestations of underlying conceptual metaphors."

Lakoff and Johnson (1980, 1999) famously provided a framework for understanding metaphor that still forms the core of most grounded and embodied approaches to abstract conceptual representation (Boroditsky, 2000; Casasanto, 2009; Gibbs, 2006; Prinz, 2002).

They reasoned that sensorimotor and other "low level" experiences provide the basic material from which concepts are developed, organized, and represented. Consider the following common expression: *Marian is a warm person*. To most native English speakers, Marian's warmth is taken to represent her kind, empathetic, and caring nature. According to CMT, a child's embodied experience of warm physical contact comes to be correlated with said traits, which are typical of nurturing caregivers. The result is that embodied experiences of warmth (source domain) help shape individuals' understanding of specific positive qualities (target domain) in others. However, it is also possible that warmth became associated with certain personality traits through language conventions and regular co-occurrences. A stronger test of the grounded claim would assert that embodying warmth would promote the corresponding feelings, thus showing that embodied experiences are part of this conceptual arena. In a clever experiment, Williams and Bargh (2008) showed that participants who experienced physical warmth (holding a warm vs. iced cup of coffee) were more likely to judge unknown target individuals as more caring, generous, etc. than participants who experienced coldness. In short, literal warm feelings engendered figurative warm feelings.

One possible criticism of CMT is that some source domains can be mapped onto many different conceptual targets. For example, the relationship between LOVE, JOURNEY, SPACE, and BODY varies somewhat. Love (1) can be a long, winding road; (2) a series of high and low points; and (3) on its last legs. In retrospect, it is difficult to determine which sensorimotor experiences best represent LOVE and are fundamental to the metaphorical mapping strategies described above. Thus, it may be that the number of mappings is indefinite and perhaps applied post-hoc.

One response to this criticism is that embodied experiences provide a *basis* for conceptual development. Recall that according to Barsalou's (1999, 2010) Perceptual Symbol Systems theory, conceptual processing involves *partial* simulations of perceptual symbols, for which embodied experiences provide the raw material. Therefore, various embodied experiences could be shared and used for representing multiple conceptual domains (i.e., LOVE via JOURNEY, SPACE, and/or BODY experiences), resulting in a complex embodied network through which metaphor relates source and target domains and represents them through their associations with other.

Blending theory. Blending Theory (Fauconnier & Turner, 1998) is another influential approach to metaphor. In contrast to CMT, which involves establishing a mapping between two conceptual domains (source and target), Blending Theory (BT) uses a set of "mental spaces", which are temporary representational structures supported by conceptual domains. More specifically, a *temporary* and *partial* mental space is constructed by combining different conceptual representations. This process involves generating a four-space model consisting of two input spaces (one for each conceptual domain), a generic space (contains shared conceptual structures), and a blending space (contains interactive properties taken from each input space). The blending space, in particular, has an emergent-like structure based on the way in which properties combine to create meaning, which could explain how multiple embodied domains become attached to an abstract concept. For example, MORALITY could be represented in temporary mental spaces like TASTE and PROPRIOCEPTION, with *bitter* and *unsavory* acting as properties for TASTE and *closeness* and *distance* acting as properties for PROPRIOCEPTION). The generic space catalogues similar properties under generic headings (*bitter* and *unsavory* are filed

under *sensory perception*, whereas *closeness* and *distance* are filed under *space*). Finally, the blending space creates a temporary representation that uses partial information to construct meaning out of these seemingly disparate domains so that *keeping distance from unsavory people* activates both TASTE and PROPRIOCEPTIVE properties.

Distributed embodied network theory. Although the prior theories each have strengths and weaknesses, it seems clear that embodied experiences have all the necessary information to provide a foundation for all types of conceptual representations, even in abstract cases. Although it could reasonably be argued that embodied experiences are too closely tied to their sensoriperceptual origins, and thus less flexible, I maintain that such experiences *lack* intrinsic conceptual content and are therefore available for the mapping and blending processes demonstrated in metaphor. By taking and combining the strongest elements of prior accounts, I therefore propose that abstract conceptual representations are represented through what I term the Distributed Embodied Network Theory (DENT). Here, a variety of perceptual experiences are connected in a network of metaphorical mappings and dynamic blending spaces. This network develops initially as a set of sensorimotor experiences, similar to Piaget's sensorimotor stage. Its connections arise first through mapping processes, through which embodied source domains are linked to single target domains based on the associative strength of the relationship and the state, constitution, and general embodiment of individual agents. For example, suppose young Marian's favorite toy was stolen, which aroused such a state of unpleasantness in her that she became physically disgusted and felt so sick to her stomach that she could not eat the rest of the day. If other events involving immoral acts repeatedly put Marian in similar physiological states of disgust, these regular co-occurrences could result in a metaphorical

connection between embodied source (TASTE) and target (MORALITY) domains, with DISGUST coming to signify something IMMORAL and vice-versa. (In a moment we will see how these sorts of fixed connections between domains can be exploited further for greater representational variation.) As shown by the above example, the associative strength of the relationship between these embodied and conceptual domains are affected by individuals' subjective states and internal constitutions. If subjective embodied experiences motivate conceptual representation, then we would expect that individuals' different embodied experiences would motivate different conceptual representations. To this end, Casasanto (2009) showed that right-handed participants mapped positive ideas on their rightward space and negative ideas on their leftward space, whereas left-handers showed the opposite pattern. Hence, the unique ways in which individuals embody their experiences determines their specific representations of abstract concepts in a permanent manner, thereby resulting in some of the individual differences evident in embodied cognition research (see also Schubert, 2004).

