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Individual differences in the impact of odor-induced emotions on consumer behavior

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Individual differences in the impact of odor-induced emotions on consumer behavior

by

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ABSTRACT

The focus of this dissertation is to understand the role of olfaction (sense of smell) in consumer behavior. The close relationship between olfaction and emotions is the center of this dissertation, examining not only the impact of odors or olfactory imagery induced emotions, but also the downstream influences on consumer decision making and judgment. Another important focus of study is to explore how individual differences in olfaction, specifically hyperosmics (or so called sensitives) and normal, respond similarly or differently to odors. A series of four experiments, including a combination of event-related potential (ERP) studies and behavioral studies, were executed to address these research questions.

Both expected and unexpected results were uncovered in this dissertation. As expected, there was a negativity bias for both olfactory groups, as stronger emotions, reflected in stronger Late Positive Potential (LPP) were detected during unpleasant odor conditions compared to pleasant. Additionally, olfactory imagery enhanced emotions for normal individuals through pleasant odor- associated pictures. Also, for sensitive individuals, unpleasant odors have a stronger influence on behavioral outcomes resulting in more severe moral judgment, negative personal evaluations. Unexpectedly, pleasant odors appear to have a negative impact on sensitive individuals, as more health-related symptoms were reported. Furthermore, emotions during olfactory imagery of pleasant odor associated pictures or ads were attenuated. Also, both pleasant and unpleasant odor conditions resulted in increased probability of healthy food choice. Possible explanations and implications are discussed. Call for future research to provide further clarity is outlined.

Finally, the role of olfactory imagery was investigated along with sniffing motions. Explained by embodied cognition, sniffing motions resulted in increased emotions, even for sensitive individuals in this case. The effect of sniffing enhanced emotions further impacted advertised product ratings and likelihood to buy ratings for sensitive but not normal individuals. In the end of the dissertation, theoretical and marketing implementations, future research are discussed.

CHAPTER 1: INTRODUCTION

Olfaction (sense of smell) is one of the senses that are often taken for granted by individuals. The role of olfaction can be seen as two fold. The first is a functional role, rooted in the survival of the species, including staying away from hazards, food ingestion and social relationships (Stevenson 2010). The other role of olfaction is a more modern role, associated with the enjoyment of activities and has gained attention recently in the consumer behavior literature (Krishna, 2011). In the consumer setting, the role of olfaction has been connected with product memory (Krishna, Lwin and Morrin 2010; Morrin, Lwin and Krishna 2011), and product evaluation (Bosmans, 2006; Spangenberg, Crowley and Henderson, 1996). It is well documented in the neuroscience and chemosensory literature that the role of olfaction is not only closely related to the memory of odor-related events (Herz and Engen, 1996), but emotions are also closely related to the detection and processing of odors in the brain (Cahill et al., 1995). The neuroanatomy of the brain provides insight into the close connection between olfactory processing and emotions processed in the brain. There are only two synapses between the olfactory nerve and the amygdala which is known as the control center for emotion processing (Herz and Engen, 1996). Most researchers examine the dual dimensions of emotions, differentiating pleasant and unpleasant. However, some studies have investigated specific odor-elicited emotions in individuals (Chrea et al., 2009; Porcherot et al., 2010) identifying five emotional dimensions, such as disgust-irritation, happiness-well-being, awe-sensuality, soothing-peaceful and energizing-refreshing. Different dimensions have been identified for different countries such as Britain and Singapore (Ferdenzi et al., 2011). Emotions often influence how individuals make purchase decisions and purchasing behavior, as shown in the marketing literature (Bagozzi et al. 2000;

Lerner and Keltner 2000). It is posited in these studies that the influence of emotions on behavior is determined by their valence (positive or negative). Hence, different positive emotions should exert a similar positive influence on behavior because they share the same positive valence. The relationship between emotions and decision making is also supported by neuroscience data (Bechara 2005).

However, what has not been examined in-depth is how emotions elicited from odors can influence further decisions and judgments consumers make in the marketplace. The consumption environment, whether it is the retail place or restaurant, is filled with different olfactory stimuli and cues. It could be in the actual chemical format, often called scent or odor. Or it could be presented as cues in the form of words or pictures. This dissertation investigates how emotions elicited from processing different types of olfactory stimuli can influence downstream consumer behavior.

Past research studying the role of olfaction in consumer behavior has focused on investigations of the normal population (Krishna, Lwin and Morrin 2010; Morrin, Lwin and Krishna 2011), recruiting from the average undergraduate population. However, we know from medical studies that smell impairments can be due to aging (Murphy et al., 2002), cigarette smokers (Vennemann, Hummel and Berger, 2008), side effects from drug treatments (Bromley 2000) and other diseases (Le Floch et al., 1993). Similarly, medical journals have investigated the other end of the olfactory continuum where studies have been conducted on enhanced olfactory sensitivity in patients undergoing chemotherapy (Bernhardson et al., 2008; Steinbach and Hummel, 2009) and pregnant women (Cameron 2007; Nordin et al., 2004) which are also related to physical and health issues. Investigations on these populations are under researched and almost absent in consumer research. This is in contrast to other senses which have gained attention in consumer research by including individual differences in preferences in terms of reliance and usage of senses, for example haptic (touch) (Peck and Childers 2003; Krishna and Morrin 2008). Other studies have focused on vulnerable groups of consumers such as individuals with impaired vision (Baker 2006; Childers and Kaufman-Scarborough 2009) and the concerns of these groups in the marketplace. Individual differences in capability based on the sense of smell have been less explored and are commonly taken for granted.

In this dissertation, individual differences in olfaction processing will be discussed by considering consumers with varying capabilities and sensitivity to smell. Specifically, individuals who are sensitive to smell often self-report that they process odor-related information more intensely and often detect odors at a lower threshold compared to others. Consequences of this include physical reactions and other irritations that affect individuals' selection of products. Scent also triggers memories and can enhance consumption experiences for individuals. However, "amplification" of these olfactory messages could become overwhelming for sensitive individuals. Preliminary insights about these different groups of individuals stemmed from in depth interviews conducted for a prior study.

Extending the concept of odor-elicited emotions, instead of physically presented odors, the literature on mental imagery has provided some interesting evidence on olfactory imagery (Djordjevic et al., 2004). Odor imagery, along with visual imagery, can be developed and processed in the brain similarly to sensory processing occurring during actual stimuli, shown using fMRI and PET (Djordjevic et al., 2005). These authors discovered that olfactory imagery can affect the perception of odor. What has not been explicitly examined is whether odor imagery can also affect the emotions of individuals.

The possibility of odor imagery was highly debated in the 90's, where some researchers provided evidence of the effect of odor imagery (Carassco and Ridout, 1993), while others had difficulty showing this effect (Crowder & Schab, 1995; Engen, 1982, 1987). Later, accumulating studies showed high variation in odor imagery across individuals, thus measures of odor imagery capabilities were developed. A subjective measure of the vividness of odor imagery questionnaire was developed by Gilbert et al. (1998), modifying a visual vividness imagery questionnaire (Marks, 1973). Later, an objective measurement of odor imagery index (OII) was developed by Djordjevic et al. (2004). OII represents the difference between matched (imaged and presented odors were the same) and mismatched (imaged and presented odors were not the same) detection during odor imagery. The authors compared the two measures and they do not seem to align. The relationship between odor imagery capabilities and actual sensitivity to smell has not been documented in the literature to our knowledge. A close but different relationship between odor detection threshold and the objective odor imagery index was examined by Djordjevic et al (2002). The relationship was not significant overall, but was moderated by gender. Females made more accurate self-judgments of their odor imagery capabilities than males. Associated with this stream of literature supporting the concept of individual differences in olfactory imagery, the relationship between individual differences in sensitivity to smell and odor imagery triggering emotions has yet to be explored. One of the main objectives of this study is to examine whether odor imagery can perform similarly to actual odors in terms of triggering emotions among individuals.

Finally, if emotions can indeed be triggered by odors, is it possible to regulate these emotions? The emotions literature has extended to intervention strategies that have been proposed to regulate emotions, especially negative emotions (Gross 1998). Such emotion regulations include cognitive reappraisal, which has been reported to be more effective and successful in regulating emotions; and suppression, which is a down-regulating strategy implemented after emotions have been elicited. These strategies have been used widely in picture stimuli, word stimuli and scenario-type events, which involve the visual sense. What has not been reported in the existing literature is whether such strategies can be effectively implemented in regulating odor-elicited emotions.

Research questions

In this dissertation, the main question of interest is to understand whether individual differences in sense of smell affects the level or intensity of emotions associated with odorants. In other words, (1) are the emotions of individuals with higher sensitivity to smell affected more by odors than the emotions of individuals with a normal sense of smell? The emotions elicited via odors are expected to be closely associated with the valence (pleasantness) and intensity of the odors. Considering the hedonic dimension, odorants can be presented as either pleasant or unpleasant odorants. Both directions are investigated in this dissertation.

In addition, neuroimaging studies research has shown that imagery odors can be perceived and processed similar to real odors in the olfactory cortex (Gonzalez et el, 2006), as evidenced in grounded cognition (Barsalou, 2008). Consumers often encounter triggers that resemble certain odors associated with memories in the marketplace or in daily situations. Another research objective looks at whether imaged odors can trigger similar emotional responses in individuals. If so, (2) is the intensity of emotions perceived to be stronger for individuals who are sensitive to smell, compared to individuals with a normal sense of smell? Furthermore, (3) will instructional cues to "sniff" or "smell" embedded in the ad trigger olfactory imagery and enhance olfaction –related emotions?

Research on emotions has moved toward the next level, which involves understanding the reactance to emotions, i.e., can individuals regulate emotions that are elicited by odorants? Two types of regulation systems have been proposed and researched over the past 15 years (Gross and John 1998), namely, cognitive reappraisal and the suppression strategy. The main differentiating factor between the two is the timing. Specifically, the former is initiated before the onset of emotions and the latter is introduced after the emotions have formed. The question I ask is (4) how would the effectiveness of these mechanisms differ among individuals varying in sensitivity to smell?

Research outline

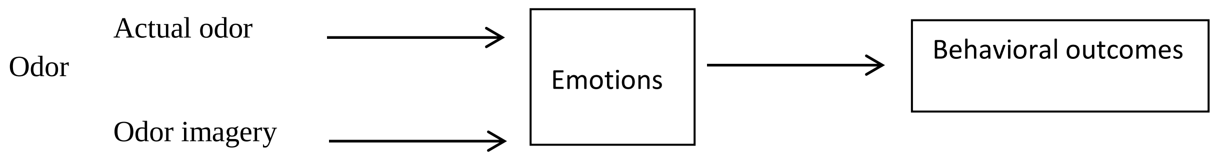
The figure below outlines the research framework included in the dissertation which is composed of three parts. Each part consists of several studies, discussed in detail in Chapter 3, which will investigate the research questions in more detail. Part 1, investigates the relationship between odors and emotions. Physical odors, pleasant or unpleasant, will be examined, either associated with a product, infused into the environment as ambient scent, or used as stimuli in an experimental setting. Two possible mechanisms for odor processing will be examined. First, bottom up processing will be tested and reported via subjective self-reports of emotions and objective measures using neuroscientific methods. Second, top-down processing, which includes cognitive processing of odors, will be examined via both explicit and implicit processing of odors.

Another form of odor, imagined odors, are investigated. Similarly, its effect on triggering emotions is further examined. Instead of using ambient scent as a trigger, olfactory imagery is induced with picture or verbal stimuli. Olfactory imagery is relevant in terms of its applications in consumer behavior. Consumers' daily activities involve encountering cues in environments that may trigger odor memories and associated odors. The impact of imaged odors and their influence on emotions will be investigated using neuroscientific methods, specifically with ERP methods. Next, odor-induced emotions are examined in terms of their downstream influence on decisions and judgments made by consumers, such as product evaluation, odor-unrelated product choice and moral judgment.

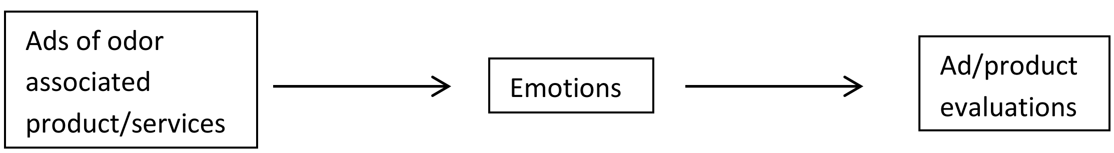
The issue of individual differences in sense of smell will be explored. Specifically, individuals with high sensitivity to smell, their responses to odors, odor-induced emotions and downstream decision making processes, will be compared with individuals who have a normal sense of smell. As an application of findings in the grounded cognition research (Barsalou, 2008; Bensafi, 2006), I investigate the effects of olfactory imagery in the context of advertisements portraying products with embodied cognition cues in the message. These effects may help shed light on how consumers enhance olfactory processing of visual or verbal information in the ads. On the other hand, it can also provide evidence for marketers to understand how sensory information can be perceived by consumers through grounded cognition.

Figure 1. Overview of framework

Part 1



Part 2



Contributions

Marketers have long discovered the power of scent and have tried to take advantage of the 20,000 breaths people take each day to connect the product and consumer. Steven Semoff, acting co-president of the Scent Marketing Institute (SMI) and technical director at US-based Belmay Fragrances, says that while the scent industry is still in its infancy, it is growing. In 2006, founder of the SMI, the late Harald Vogt, told the LA Times he expected the market could grow into a $1billion business by 2014. Marketers have started to invest in finding a signature scent for the brand. Recently, Forbes (2012) commented on how luxury hotels are designing signature fragrances and pumping it into the lobby to subtly influence the moods' of customers. Marketers are capitalizing on scent and its close relationship with memory and emotion. However, the research side of marketing has only recently, in the last ten years, started to pay attention to the role of scent. There has also been a notable lack of attention on individual differences among consumers. This dissertation fills this gap by focusing on individual differences in olfactory ability and the impact of odors on emotions. Four specific contributions are described below.

The primary objective of this research is to understand individual differences in sense of smell. More importantly, the focus is on individuals who have higher sensitivity to smell. From self-reported survey data, this group is estimated at 20% of the population, yet has been under researched. In addition, event-associated increased sensitivity to smell include patients undergoing chemotherapy (Bernhardson et al., 2008; Steinbach and Hummel, 2009) and pregnant women (Cameron 2007; Nordin et al., 2004). Among pregnant women, up to 60% have reported increased sensitivity to odors during the first trimester of pregnancy.

Furthermore, the effect of odors on emotions and downstream influence on purchase decisions and judgments of consumers are investigated in this dissertation. Past research has focused on the role of olfaction in consumers.

This research also examines the relationship between olfaction and emotions and its impact on consumer behavior. Evidence from biological and neuroanatomy research suggests that olfaction is closely connected to memory and emotions. I will focus on odor-elicited emotions and the influence of these emotions on further purchase decisions and behavior. In prior research, Krishna et al (2010) reported that scented products resulted in better memory of the brand and attributes of the product. On the other hand, studies have also investigated the impact of ambient scent, and found that the effect of ambient scent in a retail environment increased product evaluation and increased time spent in-store (Spangenberg, Crowley and Henderson 1996). However, the effects of odors on emotions are less investigated in the consumer behavior research with an exception of a few studies related to ambient scent and the shopping environment. The effects of ambient scented cues on emotions and spending behaviors of mall shoppers were found to be regulated by the perception of product and environment quality (Chebat and Michon 2003). A field study found that contemplative shoppers are found to be affected by ambient scent while impulsive shoppers are affected by atmospheric music (Morrin and Chebat 2005). In another field study, the positive effect of pleasant scents on shopping evaluations was moderated by shopping density (Michon, Chebat and Turley 2005). However, the measurement of emotions in these studies are loosely defined and operationalized. The authors used explicit perception and self-reported evaluation of shopping experience as proxies for emotions. As the third contribution, I plan to focus on both explicit and implicit associations between odors and emotions and objective measurement of emotions using neuroscientific methods. Accumulating evidence in neuroscience has suggested a strong relationship between olfaction and emotions (Zald and Pardo, 1997; Royet et al., 2000). I believe the implementation of neuroscientific methods will provide direct and objective evidence for odor elicited emotions and supplement our understanding of the role of odor-elicited emotions in consumers.

The impact of visual imagery on individuals' behavior has been explored and discussed in consumer research (MacInnis and Price 1987) and advertising (Burns et al., 1993). However, other types of sensory imagery have not been investigated. My fourth contribution is to understand the effects of olfactory imagery on consumer evaluations of ads and products. Olfactory imagery is relevant to marketing as consumers frequently encounter visual image cues or verbal cues in a shopping environment or in an online shopping setting where the actual scent or odor is not present or accessible. In such cases, we suspect the impact of odor imagery may have similar effects as the physical presence of an odor stimulus. Thus, given the close relationship between olfaction and emotions, this dissertation assesses the impact of olfactory imagery on emotions. This research will contribute to our knowledge of sensory and mental imagery in consumer research, providing evidence and insight into the role of olfactory imagery in consumers.

CHAPTER 2: LITERATURE REVIEW AND HYPOTHESES

Literature review

Olfaction

The roles of olfaction include the enhancement of both functional and hedonic experiences which are fundamental in affecting the daily lives of human beings. As discussed in detail in Stevenson's (2010) review paper, the three main functions of olfaction include ingestive behavior, avoiding environmental hazards and social communications. These functions all work towards the same goal of maintaining the survival of individuals and sustaining the longevity of the human species. From the consumer viewpoint, researchers and marketers are interested in understanding how the evaluation of odors associated with a product or experience will affect the shopping behavior and decision making of consumers. Two aspects of the human brain are closely related to the processing of odors: memory and emotions. Neuroanatomy provides evidence suggesting the processes involved in olfactory information processing are closely tied with the memory function (Herz and Engen 1996). In addition, emotions and olfaction are closely linked as they both share several limbic regions (Royet et al., 2003).

However, there are also reports of varying capabilities among individuals in terms of odor detection, identification and threshold (Larsson, Finkel and Pedersen 2000; Doty, Shaman and Dann 1984) due to age, gender and personality. In clinical medicine, there are also cases of clinical diagnosis of anosmics where individuals are olfactory impaired and do not have the functions of normal odor detection. On the other end of the continuum, there are also reports of individuals with a heightened sense of smell. For these individuals, termed hyperosmics, the detection of odors is enhanced and odors are more strongly experienced relative to normal individuals. The discussion below provides a review of the literature on individual differences in sense of smell, focusing on the sensitive end of the continuum. The discussion includes a description of the neuroscientific method, EEG, and chemosensory event-related potentials (CSERP) which are often used in understanding the processing of odors, including sensory and cognitive processes.