Returning to Marian, we previously established a general mapping between TASTE and MORALITY, specifically that immoral events are linked to *undesirable* states of disgust. Recall that CMT holds that this specific mapping between undesirability and immorality would be fixed. From these general mappings, however, more distributed and dynamic connections can be accounted for by blending spaces. Suppose Marian, now a teenager, engaged in a sudden and atypical act of theft. Surprised by this experience, and through her subsequent feelings of guilt, she finds herself more willing and able to eat her least favorite

meal that night at supper.[7] In other words, Marian's relationship between undesirability and disgust has now reversed so that disgust is now desirable. While these embodied experiences of desirability and undesirability equally draw from and inform Marian's TASTE domain, they come to represent different mappings (desirability and undesirability) with respect to DISGUST. BT accounts for these different conceptual mappings through *both* the perceptual differences (separate input spaces for DESIRABLE and UNDESIRABLE) and basic sensory commonalities (generic space for DISGUST and blending space for TASTE).

According to BT and DENT, these concepts become tied to embodied experiences via emergent blending spaces. The generic and blending spaces are supported by the embodied experiences that bear a rigid mapping to Marian's TASTE conceptual domain. In this way abstract concepts like morality can be represented using embodied states. However, from this description it might seem unclear exactly how BT and DENT differ. They both clearly use blending spaces to account for metaphorical mappings between various conceptual domains. Why posit an additional theory like DENT if BT can already explain these findings? On this view, BT's inherent flexibility is both its strength and weakness. In principle it can combine practically *any* two conceptual domains if enough linguistic imagination is applied to the blending spaces' labels and their corresponding properties. This general trait is a weakness because it no longer meaningfully explains the mechanisms that *actually* engender metaphorical mappings, nor does it tell us what is

[7] Recent research by Bastian, Jetten, and Fasoli (2011) found exactly this effect- namely, that engaging in an immoral act made participants more likely to "hurt" themselves and participate in an *undesirable* experience than participants who had not engaged in an immoral act.

critical to the representations themselves. DENT can remedy this problem by adding a critical component on which blending spaces are based: affective states.

According to DENT, emotions are the basic embodied foundations on which blending spaces are based. Recall Kousta and colleagues' (2011) finding that emotional valence accounts for the representation and processing of abstract words more than any other linguistic variable. Taken together with the *somatic marker* and *affect-as-information* hypotheses, a case can be made for the importance of emotions in human cognition. DENT predicts that emotional states are the most lasting and salient perceptual experiences that occur with respect to abstract concepts. Since the other perceptual features of event sequences that frame abstract concepts are mostly background noise and unessential to the core representations themselves (recall Barsalou's (1999) framing method), it seems most likely that emotions are the strongest and most permanent introspective perceptions that attach to abstract concepts. DENT uses emotional states to ground abstract representations and therefore all *subsequent* blending spaces are reducible to them. This process provides a layer of structure and predictability that is lacking from BT's current conceptualization. However, DENT still enjoys BT's flexibility to the extent that it can mix and match these basic emotional states with a variety of other perceptual properties and experiences, which provides each abstract representation with a complex network of perceptual symbols. This affective structure gives DENT the advantage of being able to make specific predictions about a variety of abstract conceptual representations.

With respect to MORALITY, BT and DENT would make very different predictions about the nature of the mental spaces. Again, with MORALITY as the target input space, BT could name *any* number of concepts to serve as the source input space, which is its

weakness. For example, BT could use SURGEON (*he is surgical* ***–precise-*** *with his moral reasoning*), TORNADO (*his ethics are completely unpredictable* ***–tornadoes' occurrences are nearly impossible to predict***), or LIBRARY (*he is a storehouse of moral virtue* ***– libraries are also storehouses***) to explain MORALITY. The resulting generic and blending spaces would therefore come from the linguistic associations and properties involved with the two input spaces, which are also hard to predict without having a sense of what the source input space would be or frequency ratings of the language associated with those two concepts. Hence, BT would make *no* specific predictions about the nature of the source input space, generic space, or blending space, and, most importantly, it would give no indication of the underlying representational nature of MORALITY.

DENT, however, would predict that the source input space would have an affective basis. Further, it would predict that the emotional space would be limited to one's specific perceptual experiences with MORALITY. Although the predicted source input space would vary as a function of individual differences, general predictions could be made. For example, a child's representation might use SADNESS as a source input space based on his or her likely predominant (and limited) experiences with moral events (*his moral actions were saddening*). An adult might use a more complex emotion such as SUBMISSION (the opposite of contempt, which is itself a hybrid of disgust and anger) to frame MORALITY (*he gave into his immoral desires*). Clearly, there is still a bit of variation in terms of the emotions that can be used, but DENT specifically predicts that emotions will serve as the foundation for processing abstract representations, which should be predictable (in theory) with an understanding of one's emotional history. More importantly, it grounds abstract conceptual representations in a more tractable domain (emotional valence) that

can help us understand this complex process. In addition, another advantage of DENT's affective structure is that it will also be able to make predictions about concrete conceptual representations.

Recall that Dove (2009) and Mahon and Caramazza (2008) argued that abstract concepts are poor candidates for perceptual symbols, suggesting that abstract concepts are in fact disembodied. Contrarily, it seems more probable that while *all* concepts are fundamentally embodied, some are more embodied (concept concepts) than others (abstract concepts). Therefore, another critical and unique aspect of DENT is to acknowledge that conceptual representations vary on a continuum ranging from very concrete to very abstract, which is analogous to a continuum of embodiment (very embodied-less embodied), such that the embodied continuum could potentially be used to predict the abstractness of concepts and vice-versa. Emotion in particular could also be used to predict the abstractness of concepts, with emotionally-valenced concepts being more abstract than non-emotionally-valenced concepts. As a result, DENT would use two kinds of perceptual states[8] (emotional and sensorimotor) to predict that the most abstract concepts would be high in emotional information but low in sensorimotor information, whereas the least abstract concepts would be high in sensorimotor information and low in

[8] On this view, *both* emotional and sensorimotor perceptual states refer to internal states activated by external stimuli. Emotional perceptual states are internal states that mark external stimuli and events that arouse affective responses (e.g., feeling disgusted by immoral acts or feeling satisfied by justice). These emotional states need not correspond to the *physical* properties involved with the event stimuli but rather the *outcomes* of them. In contrast, sensorimotor perceptual states refer to internal states that are activated by the physical external stimuli themselves (e.g., the physical weight of an object) as well as other proprioceptive and somatosensory states like audition and olfaction. Unlike emotional states, these states *are* indices of the physical properties of their corresponding stimuli.

emotional information. Further, in the most abstract cases, grounded representations and perceptual symbols could be supplemented with linguistic forms to facilitate concept building through context based regular co-occurrences. The central thesis, however, is that embodied experiences provide the basis for conceptual origins, representation, and development, and that metaphorical processes (i.e., mapping and blending) are the mechanisms that connect and incorporate emotional and sensorimotor information to various conceptual representations, with emotional states mainly involved in grounding abstract representations and sensoriperceptual states mainly responsible for grounding concrete representations.

DENT is clearly the offspring of PSS, CMT, and BT, and also takes cues from both the *somatic marker* and *affect-as-information* hypotheses. As a result I remain humble about its origin. It uses affective states, modal symbols, and partial simulations in a distributed, metaphor-enriched network to advance its flexibility and account for the representation of both concrete and abstract concepts. If perceptual symbols are as fundamental to conceptual representation as predicted by DENT, then they should be detectible in conceptual processing in both concrete and abstract representations, as evidenced by the present research.

Neural evidence for DENT. Another potential advantage of DENT over prior CMT and BT accounts is that it also incorporates recent findings from cognitive neuroscience and evolutionary cognition research in an attempt to specify the neural basis of these processes and how they may be implemented in the brain. Anderson (2010), in particular, has posited the *neural reuse hypothesis*, which bridges together several other hypotheses that provide evidence for brain plasticity and the distributed, non-modular

structure of the brain, its neural networks, and conceptual representation more broadly (see Gallese's (2008) *neural exploitation hypothesis*, Hurley's (2005, 2008) *shared circuits model*, Dehaene's (2005) *neuronal recycling theory*, and Anderson's (2007) own *massive redeployment hypothesis*). He observes that many approaches to understanding the brain still adopt the view that many brain regions are indeed highly specialized and that their functions can be localized in a relatively precise manner. However, even well documented regions like Broca's area, which has been traditionally understood with respect to its role in language processing, has been linked to a variety of different action-related tasks including action sequencing and imitation (Nishitani, Schurmann, Amunts, & Hari, 2005), action recognition (Hamzei et al., 2003), and action preparation (Thoenissen, Zilles, & Toni, 2002), among many others. Drawing from this and similar examples, he argues that it is evolutionarily more economical for neural circuits that are established for a particular use to be "recycled or redeployed" and put to *other* uses while preserving their original functions. As Anderson (2010) notes, the proposition uniting the above four neural theories is that "evolutionary considerations might often favor reusing existing components for new tasks over developing new circuits de novo" (p. 246). The result would be complex, dynamic, and distributed patterns of neural activity that could accommodate a variety of cognitive functions, which is similar to what a DENT model would predict. Although this is a reasonable approach to understanding the brain, it would help to outline and test specific hypotheses for this view.

Anderson (2010) outlined three specific hypotheses for neural reuse, which are organized below in his own words (p. 246):

> **1.** Most generally, we should expect a typical brain region to support numerous cognitive functions in diverse task categories. Evidence to the contrary would tend

> to support the localist story that the brain evolved by developing dedicated circuits for each new functional capacity.
>
> **2.** More interestingly, there should be a correlation between the phylogenetic age of a brain area and the frequency with which it is redeployed in various cognitive functions; older areas, having been available for reuse for longer, are ceteris paribus more likely to have been integrated into later-developing functions.
>
> **3.** Finally, there should be a correlation between the phylogenetic age of a cognitive function and the degree of localization of its neural components. That is, more recent functions should generally use a greater number of and more widely scattered brain areas than evolutionarily older functions, because the later a function is developed, the more likely it is that there will already be useful neural circuits that can be incorporated into the developing functional complex; and there is little reason to suppose that the useful elements will happen to reside in neighboring brain regions.