Processing of olfactory information

Smeets et al (2005) proposed an information-processing model of chemosensory perception which describes the two processes that have been noted and discussed in several empirical papers (Dalton 2002). The bottom-up process involves detection of the stimulus and then interpretation of the stimulus to form a hypothesis regarding odor detection. This interpretation is often influenced by prior experience, beliefs, or the context of the encounter. The decision involves "approach-or-avoidance" (rather than the fight-or-flight) response. Bottom-up processing begins with odor perception and/or trigeminally mediated sensory irritation. The perceived odor of the chemical, especially when perceived as unpleasant, can cause alarm, stress and anxiety. Factors that influence top-down processing include pre-existing knowledge, perceived risks, bias, psychosocial factors and personality. These factors determine what types of information will be retrieved from memory.

Studies show cognitive and behavioral responses from odors resulting from psychological mechanisms, such as behavioral manipulations (Dalton et al, 1997; Dalton 1996) and implicit associations (Bulsing et al, 2009). Dalton et al's (1997) study investigates how the cognitive state of the perceiver can influence how air-borne chemicals are perceived.

Individuals subjectively perceive the effects of odors and there exists a wide variability across individuals exposed to the same chemical odor. In addition, there is an observed shift in sensitivity within the individual to the same concentration of the chemical. Perception is driven by both sensory and non-sensory processing, suggesting a dual route of bottom-up and top-bottom processes when the same chemical odor was present. However, when manipulating the description of the odor from the chemical, people were led to believe the chemical was harmful and reported more health symptoms than when the same chemical was described as being beneficial to the individual.

Some individuals ascribe health symptoms to odor exposure, even when there is no present relationship of the odor and toxicological effect. These symptoms are believed to have been mediated by beliefs regarding the health effects from the odors. Building on the dual olfaction information processing model proposed by Dalton and Hummel (2000), Bulsing et al (2009) investigated the issue of misconceptions and beliefs individuals have about odors using an implicit association test. The implicit attitude test has the advantage of capturing the response underlying the autonomic or also known as the involuntary route. Such a pathway would rely on quick associations between odors and health effects. In their first experiment odor was categorized as either healthy or sick, house was used for the neutral reference category. Results showed more difficulty (longer reaction time) for participants to shift from “odor and sick” to “odor and healthy”, while the reaction time was not significantly longer when they shifted from “odor and healthy” to “odor and sick”. In conclusion, this study provides evidence that there is a strong association between the concept of odor and the concept of sickness compared to the concept of healthy. This converges with the previous behavioral study (Dalton et al, 1997) where cognitive processing can be triggered by manipulating the information associated with the odor. Odor perceptions and beliefs are examined. Other studies, show how cognitions or beliefs can modulate the sensory perception of odor exposure (Dalton 1999), increasing individuals' association of odors with risk.

In another study (Olofsson et al., 2005), the authors provided neuroscience evidence for the possibility of cognitive involvement of processing the input of odorous substances. This study examined the possible explanations for self-reported increase in sense of smell in pregnant women when exposed to odor stimuli. Results revealed an increase in P3 compared to non-pregnant women, which indicates a cognitive mechanism in process. There was no significant difference between N1 and P2, which reflects sensory processing, compared to non-pregnant women under exposure to odors. This suggests the processing of odors is enhanced by cognitive processing (top-bottom response) in pregnant women who have self-reported to be sensitive to smell.

Associated with misperceptions of odor processing, cues from one sensory modality, such as visual cues, can create biases for olfactory perception. An example of this is the impact of colors on odor perception. Colors led individuals to misjudge the presence of odor even when it was absent (Engen 1972). Odorless colors added to foods or drinks led to these products being perceived as more flavorful with taste rated as more intense (Dubose, Cardello and Maller 1980). Similarly, color-appropriate combinations with odors were rated as more intense than the odor alone (Zellner and Kautz 1990). Individuals rated white wine colored with odorless and tasteless red coloring, as more similar to red wine than white wine (Morrot et al. 2000).

In sum, people carry misbeliefs about odors and make judgments about odors based on other sensory cues. Are these beliefs and biases stronger in individuals with higher sensitivity to smell? We will now review what is known about individual differences in sense of smell.

Individual differences in olfaction

There is evidence across different sensory modalities that show individual differences in the ability to perceive and process information via different senses. Research on sensory abilities has focused on the disability or impairment of a specific sensory ability. Congenital prosopagnosia or face blindness is a recently realized condition where individuals lack the ability to recognize human faces, which is apparent from birth in the absence of brain damage (Behrann and Avidan 2005); aguesia (taste blindness), is diagnosed by the individuals' impaired ability to detect or insensitivity to a bitter chemical known as PROP (6-n-propylthioracil) (Lim, Urban and Green, 2008) ; and congenital amusia (tone deafness) is characterized by a lifelong deficit in melody perception and production that cannot be explained by hearing, brain damage or intellectual deficiencies (Peretz, 2008; Sloboda, Wise and Peretz, 2005; Peretz, Brattico and Tervaniemi, 2008). As opposed to researching disabilities, recently there have also been different streams of literature focused on extraordinary sensory abilities. This includes, super recognizers, people who are diagnosed as having superior ability in facial recognition (Russell, Duchaine and Nakayama, 2009); super tasters, individuals who are superior in detecting bitter, salty and sweet tastes and perceive taste signals as stronger and more intense (Danielle, 2008; Lim, Urban and Green, 2008); ideal listeners, referring to individuals who are skilled in detecting pitch violations (Semal and Demany, 2006). Olfaction is one of the senses that has not been well researched in terms of the extraordinary abilities of individuals. Deficit or impaired olfactory abilities are discussed in literature focused on anosmics (Hummel and Nordin 2005) which address the consequences of olfaction impairment on the well-being and quality of life. However, in this dissertation, our focus is directed to individuals with extraordinary or above average sense of smell, or so-called sensitivity in the sense of smell.

The sense of smell is one of the most important senses human beings rely upon on a daily basis, whether it is salient or not (Bushdid, Magnasco, Vosshall, Keller, 2014). Several of the important functions of the sense of smell are related to the fundamental functions of human beings (Stevenson 2010), including being safe (such as detecting fire and smoke), selecting foods and preventing intake of poisoned or spoiled foods, and mate selection, which are all important functions in keeping the human species alive. The functions of olfaction expand from the basic functional properties into more hedonic experiences (Royet et al., 2003; Warrenberg 2005), such as enjoyment of foods, product and scent preferences and other complimentary experiences that are enhanced with the addition of olfaction. Thus, based on the varying levels of ability to detect and identify odors, odor-associated memory and emotions may vary. Similarly, the enjoyment level or preferences likely varies among individuals depending on the capability of smell.

Some of these individual differences exist as a relatively stable state and could be viewed as an individual trait based on the level of sensitivity and ability to smell. There are very few studies focusing on individual differences in sense of smell in comparison to the other senses described above. However, looking at a wider spectrum of studies, individual differences could extend or result from life events such as smoking (Vennemann, Hummel and Berger, 2008; Katotomichelakis et al., 2007; Frye, Schwartz and Doty, 1990; Wack and Rodin, 1982) and aging (Cain and Gent 1991; Murphy et al., 2000), leading to decreased olfactory capabilities; or pregnancy (Nordin et al., 2004) or chemotherapy (Bernhardson et al., 2008; Comeau, Epstien and Migas, 2001; Steinbach et al., 2009), which are often associated with increased sensitivity to smell. The increased or decreased sensitivity in smell occurring during these life phases can be seen as event-dependent changes. Event-related change in sensitivity to smell is often temporary and accompanies the event. To understand the consequences of varying levels in sensitivity to smell, reviewing literature on life event influences on sense of smell can provide insights into the concerns and behaviors of individuals. In prior studies (Childers, Cross and Lin 2014), sampling from various subpopulations, including undergraduates in a Midwestern university and faculty and staff, approximately 20% of the population self-reported to be sensitive in their sense of smell. This suggests that a relatively large proportion of the population self classifies as sensitive.

The percentage of pregnant women who have reported observing an increase in their sensitivity to smell during the first trimester of pregnancy is as high as 61-67% of pregnant women (Cameron 2007; Nordin et al., 2004). Most of these reports include describing enhanced sensitivity to unpleasant odors. These odors can be classified into 3 categories: 1) social odors, such as body odor, perfume and pets; 2) food-related odors such as eggs, fish and meat; 3) noxious odors such as cigarette smoke, gasoline and smoke (Cameron, 2007).

These complaints were most common during the first trimester of pregnancy. Reports note declines in sensitivity in the third trimester and a return to normal ability postpartum.

Individuals undergoing chemotherapy also report changes in their sense of smell. A common "side-effect" reported in chemotherapy patients is increased sensitivity to smell. This was reported as the 5th most common complaint among chemotherapy patients, with distortion of taste ranked at 2nd (see Bernardson et al., 2008). Changes in olfaction and taste often occur side by side and are self-reported in 66% of chemotherapy patients (Bernhardson et al., 2009). Side effects from olfaction and taste changes during chemotherapy include decreased appetite, and a feeling of disgust and nausea (Bernhardson et al., 2008). This gives rise to the concerns of malnutrition, weight loss and decreased quality of life in these patients (Comeau, Epstien and Migas, 2001; Steinbach and Hummel, 2009). However, similar to the increased sensitivity to smell in pregnant women, this change in olfaction during chemotherapy returns to normal after the chemotherapy is over (Bernhardson et al., 2008). Taken together, pregnancy and chemotherapy are life events that many individuals may experience.

Studies point out some of the most common concerns and consequences of being above average in sensitivity to smell, such as physical reactions and illness resulting from exposure to odorous sources. Physical reactions include nausea, headache, tightening of the chest or other allergic reactions, as evidenced in pregnant women (Cameron 2007; Nordin et al., 2004) and chemotherapy (Bernhardson et al., 2008; Steinbach and Hummel, 2009).My co-authors and I also find similar results from our own in depth interview studies with individuals with high sensitivity to smell (Childers, Cross and Lin 2012).

The discussion above includes evidence showing how individuals process olfaction-related information through two different pathways, bottom-up (sensory-driven) pathway and the top-down (cognitive-driven) pathway, and also individual differences in sensitivity to smell. However, understanding whether individuals with higher sensitivity to smell process odor-related stimuli more intensively or automatically has yet to be researched and will be one of the main foci in this thesis. Furthermore, there is neuroscientific evidence supporting the different mechanisms associated with the processing of odors. Thus, another aim in this thesis is to explore individual differences in sense of smell and the downstream brain processes of olfactory information using event-related potentials. I will now focus on the prior literature on chemosensory event-related potentials.

Chemosensory event-related potentials (CSERPs)

Chemosensory research has utilized EEG along with olfactometer to present odor stimuli and record brain activity simultaneously. These studies have identified sensory-related components, N100 and P100, for indicators for detection of exogenous odorous stimuli (Bulsing et al., 2010; Lundstrum et al., 2006) and others have also included P200 to the list of indicators (Geisler and Murphy 2000; Olofson et al., 2006). Some studies focused on comparing the sensory indicators with cognitive processing indicators of the odors using P300 to investigate attention allocation toward the sensory stimuli (Geisler and Murphy 2000). The authors found that P300 amplitude was greater in the attended than ignored condition in olfactory stimuli. Others used CSERPs to investigate individual differences in perception of odors (Lundstrum et al., 2006). In this study, the authors used androstenone as odor target and found that there was a significant negative correlation between P3 and valence ratings. The group difference in N1 and P1 was nonsignificant. There was also no difference between explicit ratings on intensity and sensitivity to androstenone.

Analyses of CSERPs include the latency and magnitude of the components to indicate the speed of onset and the intensity of activation respectively. One of the common analyses and findings presented in these studies are the similarities and differences in sensory detection and cognitive processing. This dissociation is used to explain the cognitive biases and inferences people tend to make. This becomes especially interesting in incidences where there are effects in P300 under different conditions, but no differences are shown in odor detection.

The studies mentioned have used the chemicals such as H_2S and PEA (phenyl ethyl alcohol), amyl acetate or CO_2 for odor stimuli. Another form of odor related stimuli, induced through olfactory imagery, is discussed in the section below. The ability of odors to influence perceptions in individuals is not only confined to presentation of chemicals and actual scents. The impact of odors can also be presented in mental imagery form.

Olfactory imagery

The literature on odor imagery is often discussed along with visual imagery, which has been researched more extensively than odor imagery. Mental imagery, volitional imagery specifically, refers to the evocation or creation of mental representations that are initiated by external stimuli but controlled by the imager's will. One of the earliest studies providing evidence for the existence of mental imagery is Segal and Fusella (1970). Since then, studies on mental imagery have been conducted in different modalities, such as auditory (De Volder et al. 2001), taste (Triggemann and Kemps 2005) and olfactory (Carrasco and Ridout 1993). Especially with the advancement of neuroscience technologies, studies have been able to provide evidence connecting mental imagery and perception. Yoo et al. (2003) reports neural substrates of tactile imagery using fRMI. In a different sensory modality, Bensafi et al. (2003) demonstrated that olfactomotor activity (through sniffing) during imagery mimics olfactory perceptions and enhances imagery vividness.

In the consumer research literature, imagery-related studies are mostly conducted with regards to visual imagery (Dahl, Chattopadhyay and Gorn 1999; Babin and Burns 1997), investigating the impact on memory and attitude. In Krishna's (2011) recent review on sensory marketing, she draws on Barsalou (2008) who describes how perception affects cognition, also called grounded cognitions. According to Barsalou (2008), grounded cognitions, what some call embodied cognition, includes bodily state, situated action and mental simulation. The last of this category is mental simulation or mental imagery which is enough to drive cognitions. Next is a brief review of the development of olfactory imagery (Rinck, Rouby and Bensafi 2009; Stevenson and Case 2005).

Stevenson and Case (2005) defined olfactory imagery as "being able to experience the sensation of smell when an appropriate stimulus is absent." They noted how this resulted from cumulative evidence, mostly self-reported data, in three forms: 1) participants report such experiences; 2) descriptions of these experiences are similar to those of actual smelling; and 3) their reactions to certain forms of these experiences involve appropriate behavioral response. One of the earlier debates surrounded the issue of whether odors can be imagined. Some researchers have found that olfactory imagery is a widespread phenomenon among the general population (Gilbert, Crouch and Kemp, 1998) but there are researchers who are unable to find this phenomenon in their studies (Crowder and Schab, 1995; Engen, 1987). This is not surprising, as early studies comparing imagery across different sensory modalities showed that rating for clarity and vividness for olfactory items were poorest (Betts 1909). However, the accumulating research points to the conclusion that there are individual differences among olfactory imagery abilities and that the variability is considerably wide according to the odor imagery index (OII) developed by Djordjevic et al. (2004). The OII is proposed as an objective measure of an individual's odor imagery ability. A self-reported scale that has been developed by Gilbert, Crouch and Kemp (1998) is a subjective measure of individual differences in the vividness of odor imagery. This was based on the vividness of visual imagery questionnaire developed by Marks (1973). The mean scores for visual and olfactory imagery scales were similar and olfactory experts reported more vivid olfactory images than did non-experts (Stevenson and Case 2005).

More recent investigations look at the basis for the formation of mental imagery. Two schools of research have been proposed; one proposing that only propositional representation is used in imagery (Pylyshyn 2003) while the other argues that sensorial-type representations are involved in imagery (Kosslyn et al., 2001). Neuroscientific methods have provided evidence to support the latter proposition, showing the primary visual cortex is activated during visual mental imagery (Kosslyn and Thompson 2003). Similarly, brain regions involved in odor processing, such as orbitofrontal cortex, anterior insula and piriform cortex, are activated during mental imaging of odors, evidenced in positron emission tomography (PET) methods (Djordjevic et al. 2005). Recently, researchers have provided evidence using functional magnetic resonance imaging (fMRI) showing hedonic patterns for differences in mentally imaging pleasant odors compared to unpleasant odors, which matches activity in the brain when exposed to real odorants (Bensafi et al. 2007).

Visual imagery has been used in consumer behavior research, but other senses may be involved other than vision. Several neuroimaging studies have provided evidence for mental stimulation where the processing of a sensory perception is reflected in the corresponding regions in the brain. Seeing pictures of chocolate chip cookies can activate the taste cortices (Rolls, 2005; Simmons, Martin, and Barsalou, 2005); reading strong smell associated words such as “cinnamon” and “garlic” can also activate the primary olfactory cortex (Gonzalez et al, 2006).

The next question then involves understanding the mechanism behind the brain activities triggered in the absence of odors. This issue was studied in visual imagery. Researchers found that eye movements during visual imagery follow those enacted during visual perception (Spivey and Geng 2001; Laeng and Teodorescu 2002). Later, olfactory imagery was linked to the motor component of sniffing (Sobel et al 1998), which is also linked to the activation of the olfactory cortex. Bensafi et al (2005) found that sniffing was related to better olfactory imagers who took bigger sniffs when imagining pleasant odors compared to unpleasant odors. They also found a distinction between good and bad olfactory imagers (Besafi, Pouliot and Sobel 2005). Therefore, both visual and olfactory modalities have a sensory component and a motor component.

The importance of understanding and researching olfactory imagery has been evidenced through its association with outcomes such as recognition memory (Lyman and

McDaniel 1990) and odor detection (Djordjevic et al. 2004). In a more recent study, Bensafi and Rouby (2007) examined the relationship between individual differences in odor imagery and emotional perception. However, emotional perception is operationalized as an individual difference in the ability to experience positive emotions. Individual differences were measured by the anhedonia questionnaire (Chapman et al. 1976), which is the measure that identifies people with inability to experience pleasure from activities normally found to be pleasurable.

To reiterate, this study examines the relationship between olfactory imagery and perception of emotions, linking individual differences in olfaction to emotions. In the next section, we will discuss the main aspects of emotions and the association between olfaction and specific emotions, such as disgust and fear. Evidence of emotion processing in the brain is presented and researched using ERP methods. Finally, regulation of emotions is discussed and reviewed.

Emotions

What is emotion and how is it related to other affective experiences, which involve feelings of good or bad (Russell, 2003)? Emotion is the third level of affective experiences, where traits is the broadest level, and moods come second, considered to be more long lasting than emotions. The third level, emotions, is considered to be more brief, more context specific (Ekman, 1992; Schwarz, 1990). There are many debates on how to categorize emotions or define the basic emotions, often termed as the discrete approach. For instance, Smith and Ellsworth (1985) defined the eight dimensions of appraisal which combined can give rise to the specific emotions. Whether it is the discrete or dimensional approach in defining emotions, both assume automaticity in emotion elicitation. In other words, emotions can be elicited automatically, fast and may be less subject to deliberate control (Winkielman, Zajonc, and Schwarz, 1997; Russell, 2003).

Evidence from brain activity has located the region, amygdala, which is responsible for this automaticity in the generation of emotions (Cardinal et al., 2002). Neuroanatomy supports the idea that sensory processing inputs to the amygdala are faster than semantic processing from the hippocampus and cortex (LeDoux, 1996).

In the following review, I will focus specifically on odor-induced emotions related to associations from odor stimuli that may result in elicitation of emotions. Furthermore, in the recent decade, emotions have been studied using neuroscientific methods such as EEG (Hacjak, MacNamara and Olvet, 2010). Findings from ERP studies applying this technique will be reviewed and discussed. Finally, reappraisal and suppression strategies (Gross 1998; Gross 2002) have been proposed and introduced in the field of emotional regulation. The effectiveness and advantages of these intervention strategies will be examined.