To test these specific hypotheses, Anderson took a massive sample (1,469 fMRI studies) that spanned 11 different task domains (action execution, action inhibition, action observation, vision, audition, attention, emotion, language, mathematics, memory, and reasoning) and found evidence supporting all three predictions. Regarding hypothesis (1), it was found that typical cortical regions[9] were activated in nine different task domains. Results for hypothesis (2) showed that older areas of the brain were significantly more likely to be involved with later-developed functions. This result provides specific support for the DENT account, showing how older regions (i.e., limbic system structures like the amygdala) are recruited for higher-order cognitions involved with the representation and processing of abstract concepts. Finally, hypothesis (3) was confirmed with significant correlations showing that more recently evolved faculties were more distributed and activated more regions than evolutionarily older faculties. For example, it was found that

[9] There were 66 total regions used for this study (e.g., fusiform gyrus, caudal middle frontal cortex, inferior parietal cortex, posterior cingulate cortex, superior frontal cortex, parahippocampal cortex, etc.).

language-related tasks activated more regions that were also more broadly scattered throughout the brain than visual perception tasks. Together, these findings provide support for DENT at a more specific level of analysis.

Limitations, Future Directions, and Summary

The present research explored the connection between sensoriperceptual states and morality. Although the overall findings provided evidence for the grounded view of cognition, there are a few limitations. First, and most importantly, the sweet beverage (berry punch) was actually not that sweet; in fact, it was more tangy and tart. Therefore, a more explicitly sweet beverage (e.g., sugar water or possibly some kind of syrup) should be used to better explore the positive valanced aspects of morality. Second, although emotional states were undoubtedly induced, there were no explicit or implicit measures of them. One such commonly used measure is the Positive and Negative Affect Schedule (PANAS), which is a 20-item self-report measure of subjectively-felt emotion (Watson, Clark, & Tellegen, 1988). Using this sort of measure in future research would further help to clarify the connections between specific emotions and morality. Third, the somewhat mixed findings for political liberals make it difficult to determine the extent to which they really incorporate sensoriperceptual and emotional states into their moral judgments and which tastes/emotions are specific to them. A post-hoc explanation was provided for the obtained effects, but the mechanisms underlying liberals' moral judgments remain unclear. Finally, Experiment 1 suffered from relatively unequal sample sizes in terms of both gender and political orientation, which may have affected some of the findings. While Experiments 2 and 3 had relatively even sample sizes for gender and political orientation, the overall

sample sizes for conservatives and liberals in Experiment 3 were still quite small, which might challenge the generalizability of those political findings.

Moving forward, there are several possibilities for future research in this domain. First, the extant literature on moral processing is unabashedly biased in its focus on moral judgments. Very little research has explored moral *behavior*. It is a truism in social psychology that attitudes are poor predictors of behaviors (Fishbein & Ajzen, 1975). If so, then it stands to reason that moral judgments are similarly poor predictors of moral behaviors, which is a critical component of our social, cultural, and ethical lives. It is therefore unclear how well the present results would predict moral behavior. Second, from a practical and applied perspective, it is unclear how significant these results really are-that is, does drinking something disgusting affect one's moral judgments for one minute, five minutes, an entire day, etc.? Third, if emotions really do affect moral processing so deeply, then future research should investigate individual differences in trait affective states. For example, do clinically depressed individuals or those with flattened affect have more trouble making moral judgments than their healthy counterparts? Fourth, as noted earlier, the overwhelming majority of morality research is focused on transgressions. Virtually no research has explored moral virtue and the effects of perceptual and emotional states on prosociality, which has many applications for society and everyday life. Finally, a more thorough investigation of specific tastes, morality, and political orientation is warranted. Would *sour* experiences and attitudes have similar effects on moral judgments as *bitter* ones? Do conservatives and liberals differ with respect to any of these tastes? Although the present research supports the general conclusion that disgust, not specifically

taste per se, is what critically affects morality, there is much room for exploration in this area.

In conclusion, Anderson's (2010) neural reuse hypothesis provides a striking alternative approach to understanding how concepts are represented in the brain. Although more empirical investigation is needed, this approach corroborates the presently proposed Distributed Embodied Network Theory and provides a window into understanding both the mechanisms that underlie conceptual metaphorical mapping and ultimately how abstract conceptual representations are processed. Evolutionarily older mechanisms (like emotions and other sensorimotor embodied states) seem like ideal candidates for explaining and understanding how more recent higher-order cognitive faculties (like moral judgments) operate. The distributed nature of this complex network helps unite the diverse empirical findings from grounded and embodied cognition, and gives this perspective a more precise theoretical architecture. Although morality is truly a complex phenomenon, the present research shows how affective and modality-specific information contributes to moral processing and helps to enrich our understanding of how abstract concepts might be represented in general.

Appendices

Appendix A

Bob was at a family gathering when he met Ellen, a second cousin of his that he had seen once or twice before. Bob found Ellen very attractive and he asked her out on a date. Ellen accepted and they began to have a romantic and sexual relationship. They often go on weekend trips to romantic hotels in the mountains.

Please answer the following questions by making a slashmark somewhere on the line to indicate your rating.