Odor-induced Emotions

One of the powerful functions of olfaction, aside from the functionality purposes that are essential for human survival (Stevenson 2011), is the hedonic experiences and emotions associated with detection of odors (Yeshurun and Sobel, 2010). Odors can elicit pleasant or unpleasant emotions (Herz, Schankler and Beland, 2004) and memories (Ehrlichman and Halpern 1988) which in turn can influence decisions and behaviors (Chebat and Michon

2003). These odor-induced emotions can then be stored in memory and assessed later when the "odor" is presented to trigger the memories associated with the odor.

As described in the emotions literature, emotions can be defined in hedonic valence in terms of pleasant emotions, such as happiness and relaxing; and unpleasant emotions such as disgust, fear and anxiety (Porcherot et al., 2010; Chrea et al., 2009). These emotions can be associated with or induced by odors that represent different hedonic valences. For example, unpleasant odors such as sulfate-based chemicals can induce disgust. Disgust has been described as a fundamental emotion in human beings and serves as a super guard for the survival of human beings by preventing certain life threatening behaviors such as ingesting spoiled or inedible foods (Stevenson 2011). A current stream of psychological studies investigates the role of disgust emotions in moral judgments and behavior (Schnall et al., 2008). The induction of disgust emotions are shown to result in more severe judgment of moral-related issues, such as attitudes toward gay men (Inbar, Pizzaro and Bloom 2009) and purity of the body and soul (Horberg et al., 2009). Another form of negative emotions is the fear associated with odors as evidenced by the implicit associations of odor and illness (Bulsing, Smeet and Vande Hout 2009), the belief that unpleasant odors are hazardous to health (Dalton 1996). According to Oaten, Stevenson and Case (2009), the disgust emotion is a biological mechanism that can help humans avoid disease. The connection of odor and these associations seems to be regulated by negative emotions. On the other hand, positive emotions are elicited by odors that are perceived as pleasant, e.g. hedonic scents such as fragrances (Warrensburg 2005), can create positive emotions. The associations between pleasant scent and positive emotions may either attract us and unpleasant odors may elicit negative emotions that can warn us (Hummel and Nordin 2005).

This dissertation links the literature on odor-induced emotions and individual differences in olfaction, examining the varying degrees to which odors can affect the emotions of individuals and further influence decision making and behavior.

ERP and emotions

Research in emotions using neuroscientific methods have been gaining attention over the past two decades. Of the multiple dimensions of emotions or affective experiences (Ekman, 1992), researchers applying EEG technique in studying emotions have focused on two primary parameters of emotions (Hajcak et al., 2012): direction (movement toward or away from a stimulus) and intensity (strength, speed or vigor of the movement, Bradley, 2000). This is based on the assumption that emotions are rooted in the motivational states which are governed by the above dimensions. It is important to point out that no specific ERP component has been identified for a certain type of emotion. The stimuli used for ERP related emotion studies, such as the often used International Affective Picture System (IAPS; Lang et al., 2005) involve the valence (pleasantness or unpleasantness) and arousal (intensity of emotions). Other forms of stimuli include words and sounds. Both are based on the motivational systems that support either pleasantness, which reflect appetitive activation, or unpleasantness ratings, which reflect defensive activation (Bradley et al., 2001; Lang et al., 1998). The automaticity of emotions is associated with the unconscious formation of emotions. Therefore, the utilization of ERP methods to evaluate emotions have received much attention as a form of objective measure, in addition to other physiological measures including heart rate, skin conductance, facial muscle activity and functional neuroimaging (Bradley, 2000; Lang et al., 1998).

Some of the ERP identified components related to emotional responses include the P100, which is one of the early poststimulus components, occurring at 100-130ms after the stimulus. Another early emotional component is a relative negativity often observed between 200 to 300 ms following emotional stimuli at the occipital sites is the early posterior negativity (EPN). EPN has been reported to be sensitive to perceptual aspects of the stimuli, including emotional content (Bradley et el., 2007; Schupp et al., 2006). More recent work has focused on the late positive potential (LPP), which is commonly identified as a midline centroparietal occurring after 300ms and may last up to 1500ms. The sustained positive deflection of LPP is present in both pleasant and unpleasant images. It is also important to point out, as discussed in one of the earlier studies by Ito et al., (1998), (the relevance of the negativity bias) where deflection for negative stimuli is stronger than positive stimuli.

In the next section, I have outlined the framework to be investigated in this dissertation, followed by hypotheses formation. The framework starts with the investigation of the theoretical relationship between odors and emotions. Odors are represented in both “real” and “imagined” form. The odor-emotions relationship in each form is investigated in Experiments 1 and 2 respectively. Furthermore, the impact of individual differences in sense of smell on this relationship is explored. Next, examined in the framework is the application of this odor-emotion relationship in an applied context: using ads as odor imagery cues (Experiment 4). Additionally, the downstream behavioral consequences of odor-induced emotions, such as product evaluation and choice, moral judgment and health associations are further investigated in a behavioral experiment (Experiment 3).

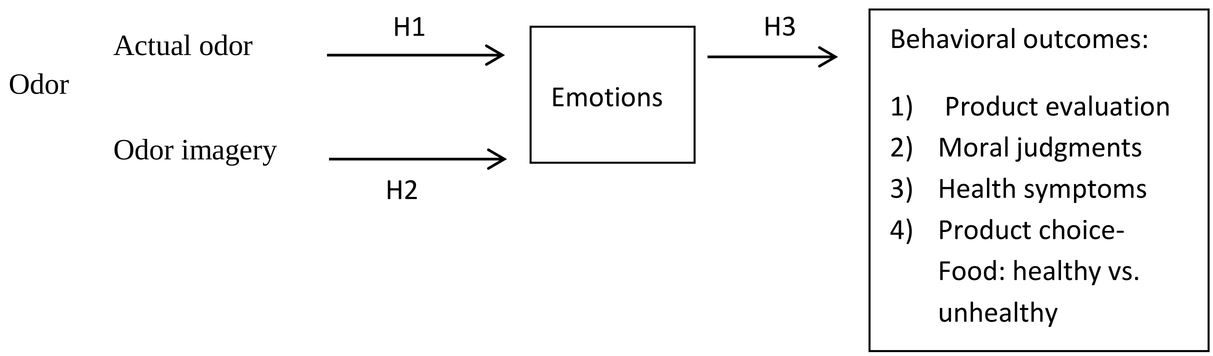
Research framework

This dissertation contains three parts. In Part 1, we depict the relationship between odors and emotions using actual odors (H1) and imagined odors (H2). Furthermore, the downstream effects of odor-induced emotions are further understood in the behavioral study (H3). In particular, odor-induced emotions on behavioral-related outcomes such as purchase decisions, product evaluation, food choices and moral judgments are hypothesized and tested.

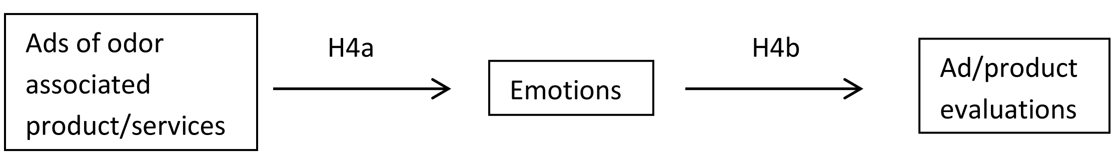
In Part 2, we focus on the role of olfactory imagery and its influence on emotions in an advertisement context. Imagined odors using odor-associated ads are hypothesized to affect evaluation of ads and products through the mediating role of emotions (H4). The role of individual differences in sense of smell is investigated and included in the design of all the studies included in this dissertation. Two groups are identified and studied: hyperosmics, individuals with increased sensitivity to smell, are compared to individuals with a normal ability to smell.

Figure 2. General hypotheses framework

Part 1



Part 2



Hypotheses

Odor-induced emotions

To establish the fundamental relationship between odors and emotions, we attempt to examine the emotions elicited by odor stimuli, in the form of actual odors and imagined odors. Based on neuroanatomy and previous research, emotions and olfaction are closely linked as they both share several limbic regions (Royet et al., 2003). In the presence of pleasant odors, we expect congruency effects and see positive emotions associated with pleasant odors and negative emotions triggered by unpleasant odors. Furthermore, we expect explicit emotions to be reported in both normal individuals and individuals with sensitivity to smell. However, due to the sensitive nature of these individuals in the latter group, we expect that individuals with high sensitivity to smell will report higher intensity in emotions to post odor stimuli, compared to individuals with the normal sense of smell. In addition to explicit self-reported emotions used in behavioral design, an objective measurement of emotions will be captured using EEG methods. Emotion-related responses are assessed by the generation of brain activity during processing of odor stimuli. Specifically, ERP components related to olfactory sensory stimuli (N1 and P1/P2) will be induced in the presence of odor stimuli. Additionally, cognitive processing of odor stimuli is expected to be increased and reflected in P300 and emotional processing of pleasant and unpleasant odorants are expected to be reflected in the increased LPP. The latter has been extensively shown to be associated with emotion processing (Schupp et al. 2006; Hajcak, Namara and Olvet 2010).

H1a: Enhanced attention will be directed toward odors for hyperosmics in comparison to individuals with a normal sense of smell, reflected in P100.

H1b: Actual odors, both pleasant and unpleasant, will elicit emotions in both olfactory groups, reflected in LPP.

H1c: These emotions will be perceived as more intense for hyperosmics in comparison to individuals with a normal sense of smell, reflected in LPP.

Olfactory imagery induced emotions

Olfactory imagery is another form of odor presentation investigated in the dissertation. Odors associated with a product are not necessarily accessible in the marketplace. Typically, products are packaged or boxed and shown visually through pictures or ads. The relationship and performance between olfactory imagery and real odors have been shown to be very similar (Carrasco and Ridout 1993; Lyman 1988). These studies used multidimensional scaling (MDS) to identify the qualitative dimensions that underlie similarity judgments between real and imagined odors.

According to Krishna's (2012) review on sensory marketing research, imagery is described as a form of embodied cognition. Neuroimaging studies have shown evidence for embodied cognition, where reading scent-associated words such as "cinnamon" is associated with increased activity in the primary olfactory cortex (Gonzalez et al, 2006). Other brain imaging studies show substantial overlap in areas activated by real odors and imagined odors (Levy et al., 1999; Henkin and Levy 2002). However, the activations were reduced in the imagery condition. In our study, olfactory imagery is cued by odor-associated pictures. Past research has relied on words as stimuli when studying olfactory imagery (Royet et al. 2003; Gonzalez et al. 2006). We argue that text and words are more abstract or less concrete in terms of eliciting olfactory imagery. We expect the intensity of emotions to be stronger when elicited by picture rather than word presentations (Holmes et al. 2008) as reflected through enhanced magnitude of LPP. First, the emotion systems in the brain evolved earlier than language systems which suggests images may more readily trigger emotions than language stimuli (Ohman and Mineka 2001). Second, mental imagery shares the neural process involved in perceiving real events (Kosslyn, Granis and Thompson 2001). Finally, it has been shown that autobiographical episodic memories are stored in the form of images, associated with emotional states (Conway 2001).

H2: Pictures of items or products associated with either pleasant or unpleasant odors will induce emotions, reflected in LPP, through olfactory imagery.

H2a: The negativity bias will result in stronger emotions in the unpleasant odor associated pictures, reflected in larger LPP magnitude, compared to pleasant odor associated pictures and non-odor associated pictures (control condition).

Finally, individual differences in sense of smell are expected to influence the magnitude of emotions elicited from the process of odor imagery. Stronger experiences and memories may be associated with the generation of stronger olfactory imagery. In fact, our preliminary data show that there is a positive correlation between olfactory imagery, measured with the vividness of olfactory imagery questionnaire (VOIQ; Gilbert, Crouch and Kemp 1998) and levels of sensitivity to smell. Individuals with higher sensitivity to smell tend to have better olfactory imagery scores than normal average individuals. Additionally, both groups scored higher in olfactory imagery than hyposmic individuals. This is similar to what the authors reported- olfactory experts reported more vivid olfactory images. Levy et al. (1999) compared anosmics with normal participants and showed that olfactory imagery induced similar brain activity. However, in a later fMRI study (Henkin and Levy 2002), the authors compared congenital anosmics- individuals who are born with no sense of smell- with normal participants, and found that attempts for olfactory imagery in the former group produced little activity. This supports the argument where odor memories and experiences are associated with successful generation of vivid olfactory imagery.

H2b: The effect of olfactory imagery induced emotions, reflected in LPP, will be stronger in hyperosmics compared to individuals with a normal sense of smell.

Contagion effects of odors on behavior

Emotions have been shown to play an important role in consumer purchase decisions and choices by affecting cognitive thoughts (Shiv and Fedorikhin 1999) and have been shown to influence impulsive purchase behaviors (Weinberg 1982). The Appraisal-Tendency Framework (ATF., Lerner & Keltner 2000, 2001; Lerner & Tiedens 2006) as a general theory describes emotion-specific influences on consumer judgments and choices. In our study, negative emotions such as disgust and fear are induced from unpleasant odors while positive emotions are induced from pleasant odors. Furthermore, the downstream effects on consumer-related decisions such as willingness to purchase and product-type choice are expected to be affected by the odor-elicited emotions and moral judgments. Past research has shown that disgust is removed by “rituals” such as washing hands after encountering immoral events (Zhong and Liljenquist 2006; Lee and Swartz 2000). In consumer behavior research, disgust is seen as having a "contagion effect" where products placed in shopping carts are organized so "disgusting products" such as cat litter are not touching other products (Morales and Fitzsimons 2007).

Individuals have the need and tendency to maintain a "moral identity," which is conceptualized as the importance of being a moral person to maintain a moral identity (Aquino and Reed 2002; Hart el al. 1999). One of the actions taken to restore or maintain this moral identity is to engage in virtuous behavior called moral cleansing. It allows one to cleanse the self of negative feelings due to immoral acts of thoughts (Tetlock et al. 2000). Embodied cognition theory (Barsalou 2008) uses metaphors to link abstract concepts to physical and sensory experiences and can be used to explain findings in moral cleansing. Zhong and Loljenquist (2006) found the act of hand washing resembling cleansing of an individual's past moral transgression. Other concepts such as smelling a citrus scent is related to cleanliness (Holland, Henriks and Aarts 2005; Schnall, Benton and Harvey 2008). Based on these past findings, we expect that individuals under a disgusted state are more likely to choose snacks representing "fresh and clean" such as mints compared to chocolate. In addition, moral and ethical issues are expected to be judged more severely under disgust states versus normal states. Inversely, individuals put into an emotional pleasant state via positive odors are expected to be less judgmental of moral issues and will select product and activity choices that are more indulging and hedonic-focused compared to more practical and or healthy options.

Furthermore, unpleasant odors have been investigated in implicit associations, such as associating illness or sickness with unpleasant smells (Bulsing, Smeets and Van den Hout, 2009). Individual differences in sensitivity to smell and corresponding decisions are expected to be reflected in stronger implicit associations of illness with unpleasant odors. Dalton et al. (1997) manipulated the description of a chemical odor- describing it as either bad for health or good for health-for the same odor-to show that cognitive interpretation of chemical odors can influence reported health related symptoms. Thus, we expect odor-induced emotions to be stronger in individuals with higher sensitivity to smell compared to normal individuals.

H3: Odor-elicited emotions will influence the downstream judgment on moral severity, product choices and product evaluations.

H3a: This "contagion effect" is expected to be stronger in hyperosmics compared to individuals with a normal ability to smell.

H3b: Unpleasant odor conditions will induce negative emotions, resulting in more severe moral judgments, more negative evaluation of products, increased reports of health symptoms, and the choice of healthy food items (e.g. raisin) compared to the condition where there is no ambient odor (control condition).

H3c: Pleasant odors conditions will induce positive emotions, resulting in less severe moral judgments, more positive evaluation of products, no reports of health symptoms, and the choice of hedonic or unhealthy food item (e.g. Snicker bar) compared to the condition where there is no ambient odor (control condition).

Sniffing effects and olfactory imagery in ads

In H2, we predict the relationship between olfactory imagery induced by odor-associated pictures to influence emotions. We further explore this relationship in a context associated with consumer experience, where ads promoting products or services associated with odors are tested. The pictorial ads are expected to function similarly to images of odor-associated products, inducing olfactory imagery and in turn eliciting emotions. Therefore, we make the same argument from H2 here in H4a for this relationship:

H4a: Ads of products or services associated with pleasant odors will induce emotions, reflected in the LPP, through olfactory imagery compared to ads not associated with odors (control). Sniffing motions will further enhance the emotions and reveal an additive effect on LPP.

Bensafi (2005) showed that people tend to generate better olfactory imagery when explicitly instructed to take "sniffs" during olfactory imagery tasks. We further demonstrate how this effect can be applied in consumers' processing of advertisements, containing images of target products where "sniff" messages are embedded. The "sniff" cues are used to activate olfactomotor which will enhance olfactory imagery. Improved olfactory imagery should result in more vivid imagery and is therefore expected to result in more positive evaluations of the ad and its associated product.

H4b: "Sniff" cues in pictorial ads will enhance positive ad and product evaluations.

H4c: Product evaluations will be rated higher in hyperosmics compared to individuals with a normal sense of smell when asked to image and sniff while viewing the ads.

CHAPTER 3: MATERIAL AND METHODS

Overview of studies

An overview of the five studies included in the dissertation is described in terms of their interrelationships and how each study complements or supplements the other. A visual representation of the five studies, interlinking the purpose and focus of each study, is presented on the last page.

This dissertation consists of three main objectives: 1) demonstrate the direct relationship between odors and emotions; 2) investigate downstream consequences of odors in terms of behavior outcomes; 3) explore emotion regulation and odor imagery in an applied context. Individual differences in sense of smell are also investigated in all aspects listed above.

Experiments 1 and 2 focus on using two forms of odor stimuli, namely actual odors and imagined odors respectively, to investigate and establish the relationship between odors and emotions. The ERP approach is used to capture the relatively early (<1000msec) impact of the induced emotions. This gives an advantage over behavioral studies where self-reported measures are utilized and may be difficult to link the cause of emotions directly to the odor. However, the contagion effects of odor on downstream behavioral outcomes, such as product evaluation, moral judgment and health associations, can be better investigated in a behavioral experiment. Differential emotions, such as disgust, fear or happiness are not yet distinguishable in neuroimaging nor ERP techniques. Thus the mediating role of emotions is further tested in the behavioral study set up (Experiment 3).

While Experiments 1 and 2 are designed to closely link the theoretical relationship between odors and emotions, Experiment 4 is designed to test the relationships confirmed in Experiments 1 and 2 on a more applied context. Specifically, Experiment 4 uses imagined odors from advertising stimuli to extend findings in Experiment 2 where odors associated with items or objects are shown in pictures to elicit emotions. Typically, in a marketplace context, products are often packaged or boxed. Furthermore, ads are presented in visual format excluding other sensory influences. To investigate the impact of olfactory imagery in a more applied context, in Experiment 4, ads are presented with odor-associated products or services. The impact of odor imagery is investigated, including the emotions associated with odor imagery and ad evaluations. In addition, the activation of olfactomotor is induced by performing a "sniff" motion. Sniff cues are presented along with the ads, to investigate the influence on emotions.