How morally wrong is this?

|_____|

not at all wrong	moderately wrong	extremely wrong

Frank's dog was killed by a car in front of his house. Frank had heard that in China people eat dog meat and he was to take a research trip to China soon. Wanting to better understand the culture he was about to visit, Frank cut up the body, cooked it and ate it for dinner.

Please answer the following questions by making a slashmark somewhere on the line to indicate your rating.

How morally wrong is this?

|_____|

not at all wrong	moderately wrong	extremely wrong

George is a personal injury lawyer. In order to find new cases for himself, he hangs out at the emergency room of hospitals, waiting for ambulances to arrive. When a new person is admitted to the hospital, he would take the person aside and tries to convince him or her to sue somebody for their accident.

Please answer the following questions by making a slashmark somewhere on the line to indicate your rating.

How morally wrong is this?

|_____|

not at all wrong	moderately wrong	extremely wrong

Congressman Arnold Paxton frequently gives speeches condemning corruption and arguing for campaign finance reform. But he is just trying to cover up the fact that he himself is often bribed by the tobacco lobby, and other special interests, to promote their legislation.

Please answer the following questions by making a slashmark somewhere on the line to indicate your rating.

How morally wrong is this?

|_____|

not at all wrong | moderately wrong | extremely wrong

Robert is unemployed and has been going to several businesses in the hopes of landing a job. He wants to look presentable when he tries to get a job but he can't afford to buy new clothes. So he has begun shoplifting. He goes to a store wearing a heavy jacket and then tries on shirts which he often wears out of the store under the jacket.

Please answer the following questions by making a slashmark somewhere on the line to indicate your rating.

How morally wrong is this?

|_____|

not at all wrong | moderately wrong | extremely wrong

Tim is a graduate student at the University of Minnesota. He likes to have library books at home to help him with his research, but the library won't allow him to check out any more books, since he has so many overdue. So he started to simply leave with the books from the library without checking them out. He has begun to take newspapers and magazines as well.

Please answer the following questions by making a slashmark somewhere on the line to indicate your rating.

How morally wrong is this?

|_____|

not at all wrong | moderately wrong | extremely wrong

Appendix B

Please answer the following questions as honestly as possible by circling a number that reflects how you feel.

How much did you enjoy the beverage?

←----------→

1	2	3	4	5	6	7
Not at all			Neutral			Very much

Did you find this beverage sweet?

←----------→

1	2	3	4	5	6	7
Not at all			Neutral			Very much

Did you find this beverage bitter?

←----------→

1	2	3	4	5	6	7
Not at all			Neutral			Very much

Did you find this beverage neutral in flavor?

←----------→

1	2	3	4	5	6	7
Not at all			Neutral			Very much

Did you find this beverage disgusting?

←----------→

1	2	3	4	5	6	7
Not at all			Neutral			Very much

Gender: _____

Age:_____

Year in college: _____

Ethnic background: _____

Major:_____

Political orientation: _____

(e.g., Conservative, Liberal, Independent, Libertarian, etc.)

Appendix C

Transgressions

Congressman Arnold Paxton frequently gives speeches condemning corruption and arguing for campaign finance reform. But he is just trying to cover up the fact that he himself is often bribed by the tobacco lobby, and other special interests, to promote their legislation.

Please answer the following questions by making a slashmark somewhere on the line to indicate your rating.

How moral is this?

|_____|

extremely morally bad	neither bad nor good	extremely morally good

Robert is unemployed and has been going to several businesses in the hopes of landing a job. He wants to look presentable when he tries to get a job but he can't afford to buy new clothes. So he has begun shoplifting. He goes to a store wearing a heavy jacket and then tries on shirts which he often wears out of the store under the jacket.

Please answer the following questions by making a slashmark somewhere on the line to indicate your rating.

How moral is this?

|_____|

extremely morally bad	neither bad nor good	extremely morally good

Virtues

Erik is a poor college student who often struggles to pay his bills. One day as he is buying groceries at a convenience store, he impulsively buys a lottery ticket. To his surprise, he wins $800. However, as he walks home, he sees a homeless mother with two children. He gives her the winning ticket, well aware that she needs the money much more than he does.

Please answer the following questions by making a slashmark somewhere on the line to indicate your rating.

How moral is this?

|_____|

extremely morally bad | neither bad nor good | extremely morally good

Darin was sitting in the park when he noticed a sleazy looking man walk up to a woman and ask her for directions. As she reached into her purse to find a map, the man punched her and grabbed her purse. Still clutching it, she fought him. Darin quickly intervened and fought off the man. Although Darin was injured, he doesn't regret his actions.

Please answer the following questions by making a slashmark somewhere on the line to indicate your rating.

How moral is this?

|_____|

extremely morally bad | neither bad nor good | extremely morally good

Controls

Erik is a new college student, and he is trying to pick out a major. Although he has narrowed down his choices somewhat, he still cannot decide if he wants to major in the humanities or the sciences. To help him make an informed decision, Erik has registered for a variety of classes to help him determine whether he prefers the humanities or sciences.

Please answer the following questions by making a slashmark somewhere on the line to indicate your rating.

How moral is this?

|_____|

extremely morally bad | neither bad nor good | extremely morally good

Jesse works as a waiter in a very nice restaurant. He has been working there for over a year and has received feedback about his performance. Jesse's routine includes learning new items on the menu, remembering daily specials, and interacting with the kitchen staff, bussers, and owners of the restaurant.