Finally, individual differences in sense of smell are considered in all studies in terms of the effect of odors in hyperosmics, individuals with increased sensitivity to smell, compared to individuals with a normal sense of smell.

Experiment 1: Odor-elicited emotions

This study focuses on investigating the emotions elicited by odor stimuli and explores how odors play a role in inducing emotions across individuals with varying abilities to smell.

Research design and participants

2 (odor: neutral (control) vs. odor) within subject × 2 (sense of smell: normal vs. hyperosmics) between subject× 2 (task: passive detect vs. identification) within subject mixed design. Thirteen participants were included for each individual difference group- normal and hyperosmics- resulting in a total of 26 participants.

Research procedure

Scents released from manufactured smell kits, Sniffin Sticks (Burghart, Germany), are utilized as odor stimuli. Participants are asked to sniff the odors presented to them while brain activity is being collected using EEG methods. Odors are manually presented for 1.5 seconds on the click of the keypad (to signal a trigger onset). Twenty different odors are included (please see Appendix A for list of odors) and 40 trials are presented for the odor conditions. Odor trials are randomly presented with 20 trials of blank sticks (control condition). The experiment consists of two tasks. Each block includes 40 trials: 20 scented trials and 20 unscented trials. The lingering scents from the previous trials are minimized by placing odor absorbing rocks in the laboratory rooms. In addition, participants are asked to rate the scent after each trial which will also allow time for the scent to diffuse. An experimenter is required to stay in the EEG room with the participant during the study to present the stimuli to the person.

Task 1 is passive odor detection which is composed of 40 trials. In random order, 20 of these are blank (control) and the other 20 sticks are scented (odor). Participants are asked to take a sniff of the scented pens presented. Task 2 is an odor identification task with procedures similar to task 1. Participants are presented with an odor or non-odor stick (blank) for 1500msecs. In addition, participants are prompted to identify the scent by selecting from 5 options, which includes a "blank" option, presented on the computer screen. A total of 40 trials (there are different scents from task 1) make up task 2, of which 20 are blank (control) and 20 are scented sticks, quasi-randomly presented (see Appendix A for trials). In both tasks, the pens are each presented for 1.5 sec while brain activity is being recorded using EEG equipment.

To ensure odor presentation procedures are implemented in a consistent and controlled manner, several precautions were taken to minimize possible confounding factors. First, a head stand with a chin rest (used by opticians) was used to help participants position their heads and keep still. A clamp was attached onto the head stand at a 45 degree fixed angle for the pens to be inserted (see Figure 4). Next, two trained experimenters performed the presentation of Sniffin Sticks. In addition, the lingering scents from the previous trials were minimized by placing odor absorbing rocks in the laboratory.

At the end of the study, the participant is asked to complete a survey including the Chemical Sensitivity Scale (CSS) and demographic questions. CSS is a scale developed by Nordin et al (2003) that quantifies the affective reactions to, and behavioral disruptions by, odorous/pungent substances. This scale was originally used to determine the level of individual sensitivity to chemicals in the environment, such as perfumes, smoke and solvents.

It is collected here for later inclusion as a potential control variable. Please see Appendix B for scale items.

Figure 4. Stimuli presentation setup (Experiment 1)

Experiment 2: Emotions-elicited in odor-associated images and olfactory mental imagery

The emotions elicited through image of objects that may be associated with a pleasant or unpleasant odor is investigated in this experiment. Specifically, an ERP experiment is designed to detect the emotions associated with odor-eliciting images compared to no odor associated images. In addition, the impact of olfactory imagery is examined through performing olfactory imagery.

Pretest

A pool of 90 odor-associated (categorized as pleasant or unpleasant) and non-odor associated pictures is constructed. Objects that are associated with pleasant odors include items from categories such as food (e.g., hamburger, cookie and pie), flowers (e.g., rose, daisy) and fruits (e.g., banana, cherry and cantaloupe). Items associated with unpleasant odors include cigarette smoke, farm animals and dirty socks. Non-odor associated images include items from categories such as furniture (e.g., table, chair), kitchenware (e.g., utensils, cup and saucer) and electronics (e.g., cellphone, computer) and other categories.

Pictures were pretested for their association with smell by asking the question, "Do you associate this item in the picture with a smell?" Items associated with an odor are further rated on the dimensions of familiarity, pleasantness and intensity on a 7-point scale. Stimuli with mean ratings of 5.5 were included in the pleasant odor category, and mean ratings below 2.5 were categorized as unpleasant. Agreement of 85% or above is required for inclusion in the stimuli. Eighty images, encompassing 30 each for pleasant and unpleasant odor and 20 for no odor associations, were included in the final stimuli set. The rating scales for these pictures are presented in Appendix C.

Research design and participants

This is a 3 (associated odor valence: neutral vs. pleasant vs. unpleasant) within subject × 2 (tasks: passive view vs. olfactory mental imagery) within subject × 2 (sense of smell: normal vs. hyperosmics) between subject mixed design study.

Undergraduates in the college of business were recruited for the pretest and ERP study. Registered graduate students on campus were included in the selection of participants for the ERP study. Sixty participants were recruited for the pretesting of stimuli. For the ERP study, 20 participants were recruited for each group, normal and hyperosmics. The individual difference groups are prescreened with a self-reported question which asks them to select the category that best characterizes their sense of smell: normal, sensitive to smell, decreased sense of smell or no sense of smell. A final number of 12 and 16 participants for normal and sensitive individuals were included respectively.

Procedure and stimuli

A total of 80 trials are presented in two blocks of 40 trials for each task. Each block consists of 15 pleasant odor-associated pictures, 15 unpleasant odor-associated pictures and 10 non odor-associated pictures. There are two tasks in this study, the passive view task and imagery task. In the passive view task, participants are asked to passively view the images. During the second task, imagery task, participants are instructed to perform olfactory mental imagery where they mentally form images of the odor associated with the object presented in the image.

Each picture is presented on the screen for 1000ms. Thirty trials for each odor valence category are presented in random order along with 20 trials in the control condition. Picture stimuli that is either associated with a pleasant odor or unpleasant odor are included with the study, along with control pictures that are not associated with an odor. These pictures are of items that are present in normal daily lives. Pictures included in the control condition are images of items such as a flat screen TV, chairs or remote control, DVD disk, and headphones. Pleasant odor-associated pictures include flowers, cake, and hamburger, strawberry, and popcorn. Unpleasant odor-associated pictures include dumpster, dirty shoes and dead fish, fire smoke, and exhaust. Please refer to Appendix C for a complete list of pictures used in the experiment.

A survey is implemented at the end of the study. The survey includes a Vividness of Olfactory Imagery Questionnaire (VOIQ) and the Disgust Sensitivity Scale (DSS). Both are individual difference scales that could be highly correlated with individuals' sensitivity to smell and perceptibility to disgust-evoking pictures presented in the unpleasant odor-associated stimuli respectively. VOIQ (Gilbert, Crouch and Kemp 1998) was developed based on the original Vividness Visual Imagery Questionnaire (VVIQ, Marks 1973). Four odorous scenes were described and participants are asked to imagine the odors associated with these scenes and then rate them for clarity and vividness, please refer to Appendix D. The DSS (Haidt, McCauley and Rozin 1994) is a 25-item scale that measures individual differences in susceptibility to disgust. People are asked to rate statements describing incidences of disgust occurring in daily situations (see Appendix E). This scale is widely used in research studying the specific emotions of disgust in various contexts. In marketing, this scale has been used to investigate the mediating role of disgust in advertising (Shimp and Stuart 2004) and individual differences in disgust sensitivity influencing variety seeking behavior in a food consumption context (Goukens et al., 2007).

Experiment 3: The "contagion effects" of odors on judgment and decision making

The objective of this study is to examine the "contagion effects" of odors. In other words, the downstream effects of odor-induced emotions are of interest in this experiment. Specifically, behavioral outcomes such as evaluation of products, subjective reports of health symptoms and food choice are examined under the influence of odor-induced emotions. It is postulated that such effects are mediated through unpleasant odor-induced emotions, such as disgust and fear. The effects of pleasant or unpleasant ambient odors on judgment and decisions are investigated through a behavioral experiment.

Pretest

Pleasant scent. Seven different scents were pretested with 19 undergraduate participants, including 8 males and 11 females. Age ranged from 19-23, with an average age of 20.4. Among the 19, 15 were Caucasian and 1 smoker was identified. 15 of the 19 participants identified themselves as normal sense of smell and 3 were sensitive. One participant reported him/herself as decreased in sense of smell.

The 7 oils were bought from a well-known retail store that specializes in aromas and scents, including scents labeled as Lemon, Warm vanilla sugar, Lavender and Vanilla, Pineapple and Mango, Japanese Cherry Blossom, Lemon mint leaf and Orange blossom. Participants were given a swatch paper infused with the oils and sealed in Zip Lock bags. Each scent was rated on a 9 point Likert scale for likeability (3 items), familiarity and strength. The Pineapple and Mango scent was rated highest in level of likeability among the 7 scents (M_{mango}= 23.58 vs. $M_{average}$= 19.92) and was selected for the pleasant condition in experiment 3. There were differences among preferences for scents evidenced by within subject repeated ANOVA ($F(6, 108)$= 6.01, $p< .001$). Familiarity ($M_{pineapplemango}$= 6.95 vs. $M_{average}$=6.67) and strength ($M_{pineapplemango}$= 6.47 vs. $M_{average}$=6.29) were rated in the moderate range. There were no significant differences in terms of familiarity among the 7 scents pretested ($F(6, 108)$= 1.33, $p> .1$). Equivalently liked as Pineapple and Mango was Japanese cherry blossom ($M_{cherryblossom}$=22.11 vs. $M_{pineapplemango}$=23.58, $t(18)$= 0.92, $p>.1$). However, Pineapple and Mango was rated significantly better liked than Lemon ($M_{pineapplemango}$=23.58 vs. M_{lemon}= 20.68, $t(18)$= 3.26, $p< .004$), but Japanese cherry blossom ($M_{cherryblossom}$= 22.11 vs. M_{lemon}=20.68, $t(18)$= 0.8, $p> .1$) was not rated significantly higher. Please see Appendix F for the levels of familiarity, strength and likeability of all 7 scents. A self-reported arousal scale was surveyed and participants identified an emotion experienced for each scent. Seven of the 19 specified that Pineapple Mango scent made them "happy," which was the most frequently identified emotion. Ten out of 19 indicated that Japanese cherry blossom made them feel "calm." Please see Appendix F for ratings of all scents pretested.

It is also worth noting that the 3 sensitives on average reported slightly lower levels of the scent in terms of likeability ($M_{sensitive}$= 21. 67 vs. M_{normal}= 23.73, t(16)= 2.26, p< .06), compared to normals. In terms of familiarity ($M_{sensitive}$= 6.67 vs. M_{normal}= 7.00, t(16)= 0.29, p> .1) and strength ($M_{sensitive}$= 5.67 vs. M_{normal}= 6.67, t(16)= 0.803, p> .1), both smell groups had similar mean ratings.

Unpleasant odor. Four different unpleasant odors were pretested with 7 undergraduate students, 6 males and 1 female. Age range of participants was 20-34, the mean age is 25.7. The four chemicals including acetone, H_2S, hexane and toluene were contained in glass vials and a smell test was performed to select the unpleasant odor for the study. Each participant was asked to rate the odor on a 7-point Likert scale for familiarity, pleasantness, and strength. H_2S, or also known as rotten eggs (or the main component of **Flatulence**) was rated as the most unpleasant (M= 2),most familiar (M= 6.7) and strongest (M= 6.43). Thus, it was selected for the unpleasant condition in experiment 3. F-test is significant for pleasantness (F(3, 15)= 5.09, p< .013), familiarity (F(3, 18)= 5.28, p< .01) and strength (F(3, 18)= 9.73, p<. 001). Please see Appendix F for the ratings for all four odors pretested.

Food choices. Five different snack choices were pretested in terms of the perceived level of healthiness, comfort level and nutritious level. Thirty-one undergraduate students, 11 male and 20 female, age range of 18-28 (M=21.8), participated in an online rating task where images of the five snacks were randomly presented. Among the five snacks, Nutri Grain, Nature Valley breakfast bar and Sun Maid Raisins were candidates for the “healthy” option. Snicker bars and Rice Krispies Treats were representatives for the “unhealthy” option. Within subject F-tests confirmed significant differences among the five snacks on healthy level (F(4, 116)= 106.211, p< .001), nutritious levels (F(4, 116)= 97.80, p< .001) and comfort levels (F(4, 112)= 7.26, p< .001). Pretest results revealed that both Sun Maid raisins and Nature Valley breakfast bars were rated highest on healthy (M= 5.57 vs. M= 5.50, t(29)= 0.311, p> .1) and nutrition (M= 5.50 vs. M= 5.53, p> .1) levels. However, comfort level for Sun Maid Raisins was rated the lowest (M= 3.83 vs. M= 4.47, t(29)= 2.16, p< .05). Hence, Sun Maid Raisins were used as the healthy option in Experiment 3. Both Snicker bars and Rice Krispies Treats were rated the lowest in healthy (M= 1.97 vs. M= 2.03, t(29)= 0.311, p> .1) and nutrition (M= 1.97 vs. M= 1.83, t(29)= -.0583, p> .1) levels. However, comfort level was rated higher for Snickers (M= 5.72 vs. M= 4.45, t(28)= 5.49, p< .001). Hence, Snickers were chosen for the unhealthy snack in Experiment 3. These rated on a 7-point Likert scale. Please see Appendix F for the ratings of all 5 snacks.

Research design and participants

This is a 3 (Ambient scent: control(no odor) vs. pleasant-aroma scent vs. unpleasant-chemical odor) between subject × 2 (normal vs. hyperosmic) between subject design. Undergraduate business students are recruited for pretest and study. Between subject design results in three conditions: control, pleasant and unpleasant ambient scent, and two individual difference groups: normal and hyperosmics. Each study session includes consumer judgment and decision making related tasks such as product evaluation, moral judgment of ethical scenarios, evaluation of personnel and a food choice task. The product chosen for the product evaluation task, facial tissue paper and moisturizer, were used in a previous study (Krishna, Lwin and Morrin 2010) and replicated in (Childers, Cross and Lin 2012).

Other possible consequences of ambient scent effects on emotional processes are examined through tasks such as self-reports of current physical health state using a LMS scale and emotions using DES scale. Discussion of the scales is described below.

A final total of 159 participants were included across all conditions. The range is 21~34/cell. Specifically, for each cell:

	Unpleasant	Neutral (control)	Pleasant
Normal	27	34	26
Sensitive	21	26	23

Procedure and scales. Participants were recruited and stimuli were set up as described. The first task involved evaluation of products, including facial tissue and moisturizer. Items were distributed to participants to evaluate. The order of the products presented to participants was counterbalanced across each study session. After examining the product, participants were asked to evaluate and rate the quality of the product, likeability of the product and likelihood to buy the product. Participants were also asked to write down their thoughts about the product.

Next, participants were given a list of health related symptoms and were asked to rate on the level of each symptom (Dalton 1997). "Do you have the following health symptoms? Please rate the degree of each symptom." The list includes two categories of symptoms, including solvent associated symptoms, e.g., headache, dry throat and itchy eyes, and 15 somatic symptoms (control), e.g., ear ringing, leg cramps, back pain. Participants are asked to report on a labeled magnitude scale (LMS). Please see Appendix G for the full list of symptoms.

Emotions were captured with the Differential Emotions Scale (DES-I). DES-I is developed by Izard (1972) consisting of 30 adjectives or phrases covering 10 emotion categories, including fear, disgust and enjoyment (please see Appendix H for the full scale). This scale is used to investigate the self-reported emotions induced by the ambient scent under the separate conditions. The responses from treatment groups (pleasant or unpleasant odors) are compared with the control condition (neutral odor).

After completion of the DES-I, a moral judgment task mas administrated which requires participants to read four short vignettes that describes a moral judgment scenarios (Schnall et al., 2008). For each scenario, they were asked to rate the severity of these incidences described on a 9-point scale, from not severe at all (1) to extremely serious (9). Please see Appendix H for the vignettes and pretest means.

Finally, the participants were told to give feedback about the study. Participants were asked to rate the professionalism of the experimenter. The same experimenter was present for all studies and all conditions. In addition, he/she was asked to present him/herself in a consistent manner and dress similarly across all studies. Participants were also asked to rate the study experience and provide any thoughts for future improvement.

At the end of the study, the experimenter asked each participant, on their way out, to select a snack in appreciation of their participation. An option of a healthy snack (raisins) or unhealthy snack (snicker bar) was provided. The choice made by the participant was recorded. Participants were debriefed after they completed the study and were asked to keep the study manipulation confidential and not reveal this to other future potential participants.

Cover story. A different cover story is designed for each condition to disguise the ambient odor manipulation as a coincidence. This was part of the study and announced in the beginning of the study to participants.

Cover study for all conditions including the control group, pleasant and unpleasant ambient scent conditions: "In this study on new products, we will ask you to help us evaluate and rate two products as part of a study we will conduct in the future. I will give you instructions and pass out products as we go along. In the second part of the study, there are also a few other series of questions followed by the new product testing that is part of scale development study and scenarios we will use in the future. Please take your time to answer them carefully, as this will help us greatly. Also, there appears to be a scent lingering, it must be from a previous study. "

Experiment 4: Are emotions enhanced by smell cues in ads?

The purpose of this experiment was to evaluate odor- elicited emotions, induced from ads containing odor-associated products, and investigate how this in turn influenced evaluations of the advertised product. The role of olfactory mental imagery is investigated by just viewing ads compared to a condition that induced an olfactory motor mechanism, such as "sniff," to the imagery process.

Stimuli pretest

A pool of 42 and 59 ads for non-odor associated ads (control condition) and pleasant odor-associated ads respectively are pretested and rated on 1) odor-association 2) level of pleasantness. Criteria used for final ad inclusion in the ERP study include 1) 75% agreement that non-odor ads were indeed not associated with an odor to be included in the control ad (non-odor) category 2) 75% agreement on odor-associated ads as indeed associated with an odor AND mean ratings that are higher than 5.5 on a 7 point scale for pleasantness were included within the pleasant odor ad category.

To control for the effect of visual appeal of the ad, a 4-item vividness scale was used to determine the uniformity of vividness across ads. Ads with mean vividness ratings below 4.0 or above 5.5 on a 7-points scale were removed. In the end, a total of 66 ads (28 non-odor associated ads; 38 pleasant odor-associated ads) were included in the experiment. Please see Appendix J for ratings and final ads included in the experiment.

In addition, ads chosen were constructed in a manner to ensure they would that would represent "real" ads. A fake brand name was included in the ad to increase believability. Words were screened and chosen from the extended database of noun norm ratings originally created by Paivio, Yuille and Madigan (Clark and Paivio, 2004). The nouns selected and paired with our ads were controlled to ensure words chosen possess low emotionality, low imagery replication, mid-range (rated 3.5-4.5) on gender ladenness, neutral (3.5-4.5) pleasantness. Existing brands names were removed from the list. Please refer to Appendix J for the full set of ads with its corresponding brand name, odor and valence ratings, and vividness ratings.

Research design and participants

This is a 2 (tasks: mental image vs. sniff and mental imagery) between group × 2 (sense of smell: normal vs. hyperosmics) between subject study. Forty participants are recruited for each group (normal vs. hyperosmics), resulting in 80 participants total. We ended up with a total of 54 participants. The mental imagery group consists of 11 normal and 12 sensitive individuals. The mental imagery/sniff consists of 17 normal and 14 sensitive participants.

Participants are presented with 28 odor-neutral ads (control condition) and 38 odor-associated ads. All participants participated in the view task which consisted of control and odor-associated ads. Task 2 was a between subject design, approximately half of the participants were asked to perform olfactory imagery while viewing the ads. The other half were asked to sniff during the same time they performed olfactory imagery. Behavioral data collection include recording scale ratings of both product and ad evaluations in terms of likeability (consists of 3 items), and likelihood to buy (1 item question). Please see Appendix J.

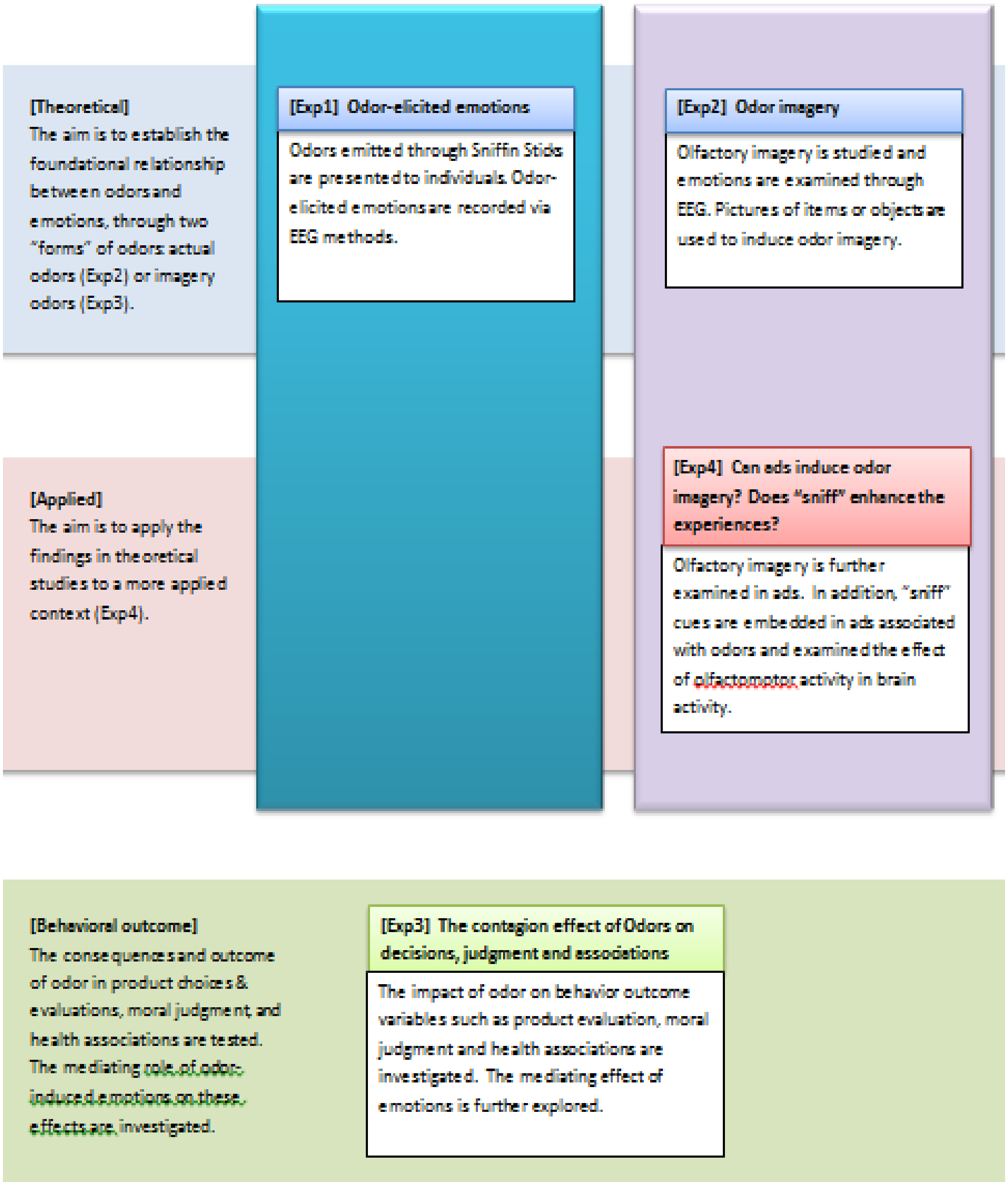
ERP research procedure

To set the baseline to compare imagery and imagery/sniff reactions a control condition was included for all participants. Task 1 involved passive view of all 66 ads. Non-odor and odor associated ads were presented in random order. Each ad was also presented on the screen for 2secs each. In task 2, only odor-associated ads were presented along with the following instructions. The imagery group was asked to perform olfactory imagery and to imagine the scent associated with the product or service presented in the ad. Participants randomly assigned to the imagery/sniff group were asked to imagine AND physically "sniff" when presented an ad. Task 1 composed of 66 trails (control ads and pleasant odor ads) and task 2 composed of 38 trials (pleasant odor ads). During the second task, participants were prompted to rate each ad and the product advertised and finally rate the level of likelihood to buy.

Data analyses

Physiological data collected in ERP studies included brain data that was analyzed with EMSE and graphs generated in Matlab. Further, measurements for components indicating emotions, attention and other cognitive processing were be captured in EMSE and analyzed using ANOVA with statistical software. In addition, behavioral responses from Experiment 1, 3 and 4 were be analyzed with ANOVA using statistical software.

Figure 3. Overview of exaperiments



CHAPTER 4: RESULTS

Results of the four experiments described in Chapter 3 are reported in this chapter. Experiment 1 is designed to understand odor-elicited emotions in a passive odor detection task versus a more cognitively involved odor identification task. LPP is detected and analyzed to further understand emotional processes during exposure to odor. Experiment 2 uses pictures to induce and examine a slightly different form of odor processing, focusing on emotional processes, through olfactory imagery. Experiment 3 is a behavioral experiment that examines how ambient odor valence impacts consumer decision making, judgment and choice through analyses of various task outcomes. Finally, experiment 4 is designed to take findings from experiment 2 and 3 a step further and examine the effect of olfactory imagery and sniffing motions on emotional processes and evaluation of ads and products. Across all studies, the phenomenon of individual differences in sense of smell is investigated. Each experiment includes a comparison of individuals sensitive to smell with normal individuals.

Odor-induced emotions

Experiment 1 is an ERP design and includes two tasks. Task 1 is passive odor detection which is composed of 40 trials. In random order, 20 of these are blank (control) and the other 20 sticks are scented (odor). Participants are asked to take a sniff of the scented pens presented. Task 2 is an odor identification task. This time participants are asked to identify the scent and select from 5 possible options presented to them on the screen, including a blank option. A total of 40 trials are included. Behavioral responses are collected in the second task. Attentional processes (P100) and emotional processes (LPP) are examined using physiological EEG data.

Experiment 1: Odor-elicited emotions

Behavioral outcome. During the odor identification task, behavioral responses reveal an average accuracy rate of 83% across all individuals. Furthermore, accuracy rates are higher for blank trials than correctly identifying an odor (M_{blank} = 0.868 vs. M_{odor} = 0.785, t(38) = 2.97, p < .01). This finding is similar between both smell groups, for blank trials ($M_{blank/normal}$= 0.873 vs. $M_{blank/sensitive}$= 0.863, t(37)= 0.188, p> .1) and for odor trials ($M_{odor/normal}$= 0.783 vs. $M_{odor/sensitive}$= 0.787, t(37)= -0.100, p> .1). This suggests that behavioral responses do not seem to differentiate the two smell groups as reflected in equivalent accuracy responses in odor detection results.

Physiological outcome- Attention. In attempt to test H1a, the following analyses of P100 conducted. MANOVA results indicate that there are significant main effects of task (F(1, 24)= 4.6, p < .05) and two-way interactions between task × group (F(1, 24)= 5.14, p< .05), and odor × task (F(1, 24)= 4.38, p < .05) on P100 brain activity (Figure 4). The three-way interaction between task × group × odor however was not significant (F(1, 24)= 0.235,p> .1). Follow up t-tests reveal an increase in P100 for task 2 (odor identification) compared to task 1 (passive detection) in normal individuals ($M_{passive}$ = 1.43 μV, $M_{identify}$ = 2.65 μV, t(12)= -2.70, p < .05). However, task effect is not significant in sensitive individuals, ($M_{passive}$ = 1.78 μV, $M_{identify}$ = 1.74 μV, t(12)= .11, p > .10). This finding suggests that the more cognitively effortful task of odor identification increased attention in normal individuals. However, sensitive individuals do not appear to need to increase attention to complete the identification task. And the two groups performed equivalently well as reflected in their behavioral responses.

Post-hoc tests conducted for odor × task in the two olfactory groups revealed that during the passive detection task, both normal (M_{blank} = 1.05, M_{odor} = 1.81μV, t(12)= -1.31, p > .10) and sensitive individuals (M_{blank} = 1.28, M_{odor} = 2.27μV, t(12)= -1.37, p > .10) do not show an increase in attention toward olfaction, evidenced by P100 (95-125ms) at Oz. However, there was a significant task effect during blank conditions ($M_{passive/blank}$ = 1.06 μV, $M_{identify/blank}$ = 3.06μV, t(12)= 3.39, p < .01) in normal individuals. This significant increase in P100 during the identification task, which is a more cognitive effortful task, vs. detection task) suggested more additional attentional resources are allocated in comparison to the detection task. However, this effect did not occur during odor conditions ($M_{passive/odor}$ = 1.81μV, $M_{identify/odor}$ = 2.25 μV, t(12)= -.45, p > .10).

As for individuals sensitive to sense of smell, the task did not have a significant effect on blank conditions ($M_{passive/blank}$ = 1.28 μV, $M_{identify/blank}$ = 1.73μV, t(12)= 0.75, p > .1), nor did it have an effect on odor conditions ($M_{passive/odor}$ = 2.27μV, $M_{identify/odor}$ = 1.75 μV, t(12)= 0.03, p > .1).These findings suggest that there are individual differences in terms of how attentional resources were allocated during olfactory and non-olfactory conditions. Normal individuals display an increase in olfactory perceptions during blank trials only when the cognitive task required more effort as in the identification task. In contrast, individuals sensitive to smell appear to be "screening the environment," automatically directing attention to the odor even without instructions to do so. Thus, an identification task does not enhance attention for individuals sensitive to smell.

Results suggest that normal individuals are not paying as much attention to the odor information until explicitly directed to do so. On the other hand, individuals sensitive to sense of smell appear to implicitly pay some level of attention to the odor information even during a natural state (passive smell). H1a is not supported, but our results reveal underlying differences between smell orientation groups in terms of attentional mechanisms. We also demonstrate how “odor cues” (identification task) can help direct individuals with a normal sense of smell to odors. But what may be more relevant is that automatic attention is increased even during supposedly “non-odor” situations when sniffing was instructed in individuals sensitive to smell (as seen in the passive task).

Physiological outcome- Emotions. Odor induced emotion is measured and reflected through the LPP. Measurements taken across 450-800msec at midline sites (Fz, FCz, Cz, Pz) help us understand the change in LPP (emotions) across the window (Figure 5). The following tests were conducted to test H1b. Analyses were performed using repeated measures MANOVA using a task (passive vs. identify) × condition (control vs. odor) × electrode (Fz, FCz, Cz, Pz) × group (normal vs. sensitive) mixed design. Results from early LPP (450-600ms) revealed significant main effects of electrode ($F(3, 69)= 14.116$, $p<0.001$) and condition ($F(1, 23)= 15.66$, $p< .001$). There was moderate interaction effects between Condition × Task ($F(1, 23)= 3.195$, $p< .087$). Other effects not reported are not significant (p’s > .1). LPP was further analyzed using site Pz which has the highest recording of LPP ($M_{FZ}= -1.91$vs. $M_{FCz}= -1.43$ vs. $M_{Cz}=0.75$ vs. $M_{Pz}= 1.27$, $F(3, 69)= 14.116$, $p<0.001$). Overall group ($M_{normal}= 1.39$ vs. $M_{sensitive}= 1.51$, $F(1, 23)= 0.017$, $p> .1$), task ($M_{passive}= 1.24$ vs. $M_{identify}= 1.66$, $F(1, 23)= 1.335$, $p> .1$), condition ($M_{control}= 1.56$ vs. $M_{odor}= 1.33$, $F(1, 23)= 0.814$, $p> .1$) main effects were not significant. Two-way interaction was insignificant for task × group ($F(1, 23)= 1.567$, $p> .1$). However, the group × condition interaction effect was significant ($F(1, 23)= 5.6$, $p< 0.027$). Three-way interaction was also insignificant ($F(1, 23)= 0.745$, $p> .1$).

In order to test for H1c, further analyses were done for the individual difference groups (Figure 6). Results revealed that the individuals with a normal sense of smell revealed a weakly significant interaction between Task × Cond ($F(1, 12)= 3.73$, $p< .07$). Post hoc tests showed that under passive smell instructions, LPP is significantly increased during odor trials compared to blank (control) trials ($M_{passive/control}= 1.02$ vs. $M_{passive/odor}= 1.79$, $t(12)=-2.05$, $p< 0.056$). When instructed to identify the odor presented, LPP levels are similar between the two conditions, blank and odor ($M_{identify/control}= 1.38$ vs. $M_{identify/odor}= 1.36$, $t(12)= 0.055$, $p> .1$). On the other hand, individuals sensitive to smell displayed a higher LPP during blank conditions compared to odor conditions ($M_{control}= 1.925$ vs. $M_{odor}= 1.08$, $F(1, 11)= 3.87$, $p< .07$). Unlike normal individuals, blank conditions appear to activate higher LPP magnitudes. Both blank conditions under passive ($M_{passive/control}= 1.565$ vs. $M_{passive/odor}= 0.576$) and identify ($M_{identify/control}= 2.285$ vs. $M_{identify/odor}= 1.594$) tasks generate a higher LPP than under odor conditions.

In sum, when passively detecting a scent (task 1), emotions of normal individuals are automatically generated as reflected by the elevated LPP magnitudes. However, when a more cognitive task is involved as demonstrated in the odor identification task (task 2), emotions are less enhanced. For individuals sensitive to smell, there appears to be an automatic suppression of emotions as indicated by the lower LPP under odor conditions. This could be a result of “sense making” which may be a process similar to the odor identification task. Sensitive individuals may automatically, without being prompted, try to discern what the scent is. This rational reaction (cold system) works against the emotional process (hot system), which is reflected in the attenuated LPP during odor conditions. On the other hand, emotions are elevated during blank trials. This perhaps indicates a “pleasant surprise” from the unscented target trial. These results do not support H1b, but suggest other automatic cognitive mechanisms that may be involved in regulating emotions and would have to be confirmed in future studies.

The effects of task × condition at a later LPP window (600-800ms) are similar to early LPP with only slight differences. Statistically, the task × condition interaction effect has become more significant ($F(1, 23)= 8.63$, $p< .007$). Analyses performed at Pz revealed significant condition effects ($F(1, 23)= 5.19$, $p< .05$) on LPP, suggesting blank trials trigger larger LPP magnitudes compared to odor trials ($M_{control}= 1.64$ vs. $M_{odor}= 0.9$). Similar patterns and effects of task and condition are found in the two smell groups, sustaining the earlier effects but at a slightly lower magnitude.

Figure 4. P100 activity at Oz during detection vs. identification tasks, groups combined

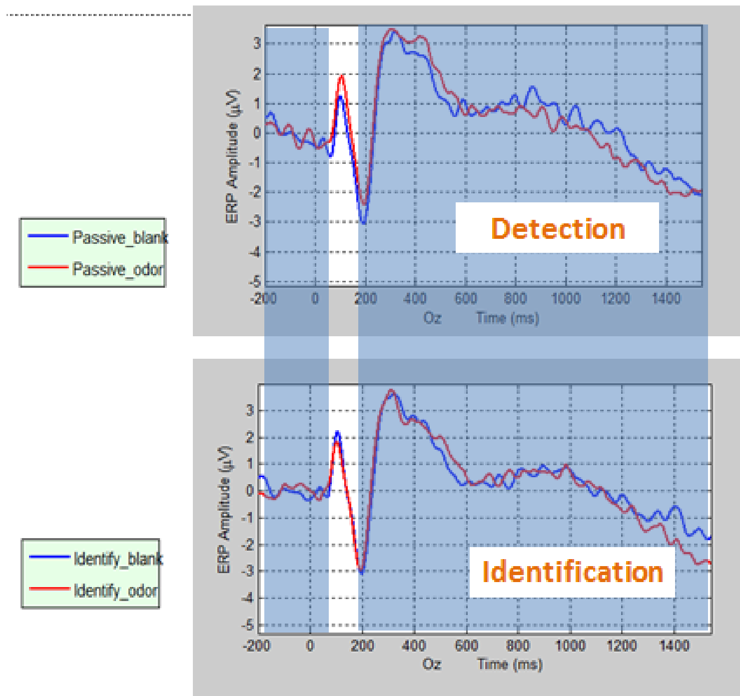


Figure 5. LPP shown across midline electrodes and topographic map of activity

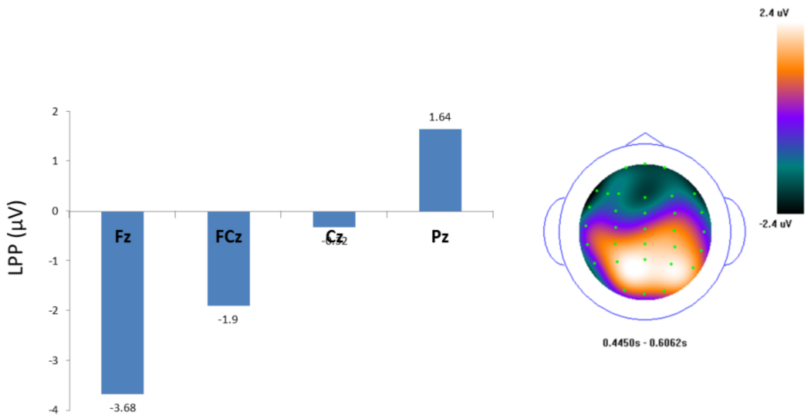
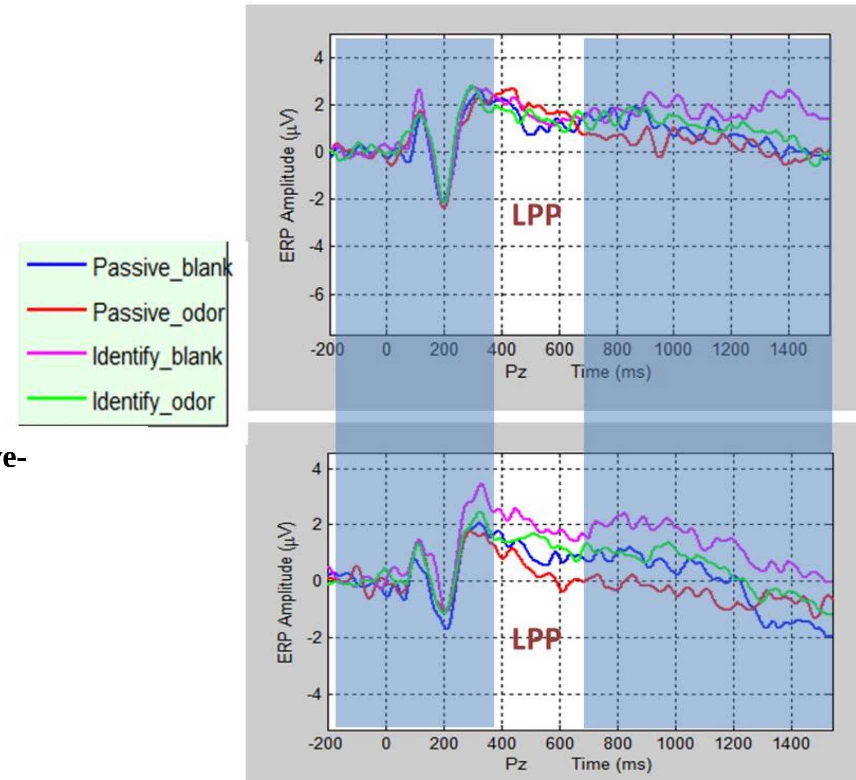


Figure 6. LPP activity at Pz during passive detection vs. identification tasks

Normal-

Sensitive-



Olfactory imagery induced emotions

The role of olfactory imagery on emotional processes is the focus in Experiment 2. The impact of odor valence and individual differences in sense of smell on emotions are of interest. Pictures associated with odors including two valence categories, pleasant and unpleasant, were compared with non-odor associated pictures (control). EEG is recorded and individual differences in emotional processes (reflected in LPP) are investigated.