Please answer the following questions by making a slashmark somewhere on the line to indicate your rating.
How moral is this?

|_____|

extremely morally bad | neither bad nor good | extremely morally good

Appendix D

How did you perceive the beverage?

|_____|
very disgusting neutral tasting very delicious

How much do you like **sweet foods**?

←----------→
1 2 3 4 5 6 7
Not at all Neutral Very much

How much do you like **bitter foods**?

←----------→
1 2 3 4 5 6 7
Not at all Neutral Very much

How much do you like **salty foods**?

←----------→
1 2 3 4 5 6 7
Not at all Neutral Very much

How much do you like **sour foods**?

←----------→
1 2 3 4 5 6 7
Not at all Neutral Very much

How much do you like **spicy foods**?

←----------→
1 2 3 4 5 6 7
Not at all Neutral Very much

How much do you like **savory foods**?

←----------→
1 2 3 4 5 6 7
Not at all Neutral Very much

How **open** are you to trying different kinds of foods?

←----------→

1	2	3	4	5	6	7
Not at all			Neutral			Very much

Did you find this beverage sweet?

←----------→

1	2	3	4	5	6	7
Not at all			Neutral			Very much

Did you find this beverage bitter?

←----------→

1	2	3	4	5	6	7
Not at all			Neutral			Very much

How would you describe your political orientation?

←----------→

1	2	3	4	5	6	7
strong liberal/ democrat					strong conservative/ republican	

Gender: _____

Age:_____

Year in college: _____

Ethnic background: _____

Major:_____

Table 1
Participant taste preferences (Exp. 1)

Conditions	Bitter	Sweet	Water
Bitter taste	6.40 (.99)	1.76 (1.26)	1.17 (.71)
Sweet taste	1.07 (.26)	5.52 (1.36)	1.33 (.97)
Neutral taste	2.00 (1.36)	1.81 (1.44)	6.61 (.98)
Disgusting taste	6.13 (1.36)	1.38 (.74)	1.89 (1.81)

Table 2
Participant ratings for moral vignettes (Exp. 2)

Vignettes	Transgression	Control	Virtue
	17.00 (11.21)	56.08 (19.01)	88.90 (10.83)

Table 3
Correlations between political orientation and taste preference (Exp. 2)

Variables	1.	2.	3.	4.	5.	6.	7.	8.
1. Pol. ori.	-	0.157	.289*	0.018	0.026	0.155	-0.11	0.003
2. Sweet		-	.421**	-0.173	-0.001	-0.082	-0.385	-0.107
3. Bitter			-	-0.034	0.076	0.074	-0.069	-0.176
4. Salty				-	0.246	-0.139	0.107	-0.073
5. Sour					-	0.21	0.085	-0.152
6. Spicy						-	0.045	0.077
7. Savory							-	.297*
8. Openness								-

Table 4
Participant taste preferences (Exp. 3)

Beverage type	Swedish Bitter	Berry Punch	Water
Bitter Taste	5.52 (1.95)	1.44 (.51)	1.37 (.49)
Sweet Taste	1.22 (.42)	5.44 (1.37)	1.44 (.50)
Neutral Taste	3.15 (.72)	5.30 (1.03)	4.96 (1.65)
Disgusting Taste	5.56 (2.01)	1.81 (1.39)	1.95 (1.68)

Table 5
Correlations between political orientation and taste preference (Exp. 3)

Variables	1.	2.	3.	4.	5.	6.	7.	8.
1. Pol. ori.	-	0.114	0.322	-0.004	0.049	0.133	*-0.468	-0.26
2. Sweet		-	0.058	0.007	0.039	-0.034	0.19	0.31
3. Bitter			-	-0.005	0.048	0.008	-0.111	0.337
4. Salty				-	**0.737	0.25	0.316	-0.003
5. Sour					-	**.624	*0.385	-0.134
6. Spicy						-	0.307	-0.174
7. Savory							-	0.263
8. Openness								-