Experiment 2: Emotions-elicited in odor-associated images and olfactory mental imagery

Repeated measures ANOVA was done using a 3 (Valence: neutral vs. pleasant vs. unpleasant) within subject × 2 (Task: view vs. imagery) within subject × 4 (Electrode: Fz, FCz, Cz, Pz) within subject × 2 (Groups: normal vs. sensitive) between subject mixed design. Main effects of task ($F(1, 25)= 4.19$, $p< .05$), valence ($F(2, 50)= 6.81$, $p< .002$) and electrode ($F(3, 75)= 15.885$, $p< .001$) are significant. The main effect for the between subject group factor is not significant ($F(1, 25)= 0.252$, $p>.1$). Two-way interactions are not significant for task × group ($F(1, 25)= 0.017$, $p> .1$), valence × group ($F(2, 50)= 1.2$, $p> .1$), electrode × group ($F(3, 75)= 0.90$, $p> .1$), task × valence ($F(2, 50)= 1.76$, $p> .1$). However, valence × electrode ($F(6, 150)= 23.762$, $p< .001$) and task × electrode ($F(3, 75)= 6.90$, $p< .001$) are significant. Three-way interactions between task × valance × group ($F(2, 50)= 3.68$, $p< .05$) is significant, but valence × electrode × group ($F(6, 150)= 0.301$, $p> .1$) and task × valence × electrode ($F(6, 150)= 0.305$, $p> .1$) are not significant. The four-way interaction is insignificant as well ($F(6, 150)= 0.743$, $p> .1$). Electrode means reveal largest LPP activity is at Pz (M_{Fz}= -3.68, M_{FCz}= -1,90, M_{Cz}= -0.32, M_{Pz}= 1.64). Hence, further analyses are conducted at the Pz site (Figure 7).

We analyzed LPP at the electrode site Pz, in the window of 500 to 700ms. Significant main effects of valence on emotions (reflected by LPP) is revealed, F(2, 52)= 12.36, p< .001. Unpleasant odor-associated images trigger the highest LPP levels compared to the other two conditions ($M_{unpleasant}$= 3.01 vs. $M_{neutral}$= 0.86, t(26)= 4.735, p< .001; $M_{unpleasant}$= 3.01 vs. $M_{pleasant}$= 0.90, t(26)= 4.34, p< .001). This supports H2a and indicates the presence of a a negativity bias. However, the task main effect was not significant, M_{view}= 1.85 vs. $M_{imagery}$= 1.33, F(1, 26)= 2.30, p> .1. And neither were the interaction effects, valence × task, valence × group, task × group, p's >.1.

Analyses for the two olfactory groups were carried out for testing H2b and also based on the significant 3-way interaction task × valance × group (F(2, 50)= 3.68, p< .05) detected in the ANOVA earlier. In addition, experiment 1 and theory points to possible differences in olfactory groups. Thus follow up analyses of LPP in the individual difference groups were performed and reported. Individuals with normal sense of smell demonstrated a negativity bias in both view and imagery tasks, confirming H2a. However, the level of emotions generated from the unpleasant condition was slightly stronger in the view condition compared to the imagery condition ($M_{view/unpleasant}$= 3.41 vs. $M_{imagery/unpleasant}$= 2.30, t(11)= 0.966, p< .1). Emotions generated during the pleasant odor-associated condition, on the other hand, increased during the imagery task in comparison to the view task ($M_{view/pleasant}$= 0.15 vs. $M_{imagery/pleasant=}$ 1.14, t(11)= 1.902, p< .05). At the same time, emotions elicited under neutral picture condition displayed an opposite pattern, emotions were stronger during passive view and was attenuated during olfactory imagery ($M_{view/neutral}$= 0.96 vs. $M_{imagery/neutral}$= 0.13, $t(11)= 1.63$, $p< .05$). This relationship between task and valence suggests that directing focus onto pleasant olfactory associated information increased emotions for individuals with normal sense of smell. Visual information however elicited stronger emotions in the neutral pictures but was decreased once instructions directed focus onto olfactory imagery. Further discussion of these results is provided in the discussion chapter.

In individuals sensitive to smell, LPP during passive view task was compared to the olfactory imagery task (Figure 8). LPP results show moderately increased emotions during view conditions compared to imagery conditions for both non-odor (neutral) associated pictures ($M_{view/neutral}$= 1.92 vs. $M_{imagery/neutral}$= 0.71, $t(14)= 1.89$, $p< .08$) and pleasant odor associated pictures ($M_{view/pleasant}$= 1.75 vs. $M_{imagery/neutral}$= 0.82, $t(14)= 1.84$, $p< .08$). Or in other words, the level of emotions appeared to be attenuated during the olfactory imagery task for both pleasant and neutral conditions. Unpleasant odor-associated pictures induced strong levels of emotions during both the view ($M_{view/unpleasant}$= 3.33 vs. $M_{view/neutral}$= 1.92, $t(14)= 2.30$, $p< .038$) and imagery tasks ($M_{imagery/unpleasant}$= 3.36 vs. $M_{imagery/neutral}$= 0.72, $t(14)= 2.33$, $p< .035$). However, olfactory imagery did not enhance LPP further in unpleasant odor associated pictures ($M_{view/unpleasant}$= 3.33 vs. $M_{imagery/unpleasant}$= 3.36, $t(14)= -0.063$, $p> .1$). Results were not as supportive of H2b as emotional processing reflected in LPP was attenuated in sensitive individuals particularly during pleasant odor conditions. We defer to the discussion chapter for further discussion of this observation. However, we note that this finding echoes and coincides with results from Experiment 1. Experiment 1 also revealed possible automatic attenuation under odor conditions (in comparison to control conditions) in sensitive individuals.

Unlike individuals sensitive to smell, normal individuals do not seem to automatically process odor associated information under a passive view task. They appear to focus on visual information especially in the unpleasant conditions which often signal danger and are relevant to human survival. When directed to the odor information under an imagery task, individuals with normal sense of smell thus process odor information and in turn emotions are increased for the pleasant condition. The small dip in emotions during imagery of unpleasant odor pictures could indicate that normal individuals rely on visual information more extensively. Another possible explanation is that similar to sensitive individuals, a protective mechanism kicks in to suppress emotions in unpleasant conditions.

Figure 7. LPP shown across midline electrodes and topographic map of activity

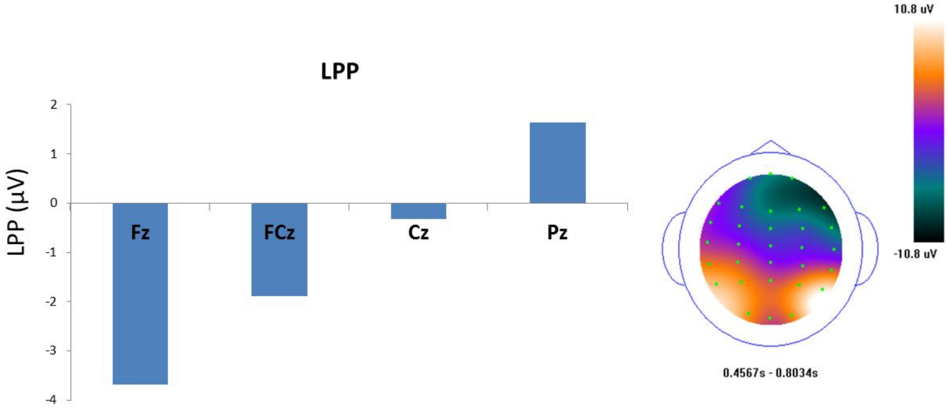
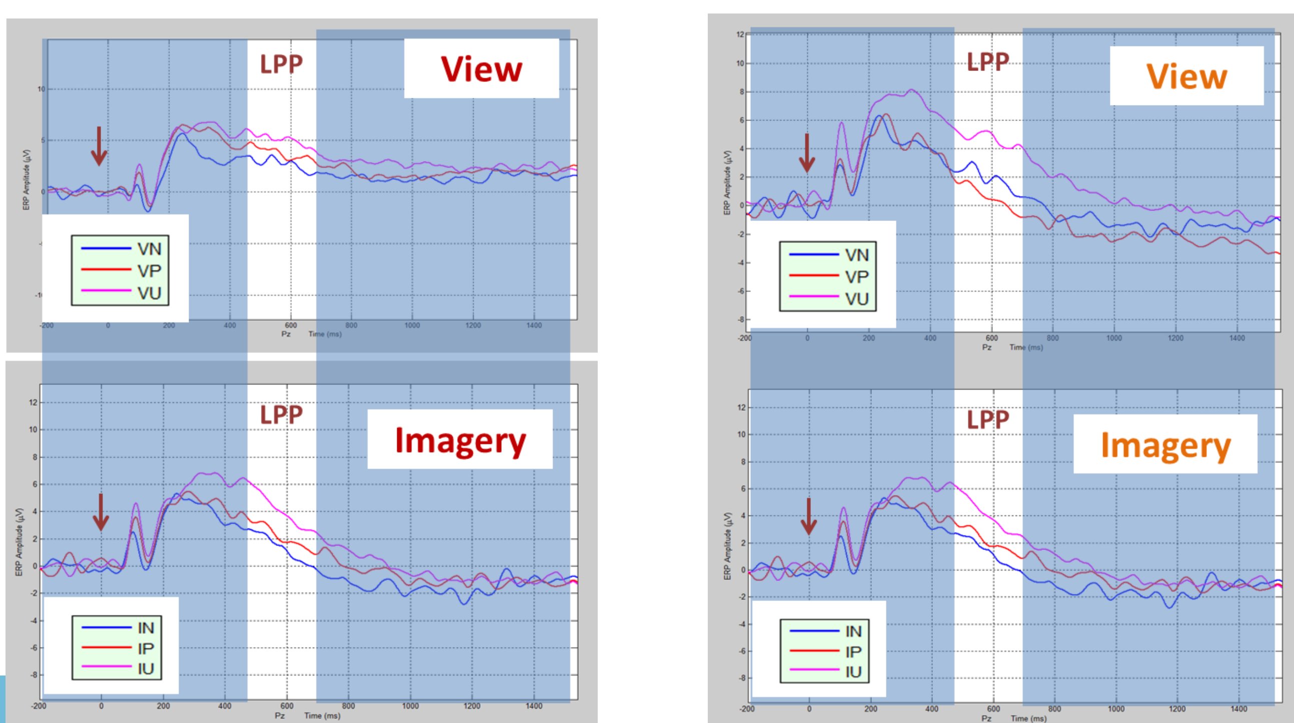


Figure 8. LPP waveforms under view and imagery tasks (a) Normal (b) Sensitive. VN: view/neutral; VP: view/pleasant; VU: view/unpleasant; IN: imagery/neutral; IP: imagery/pleasant; IU: imagery/unpleasant.



Contagion effects of odors on behavior

This behavioral experiment is designed to help understand downstream behavioral outcomes of odor-induced emotions. The impact of odor valence, including pleasant (H3b) and unpleasant (H3c) ambient odors, on self-reported emotions, health symptom reports, severity of moral judgment, product ratings and personal evaluations, and food choices are compared with outcomes during a neutral (control) condition. The influences of individual differences in sense of smell on behavioral outcomes are also examined (H3c).

Experiment 3: The "contagion effects" of odors on judgment and decision making

The effect of ambient scent on emotions. Differentiated emotions scale (DES; Izard 1972) was used specifically to detect any specific emotions triggered by the odors used during unpleasant and pleasant ambient scent conditions. Please refer to Methods chapter-Experiment 3 and Appendix H for more details. Repeated measures analyses of the emotions × ambient condition mixed design was performed and results suggest significant effects of emotions ($F(9, 1359)= 196.42$, $p< .001$) and emotions × condition ($F(18, 1359)= 2.54$, $p< .001$). There was also significant interaction effect between emotions × smell groups ($F(9, 1359)= 1.93$, $p< .044$). Sphericity effects were corrected using Greenhouse-Geisser correction.

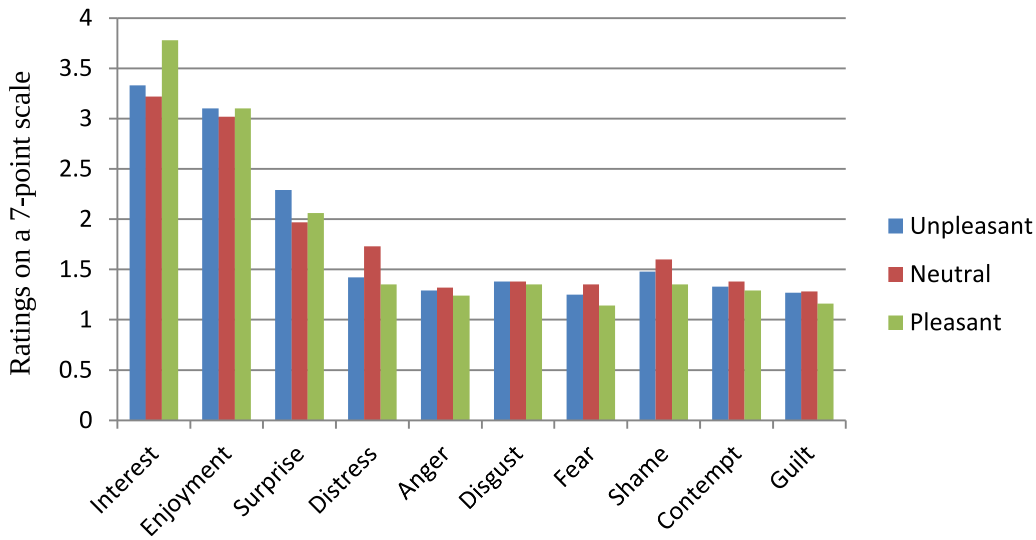
The "surprise" emotion ($M_{unpleasant}= 2.29$ vs. $M_{neutral}= 1.97$, $t(113)= -2.064$, $p< .05$) was induced under the unpleasant condition. Under the pleasant condition, "interest: attentive, concentrating, alert" emotion was increased significantly ($M_{pleasant}= 3.78$ vs. $M_{neutral}= 3.22$, $t(113)= -2.56$, $p< .012$) while "distress: downhearted, sad, discouraged" emotion ($M_{pleasant}=$

1.35 vs. $M_{neutral}$= 1.73, t(113)= 2.14, p< .034) was significantly reduced in comparison to neutral condition. Please see Figure 9 for the other differentiated emotions.

Taking a closer look at the two individual difference groups, there are some slight differentiations among the two groups. Pleasant ambient scent, on the other hand, helped reduce levels of "distress" ($M_{pleasant}$= 1.23 vs. $M_{neutral}$= 1.65, t(61)= 1.80, p< .07) and fear ($M_{pleasant}$= 1.08 vs. $M_{neutral}$= 1.38, t(60)= 1.98, p< .05) in comparison to neutral.

Similarly, individuals with sensitive sense of smell reported increased levels of "interest" ($M_{pleasant}$= 3.83 vs. $M_{neutral}$= 2.88, t(47)= -3.87, p<.001) during pleasant ambient scent. During the unpleasant ambient scent condition, individuals reported a weakly significant higher levels of "enjoyment" ($M_{unpleasant}$= 3.24 vs. $M_{neutral}$= 2.65, t(45)= -1.94, p< .06) in comparison to neutral condition. Overall, the role of ambient scent appears to induce a sense of "interest" and "enjoyment: delighted, happy, joyful," despite the valence of the odors individual are exposed to. Both of these emotions indicate a possible arousal effect, despite the valence. This effect is further discussed in the next chapter.

Figure 9. Differential Emotional Scale (DES; Experiment 3)



The effect of ambient scent on health symptoms. Repeated measures ANOVA analyses of the effects of ambient scent on perception of health symptoms were collected through the labeled-magnitude scale (LMS; Dalton et al., 1997). Health symptoms, either solvent-related or somatic-related (control), are rated on LMS. Please refer to Chapter 3 methods- Experiment 3 and Appendix G for more details. Results revealed a significant 2-way interaction between condition × individual difference smell group, $F(2, 139)= 3.348$, $p< .05$. In addition, there is also a significant LMS effects, $F(20, 2780)= 2.22$, $p< .01$ and a 3-way interaction between LMS × condition × individual difference group, $F(40, 2780)= 1.67$, $p< .005$. Judging from Figure 10, unpleasant and pleasant ambient scent conditions appear to result in significant elevated levels of light headedness ($M_{unpleasant}= 1.61$ vs. $M_{neutral}= 0.15$, $t(108)= -2.41$, $p< .018$; $M_{pleasant}= 1.5$ vs. $M_{neutral}= 0.15$, $t(109)= -2.3$, $p< .023$). In addition, under the unpleasant ambient scent condition, there was increased levels of throat irritation reported ($M_{unpleasant}= 5.72$ vs. $M_{neutral}= 3.53$, $t(110)= -1.94$, $p< .05$) and moderate levels of headache ($M_{unpleasant}= 3.79$ vs. $M_{neutral}= 1.3$, $t(110)= -1.7$, $p< .09$). During pleasant ambient scent conditions, there appears to be higher reports of nasal irritation ($M_{pleasant} = 5.12$ vs. $M_{neutral}= 3.25$, $t(110)= -2.56$, $p< .012$) in comparison to neutral condition.

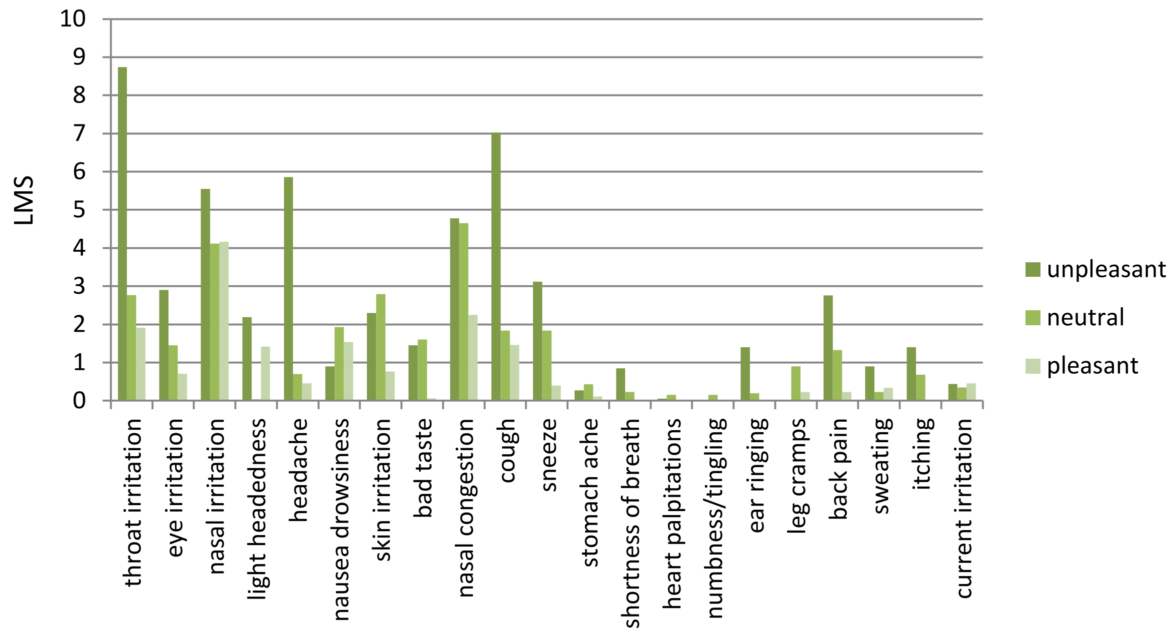
Taking individual differences in sense of smell into consideration, there appears to be interaction effects of smell group and condition on health symptoms. Specifically, for individuals with a normal sense of smell, the unpleasant ambient scent effect increases the chance of solvent-related symptoms. This includes throat irritation ($M_{unpleasant}=8.74$ vs. $M_{neutral}= 2.77$, $t(63)= -2.2$, $p< .034$), light headedness ($M_{unpleasant}= 2.19$ vs. $M_{neutral}=0.04$, $t(62)= -2.24$, $p< .029$) and headache ($M_{unpleasant}= 5.86$ vs. $M_{neutral}= 0.7$, $t(63)= -2.0$, $p< .05$) in comparison to neutral condition. Increased reports of somatic-related symptoms (control) include cough ($M_{unpleasant}$= 7.02 vs. $M_{neutral}$= 1.84, $t(63)= -2.03$, $p< .05$). During the other two conditions, pleasant and neutral, there was no significant increase or decrease in solvent-related symptoms.

As for individuals that are sensitive to sense of smell, few symptoms were reported significantly under the effect of unpleasant ambient scent. Very weak effects of unpleasant odors on health symptom reported included nausea ($M_{unpleasant}$ = 1.98 vs. $M_{neutral}$ = 0.57, $t(42)= -1.35$, $p< .18$), skin irritation ($M_{unpleasant}$ = 1.06 vs. $M_{neutral}$ = 0.14, $t(42)= -1.34$, $p< .18$) and bad taste ($M_{unpleasant}$ = 0.35 vs. $M_{neutral}$ = 0.01, $t(42)= -1.35$, $p< .18$). However, what turned out to have more significant impact on sensitive individuals was the effect of pleasant ambient scent conditions. There was increased level of reported solvent-related symptom, nasal irritation ($M_{pleasant}$ = 6.16 vs. $M_{neutral}$ = 1.74, $t(45)= -2.38$, $p< .02$). Somatic symptom such as bad taste ($M_{pleasant}$= 2.37 vs. $M_{neutral}$= 0, $t(45)= -1.8$, $p< .079$) was weakly significant under the influence of pleasant ambient scent. Future studies should investigate the impact of pleasant odors in individuals sensitive to smell.

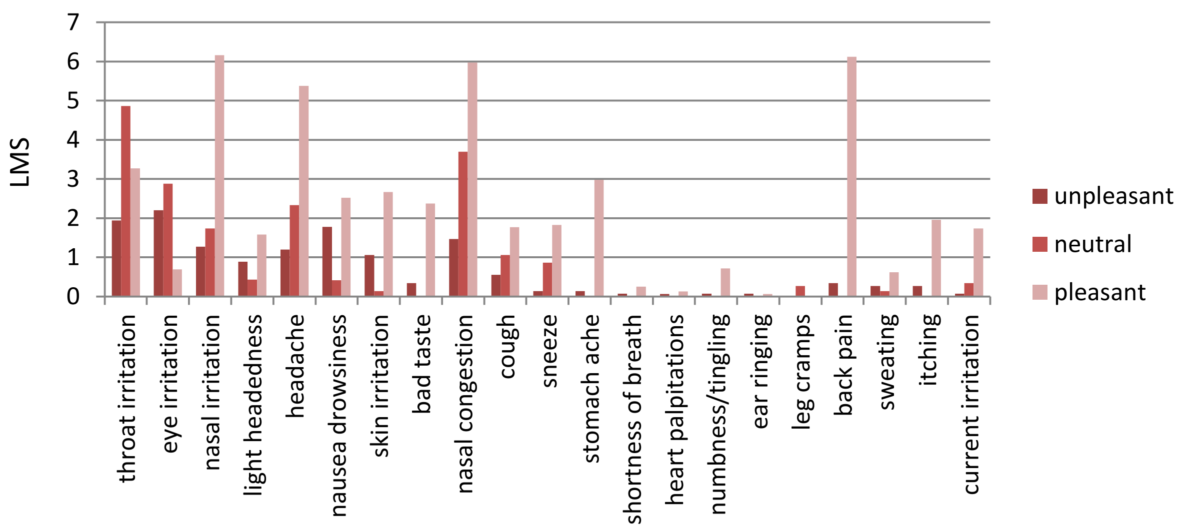
Results taken together suggest that individuals with a normal sense of smell are more likely to be affected by unpleasant odors and report a wider range of symptoms compared to individuals under a neutral condition. On the other hand, individuals sensitive to smell report more symptoms when exposed to pleasant ambient scent in comparison to a neutral condition. In sum, what is expected to be “pleasant” to the normal population appears to be perceived as irritating to individuals who are sensitive to smell as reflected in health symptoms. Our pretests do indeed show the pleasant scent, Pineapple and Mango, is rated slightly lower in pleasantness by individuals sensitive to smell in comparison to normal ($M_{sensitive}$= 21.67 vs. M_{normal}= 23.73, $t(16)$= 2.26, $p < .06$). However, the absolute ratings are not low enough to be considered “unpleasant.”

Figure 10. Health symptom reports (Experiment 3)

Normal-



Sensitive-



The effect of ambient scent on moral judgment. Four moral judgment scenarios (Schnall et al., 2008) were rated on a 9-point Likert scale by all participants (see Appendix I). First, MANOVA was conducted to examine the effect of ambient scent (pleasant vs. neutral vs. unpleasant) and smell groups (normal vs. sensitive) on moral ratings using a cumulative score of the four scenarios. The main effect of ambient scent was not significant ($F(2, 154)= 1.31$, $p >.1$), and smell group effect was not significant either ($F(1, 154)= 0.088$, $p> .1$). The two-way interaction effect was also not significant ($F(2, 154)= 1.59$, $p> .1$). However, all means were in the direction as predicted, ($M_{unpleasant}= 26.79$, $M_{neutral}= 26.24$, $M_{pleasant}= 25.47$; higher scores represented stronger violation of moral).

Repeated-measures ANOVA was used to analyze the effects of ambient scent on severity of moral judgment across the four scenarios. This was done in part that direction was as expected but not significant, but also the pretest results of the scenarios showed that one of the scenarios is rated close to ceiling ($M_{wallet}= 8.57$ on a scale of 1 to 9) and another is close to floor ($M_{cousin}= 2.0$ on a scale of 1 to 9). Please see Appendix I for pretest results. Again, the effect of ambient scent condition on moral judgment was not significant $F(2, 155)= 1.256$, $p< .1$. However, the within subject scenario effect was significant, $F(3, 465)= 24.42$, $p< .001$. Across all four scenarios, the severity of moral judgment was increased when under unpleasant ambient scent and was slightly less severe under the pleasant ambient scent compared to the neutral condition. In fact, pretest results of the four scenarios suggested significant differences among the four scenarios ($F(3, 18)= 11.12$, $p< .001$). Please refer to Appendix I for pretest reports of moral scenarios. Hence in the follow up analyses, evaluation for each scenario was analyzed separately.

Taking individual differences in sense of smell into consideration reveals that the impact of ambient scent on moral judgment is in fact stronger in individuals who are more sensitive to smell versus normal individuals. In the sensitive individuals, the scenarios #1(plane) and #2(job) show that the effect of unpleasant ambient scent can have a significant impact on severity of moral judgment, ($M_{unpleasant}$= 7.9 vs. $M_{neutral}$= 7.2, $t(42)$= 1.98, $p<.06$ and $M_{unpleasant}$= 8.71 vs. $M_{neutral}$= 8.31, $t(45)$= 1.953, $p<.05$ respectively). This effect was not present in the other two scenarios #3(cousin) and #4 (wallet), ($M_{unpleasant}$= 3 vs. $M_{neutral}$= 2.96, $t(42)$= 0.054, $p> .1$ and $M_{unpleasant}$= 8.29 vs. $M_{neutral}$= 7.92, $t(45)$= 0.744, $p> .1$ respectively). Pretest of the four scenarios have shown that moral severity for #3 was lowest (M_{cousin}=2 vs. M_{plane}=5.85, $t(6)$= 2.40, $p< .05$) and #4 was highest (M_{wallet}=8.57 vs. M_{job}= 6.57, $t(6)$= $p< .027$). Again, this may explain the weak effects of unpleasant odors on moral judgment as the former did not appear to be a moral debatable situation and the latter may suggest a ceiling effect. The influence of pleasant ambient scent on moral judgment was not significant in all cases (p's> .1), although the direction was in the direction hypothesized for all scenarios. This seems to suggest a negativity bias in effect. The influence of ambient scent does not seem to play a role in the severity ratings of moral scenarios in individuals with normal sense of smell (p's> .1). Moral ratings are similar across all conditions for all four scenarios. Please see Figure 11 for moral mean ratings of all scenarios under each condition.

To sum up, the impact of ambient odors on severity of moral judgments is more relevant for individuals with a sensitive of smell. Participants with a normal sense of smell are not influenced by the valence of ambient scent.

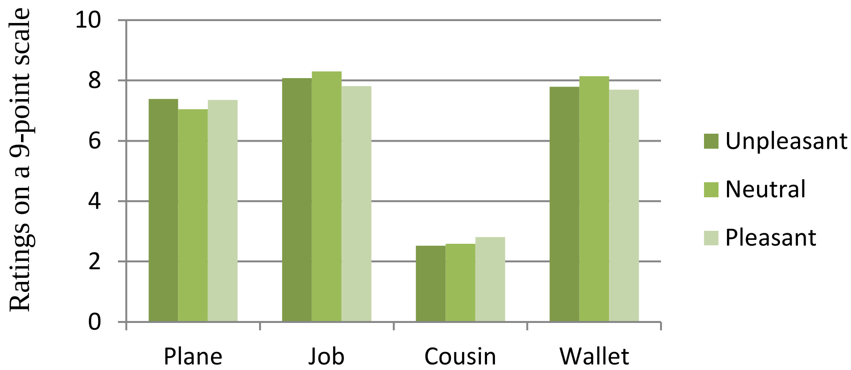
The effect of ambient scent on product evaluations. Participants were instructed to evaluate two unscented products, facial tissue and hand cream, for this section of the study. Products that could be found in unscented or scented options were chosen to examine the effect of ambient scent on unscented product evaluations. Order of product presented was counter balanced across all three conditions. MANOVA tests showed that in general, the likeability ($F(2, 150)= 0.085, p> .1$) quality ($F(2, 150)= 0.086, p> .1$) and likelihood to buy (LTB; $F(2, 116)= 1.4, p> .1$) of the facial tissue was not affected by ambient scent conditions. There was also no main effect of smell groups on facial tissue likeability ($F(1, 150)= 0.88, p> .1$), quality ($F(1, 116)= 0.003, p> .1$) and LTB ($F(1, 150)= 1.41, p>.1$). Interaction effects between ambient scent condition × smell groups on tissue likeability ($F(2, 150)= 1.045, p> .1$), quality ($F(2, 116)= 0.348, p> .1$) and LTB were also insignificant ($F(2, 150)= 0.07, p>.1$).

The main effects of ambient scent on hand cream evaluation were not significant, likeability ($F(2, 151)= 0.259, p> .1$), quality ($F(2, 151)= 1.7, p> .1$), and LTB ($F(2, 115)= 0.525, p> .1$). Smell group also did not have a main effect on likeability ($F(2, 151)= 0.227, p> .1$) and LTB ($F(2, 151)= 0.242, p> .1$). However, smell group had a significant main effect on hand cream quality ($M_{normal}= 16.81$ vs. $M_{sensitive}= 14.87$, $F(2, 151)= 6.41, p< .013$). Interaction effects between ambient scent condition × smell group on hand cream likeability ($F(2, 151)= 0.02, p> .1$), quality ($F(2, 115)= 0.456, p> .1$) and LTB ($F(2, 151)= 0.11, p> .1$) were all insignificant.

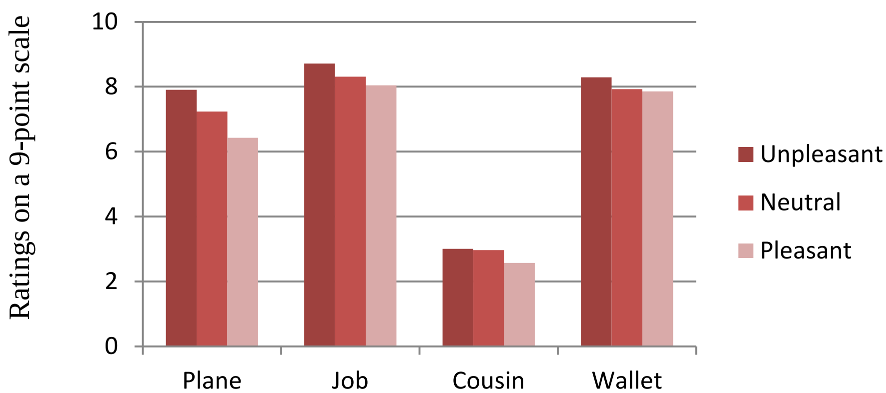
In conclusion, the effect of ambient scent did not have significant effects on product evaluation, for both facial tissue and hand cream. The only significant effect found was there were group differences on hand cream quality.

Figure 11. Moral ratings for four scenarios (Experiment 3)

Normal-



Sensitive-



The effect of ambient scent on personal evaluation. The person (experimenter) is a 20 year old Caucasian female. She was asked to dress in similar outfits during experiments and followed a script to ensure consistency across all study sessions. As part of the study, participants were asked to provide ratings for the study and the experimenter for our feedback. The experimenter was rated on professionalism, capability and level of knowledge with a 7-point scale. A sum of the 3 ratings was used for analyses. The main effect of ambient scent condition was significant in Univariate analyses, $F(2, 155)= 3.11$, $p< .05$. Smell category effects on personal ratings were not significant ($F(1, 155)= 0.022$, $p> .1$). There was also no evidence of interaction effects between ambient conditions and smell category ($F(2, 155)= 0.416$, $p> .1$). Post-hoc test revealed a negativity bias of the impact of ambient scent on personal ratings. Unpleasant ambient condition resulted in significantly lower evaluation scores ($M_{unpleasant}= 18.36$ vs. $M_{neutral}= 19.54$, $t(113)= 2.46$, $p< .015$). Pleasant ambient did not increase personnel evaluations ($M_{pleasant}= 19.45$ vs. $M_{neutral}= 19.54$, ns). Expected contagion effects, but only for unpleasant conditions, were supported with our findings.

Next, individual differences were considered. A weak negativity bias was revealed in both groups, the unpleasant condition resulted in lowest personal evaluations (Normal: $M_{unpleasant}= 18.5$ vs. $M_{neutral}= 19.61$, $t(64)= 1.53$, $p< .13$; sensitive: $M_{unpleasant}= 18.22$ vs. $M_{neutral}= 19.47$, $t(45)= 1.57$, $p< .12$). In addition, ratings by sensitive individuals showed a step-wise insignificant increase in evaluations. Ratings under pleasant ambient scent was highest ($M_{pleasant}= 19.76$ vs. $M_{neutral}= 19.47$, ns). However, this was not the case for individuals with a normal sense of smell ($M_{pleasant}= 19.61$ vs. $M_{neutral}= 19.61$, ns).

Results for personal evaluations are not consistent statistically with the expected effects. In addition, results do not rise to the level of statistical significance common in most testing situations. We interpreted these results only to give some sense of the general direction of the effects which should be at best interpreted as suggestive for further research. Contagion effects of ambient scent on personal ratings displayed a pattern that was consistent with the hypothesized pattern of results. However, effects are asymmetric, as unpleasant ambient conditions seem to have a stronger impact reflected in lower ratings in comparison to neutral conditions. Scent valence effect plays an even more relevant role for individuals with sensitive sense of smell on evaluations of a person. Not only do unpleasant ambient odors result in lower evaluations of a person, pleasant ambient scent might create a positive image of the person and result in higher evaluation of the person.

The effect of ambient scent on food choice. Under neutral conditions, 59 out of 63 (93.7%) chose the unhealthy option (Snicker bar) versus only 4 out of 63 (6.3%) chose the healthy option (SunMaid raisins). Under the unpleasant ambient scent condition, the number of individuals that preferred the healthy option went up to 28% (12 out of 50) versus 38 out of 50 (76%) chose the unhealthy option. Similarly, under the pleasant ambient scent condition, individuals were more prompted to choose the healthy option, 11 out of 49 (22.45%), although 77.55% of the individuals still chose the unhealthy option.