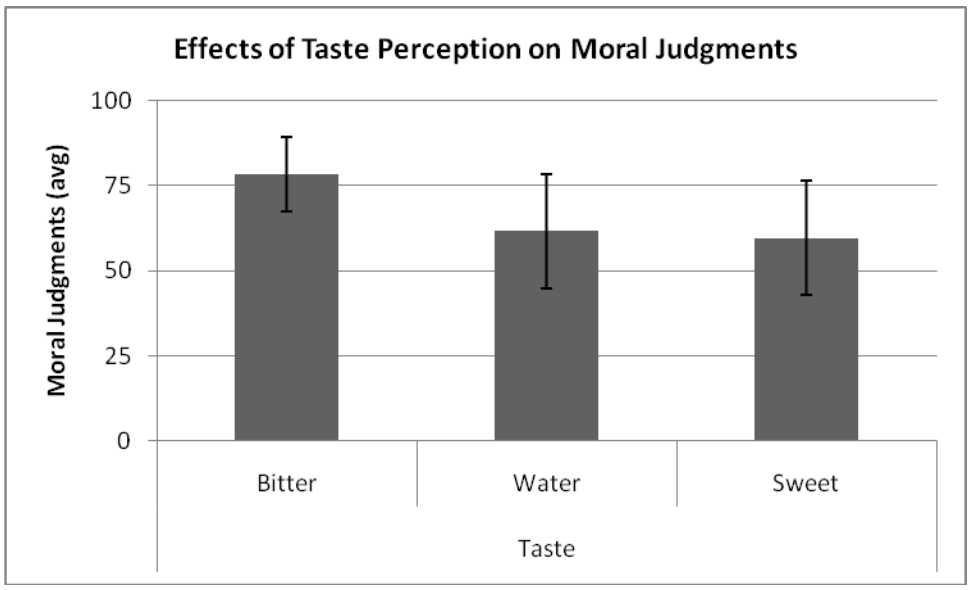

Figure 1. Participants' mean moral judgments as a function of the taste condition, where higher numbers indicate harsher judgments. (Experiment 1)

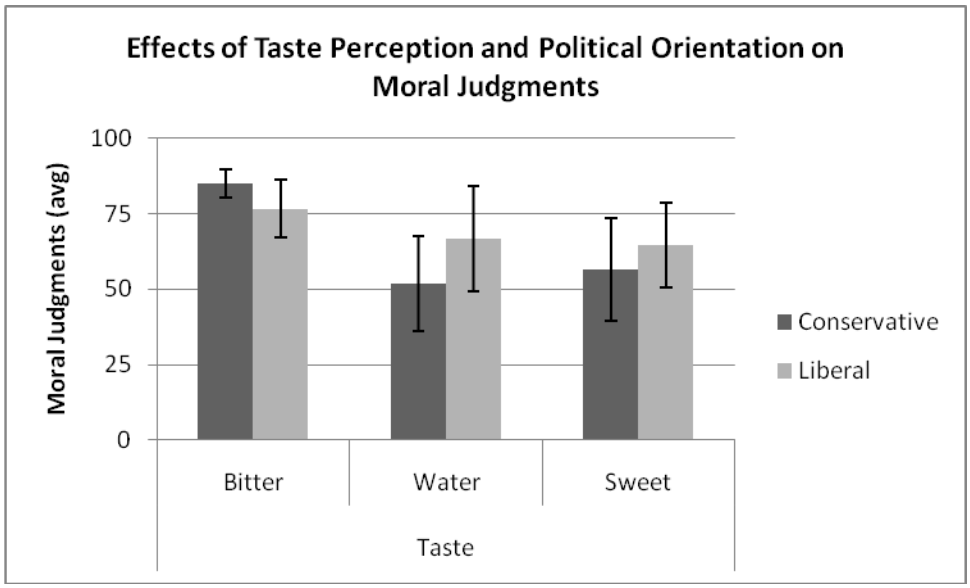

Figure 2. Participants' mean moral judgments as a function of taste and political orientation, where higher numbers indicate harsher judgments. (Experiment 1)

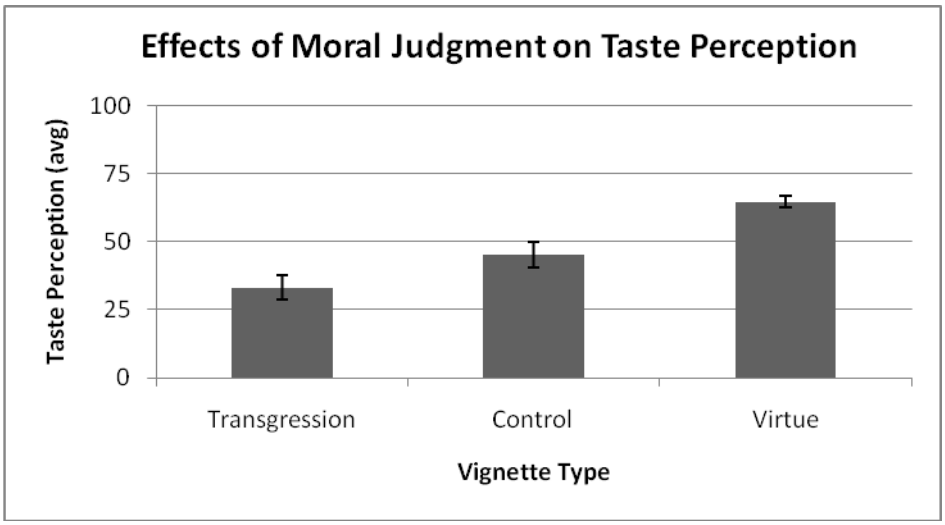

Figure 3. Participants' mean taste perceptions as a function of moral judgments, where higher numbers indicate more delicious taste perceptions. (Experiment 2)

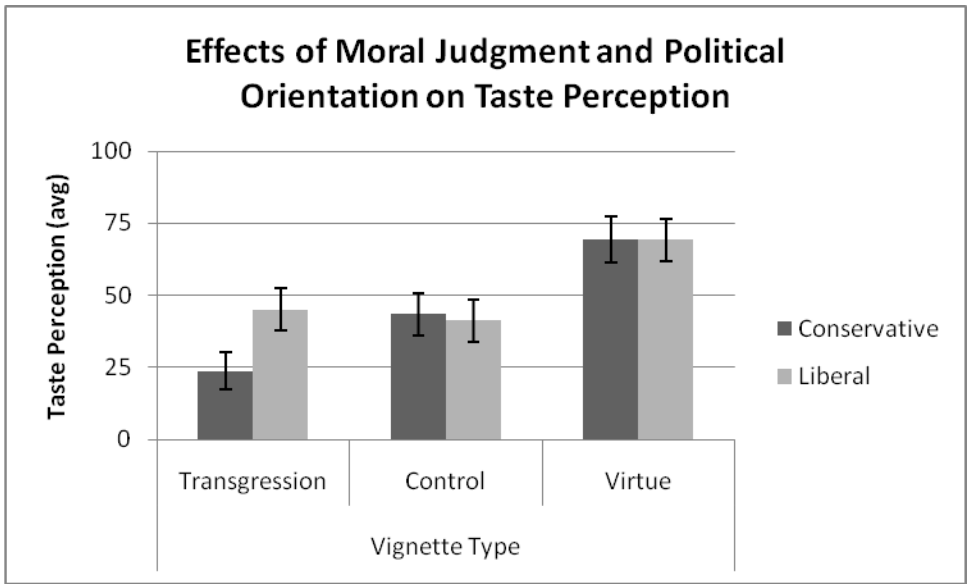

Figure 4. Participants' mean taste perceptions as a function of moral judgments and political orientation, where higher numbers indicate more delicious taste perceptions. (Experiment 2)

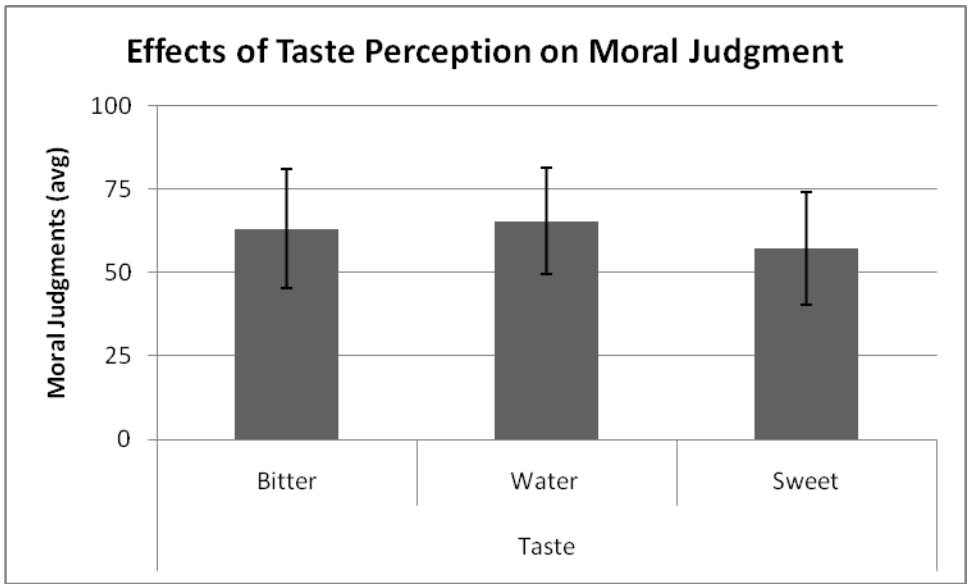

Figure 5. Participants' mean moral judgments as a function of the taste condition, where higher numbers indicate harsher judgments. (Experiment 3)

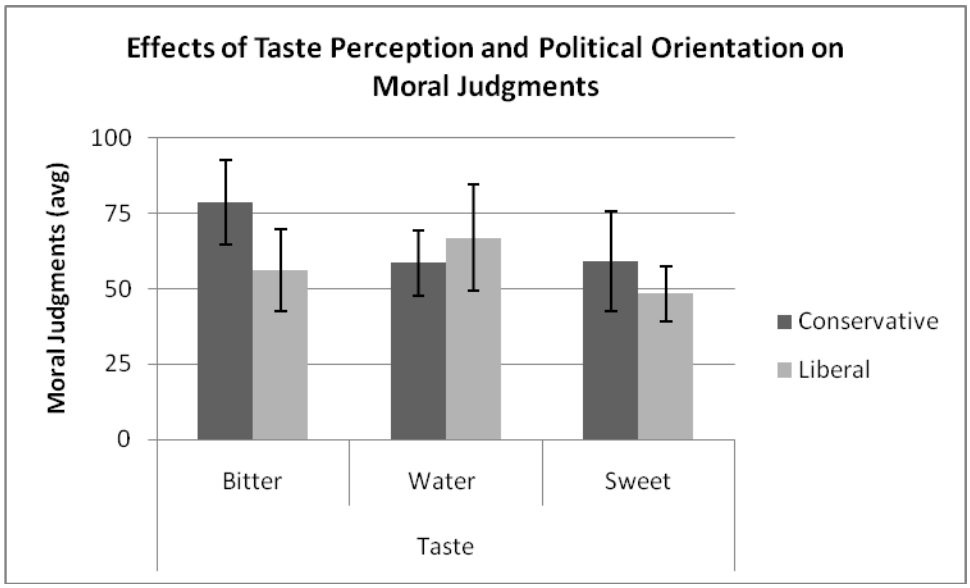

Figure 6. Participants' mean moral judgments as a function of taste and political orientation, where higher numbers indicate harsher judgments. (Experiment 3)

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