Univariate ANOVA showed that ambient scent had an impact on the food choices made at the end of the study, $F(2, 154)= 4.08$, $p= .019$. Follow up t-tests showed that both pleasant ($M_{pleasant}= 0.21$ vs. $M_{neutral}= 0.06$, $t(113)= 2.83$, $p< .019$) and unpleasant ($M_{unpleasant}=$

0.23 vs. $M_{neutral}$= 0.06, $t(113)$= 2.64, $p< .01$) ambient conditions result in significantly higher chance of selecting a healthy snack option in comparison to neutral condition.

Taking a closer look at the impact of ambient scent on individual differences in sense of smell reveals that ambient scent had a similar influence on food choices for both smell ability groups. Normal individuals selected the healthy option slightly more often under unpleasant ($M_{unpleasant}$= 0.24 vs. $M_{neutral}$= 0.08, $t(64)$= 1.82, $p< .073$) and pleasant($M_{pleasant}$= 0.23 vs. $M_{neutral}$= 0.08, $t(61)$= 1.68, $p< .09$) in comparison to the neutral condition. Sensitive individuals were significantly more likely to select a healthy food option during both unpleasant ($M_{unpleasant}$= 0.24 vs. $M_{neutral}$= 0.08, $t(45)$= 2.09, $p< .042$) and pleasant ($M_{pleasant}$= 0.22 vs. $M_{neutral}$= 0.04, $t(47)$= 1.94, $p< .058$) condition in comparison to the neutral condition.

In sum, food choices appear to be influenced by ambient scent, and people display an increased preference for healthier food options compared to a less healthy choice. Interestingly, the valence of ambient odors does not matter. Both pleasant and unpleasant ambient scent created an increased preference for healthier food choice. Furthermore, the ambient odors effect was similar for both smell groups. Possible explanations of such findings are discussed in the next chapter.

In conclusion, H3 is partially supported from experiment 3 results. Moderate arousal effects through self-reported emotions, surprise and interest, are reported during pleasant and unpleasant ambient scent conditions. In turn, ambient odors can have an impact on downstream consumer behaviors such as food choices, and personal ratings. Additionally, ambient odors on a whole also influence severity of moral judgment, which could be applied in service recovery and company image situations, and personal ratings -could be applicable in a service sector. Ambient odors also result in increased reports of health symptoms, especially worth noting is that what is considered a pleasant scent resulted in increased reports of health symptoms in sensitive individuals. These findings are important factors to consider in retail environmental settings. However, the level of impact and interaction between valence and individual difference groups is much more complex and less straight forward as hypothesized in H3a, H3b and H3c. In general, there is a negativity bias, which implies that unpleasant ambient odor has a larger influence on the behaviors and evaluation tasks such as moral judgment and personal ratings. These contagions effects are also more prevalent among individuals with sensitive sense of smell. These findings support H3a and partly support H3b.

Another interesting finding was that the effect of odor valence did not seem to differentiate emotions and product choice. The mere presence of ambient odors, whether it was pleasant or unpleasant, induced some form of emotion (surprise and interest) and also increased more frequent choice of healthy food item. This finding was consistent in both sensitive and normal individuals.

Olfactory imagery in ads

The role of olfactory imagery on emotional processing is further studied in Experiment 4 by introducing a sniff motion. Participants are asked to view a set of ads that are either associated with a pleasant odor or not associated with an odor (control). Manipulation of tasks include performing olfactory imagery or sniff plus olfactory imagery while viewing the ads. EEG is recorded. First part of the experiment is a passive view task. In the second part of the experiment, participants are randomly assigned into one of the two tasks: olfactory imagery or sniff + olfactory imagery. A behavioral task that involves rating the ads and products/service advertised in the ad is conducted during the second part of the experiment. Please refer to chapter 3 for details of study design, materials and ads (Appendix J).

Experiment 4: Are emotions enhanced by sniff cues in ads?

ERP results. Two separate analyses were done for LPP due to the experiment set up. The first task is passive view of ads which sets the baseline. The second task involves manipulation of either olfactory imagery only or sniffing motions plus imagery. The following analyses test H4a. First was repeated measure analysis of odor (control vs. scent) × electrode (Fz, FCz, Cz, Pz) × group (normal vs. sensitive) mixed design. Note the task here is passive view. All measures were taken at the LPP window of 550-750 msec. Results revealed a significant electrode effect (M_{Fz}= -4.34 vs. M_{FCz}= -3.72 vs. M_{Cz}= -1.61 vs. M_{Pz}= 3.45, $F(3, 156)= 106.31$, $p<. 001$). Electrode effect displayed a strong linear relationship ($F(1, 52)= 122.872$, $p< .001$). All other main effects were non-significant, however, there was weakly significant 3-way interaction between electrode × odor × group ($F(3, 156)= 2.46$, $p< 0.065$). LPP was strongest at Pz and thus a follow up analysis was done at Pz. Mixed ANOVA revealed no evidence of a main effect of odor on LPP, however, there was a weak interaction effect between group × odor ($F(1, 52)= 2.246$, $p< .1$).

A second set of analyses were performed to test the effect of task (imagery vs. sniff) on LPP in the two smell groups (normal vs. sensitive). Repeated measures analyses were done for the task (imagery vs. sniff and olfactory imagery) × electrode (Fz, FCz, Cz, Pz) × group (normal vs. sensitive) mixed design. The main effect of electrode was significant (M_{Fz}= -0.96 vs. M_{FCz}= 0.20 vs. M_{Cz}= 2.37 vs. M_{Pz}= 3.69, $F(3, 150)$= 27.271, $p< .001$) and the interaction between electrode and task was significant ($F(3, 150)$= 11.336, $p< .001$). Figure 12 shows the LPP scalp distribution (e.g., electrode) which reveals topographic differences between the two tasks (imagery vs. sniffing). Interestingly, during the imagery task, LPP is strongest at Cz in individuals sensitive to smell. This indicates a more frontal distribution of LPP. In comparison, LPP is strongest at Pz, a more posterior distribution, for individuals with normal sense of smell (Figure 13).

Across electrodes, the main effect of task is significant ($M_{imagery}$= 1.911vs. M_{sniff}= 0.736, $F(1, 50)$= 6.155, $p< .017$) and the interaction between task and group is weakly significant ($F(1, 50)$= 3.70, $p< .06$). The relationship between electrodes were linear ($F(1, 50)$= 36.442, $p< .001$) and LPP was again strongest at Pz (M_{Fz}= -0.96 vs. M_{FCz}= 0.20 vs. M_{Cz}= 2.37 vs. M_{Pz}= 3.69). Thus further analysis was done using measurements taken at Pz. Univariate ANOVA was done for the task × (imagery vs. sniff) × group (normal vs. sensitive) between subject design to test LPP effects at Pz. Results indicated a task main effect ($M_{imagery}$= 2.304 vs. M_{sniff}= 5.075, $F(1, 50)$= 5.594, $p< .022$). Individual group analyses revealed similar task effects for both groups, suggesting that the sniffing motions has a significant effect on emotions for both normal ($M_{imagery}$= 2.778 vs. M_{sniff}= 5.594) and sensitive ($M_{imagery}$= 1.83 vs. M_{sniff}= 4.56) individuals.

Findings from our ERP results only partially supported H4a. Passive viewing of odor-associated ads resulted in slightly elevated emotions in sensitive individuals. The direction was opposite (but not significant) for normal individuals. However, both smell groups were indeed affected by sniffing motions which demonstrated a strong impact on emotions, supporting H4a. Figure 12 reveals the effect of sniffing, which appears to remove the suppression effect of imagery during odors trials in sensitive individuals.

Figure 12. LPP activity at Pz during passive view vs. imagery and sniff instructions in sensitive individuals

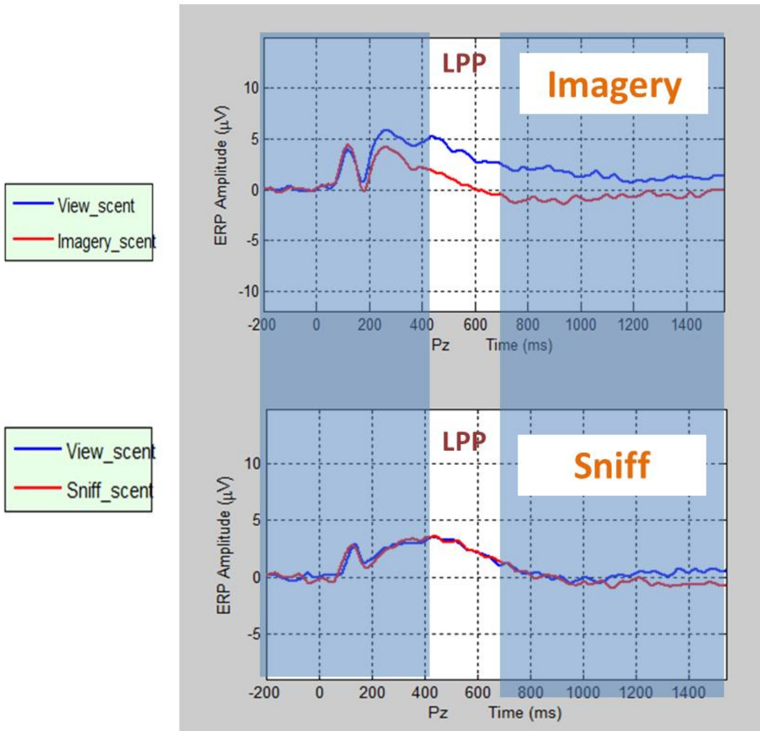
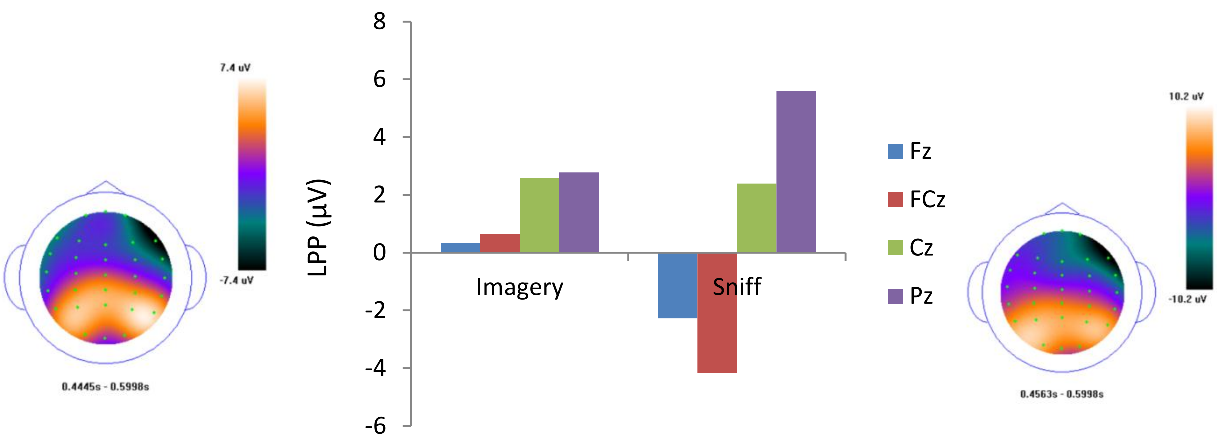
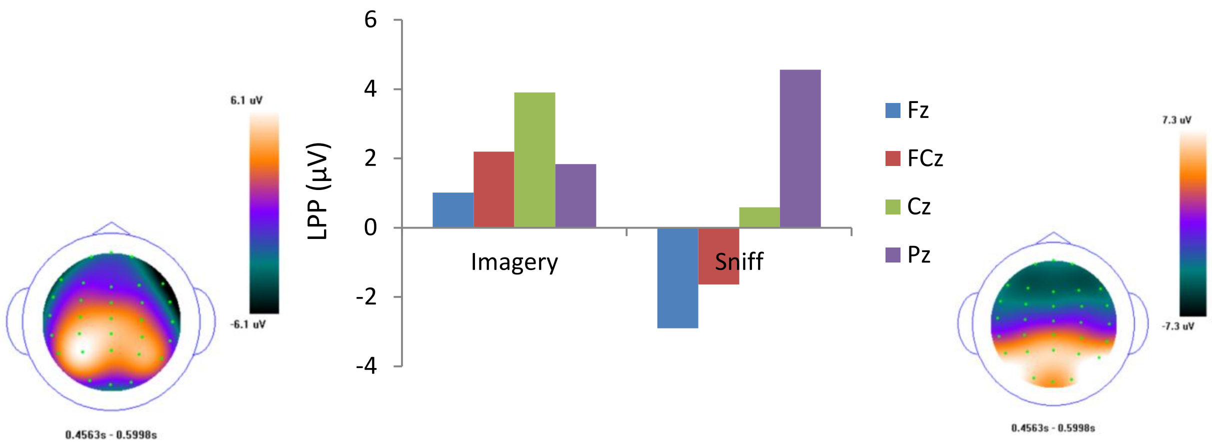


Figure 13. Sniffing effects on LPP (450-600msecs) during odor-associated ads: Task (Imagery vs. sniff) × Electrode (Fz, FCz, Cz, Pz) (Experiment 4)

Normal-



Sensitive-



Behavioral results. This is a 2 (Task: imagery vs. sniffing/imagery) × 2 (Group: normal vs. sensitive) between subject design. MANOVA was done to determine the effects of "sniffing" motions and group effects on ad ratings, product ratings and likelihood to buy (LTB) in task 2, which assists with testing H4b. Task did not result in a significant main effect on ad ratings ($F(1, 63)= 0.071$, $p> .1$), product ratings ($F(1, 63)= 0.461$, $p>.1$) and likelihood to buy ($F(1, 63)= 0.443$, $p> .1$). However, group effects were weakly significant on ad ratings ($F(1, 63)= 3.38$, $p< .071$), and significant on product ratings ($F(1, 63)= 5.46$, $p< .021$). There was a significant interaction between task × group on ad ratings ($F(1, 63)= 4.60$, $p< .036$), product ratings ($F(1, 63)= 5.45$, $p< .023$) and likelihood to buy ($F(1, 63)= 4.62$, $p< .035$). Please see Figure 14 for interaction effects between group and task.

Follow up post-hoc t-tests were conducted based on the significant interaction results between group and task and to test H4c. Specifically, individuals with normal sense of smell rated likeability of ads at similar levels during both imagery and sniffing instructions ($M_{imagery}= 14.24$ vs. $M_{sniffing}= 13.34$, $t(34)= 1.445$, $p> .1$) as well as for product ratings ($M_{imagery}= 14.05$ vs. $M_{sniffing}= 13.32$, $t(34)= 1.171$, $p> .1$) and LTB ($M_{imagery}= 4.20$ vs. $M_{sniffing}= 3.94$, $t(34)= 1.036$, $p> .1$). On the other hand, task effects are not significant for ad ratings ($M_{imagery}= 12.32$ vs. $M_{sniffing}= 13.48$, $t(29)= 1.57$, $p> .1$) for sensitive individuals. However, sniffing effects are significant for product ratings ($M_{imagery}= 11.96$ vs. $M_{sniffing}= 13.30$, $t(29)= 2.13$, $p< .05$) and LTB ($M_{imagery}= 3.64$ vs. $M_{sniffing}= 4.13$, $t(29)= 2.02$, $p< .05$).

In sum, sniffing motions do not appear to enhance ad ratings, product rating, or degree of LTB in normal individuals. However, sniffing motions can increase product ratings and LTB in individuals sensitive to smell. Sniffing motions appear to counteract automatic emotional suppression and physical irritation reports in individuals sensitive to smell as found in previous experiments during pleasant odor conditions. The underlying mechanism needs to be further researched.

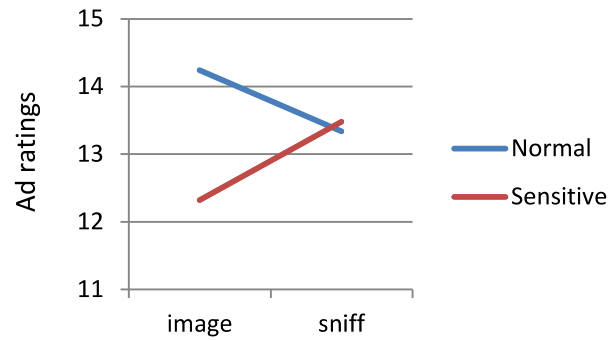
As noted earlier, the group effect was significant on ad ratings and product ratings. Specifically, individuals sensitive to smell rated products lower (than normal sense of smell ($M_{sensitive}$= 12.63 vs. M_{normal}= 13.68, $F(1, 63)$= 5.64, $p< .05$) and rated ads weakly significant lower than normal individual ($M_{sensitive}$= 13.34 vs. M_{normal}= 14.24, $F(1, 63)$= 3.38, $p< .071$). It is interesting to note here that supposedly pleasant scented products in the ads (reflected in our pretest results) were less liked by individuals sensitive to smell. This echoes with our results found in Experiment 3, where scented products/ambient scent were not always considered as a positive stimulation.

In conclusion, our behavioral results indicate that H4b is partially supported such that sniffing enhances product ratings and LTB, but not for all individuals. In fact, this effect depends on the level of sensitivity in olfaction of the individual, leading into H4c which is better supported. Sniffing motions appear to have a stronger effect in individuals sensitive to smell. As this appears to counter previous findings, it is worth noting that a small manipulation, "sniff," appears to counteract negative outcomes in sensitive individuals. As noted before, the exact physical mechanism needs to be studied, however, this indicates a form of embodied cognition in effect. Meanwhile, this effect is absent in individuals with normal sense of smell. Sniffing motions do not enhance ad rating, product rating and willingness to buy. For individuals sensitive to smell, this additional nose movement called sniffing, even during the absence of actual scent, can enhance the liking and evaluation of ads and products and even willingness to buy the product advertised.

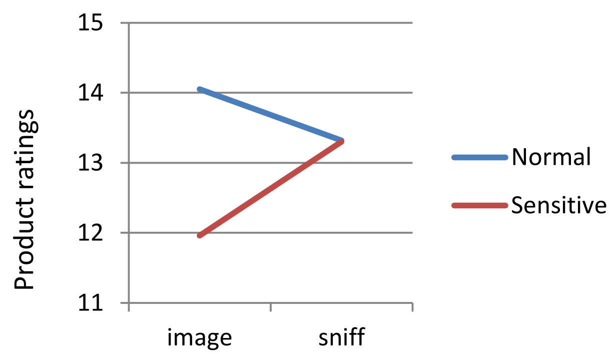
Physiological tests and behavioral outcomes taken together suggest that sniffing motions indeed have a significant impact on emotions reflected by elevated LPP, especially during odor-associated ads. This effect was observed in both sensitive and normal individuals. However, whether odor-induced emotions play a role in purchase decisions depends on the olfactory sensitivity characteristic of the individual. Our results reveal that individuals sensitive to smell are more likely to buy a product when engaging in sniffing versus when only olfactory imagery was involved.

Figure 14. Interaction between group (normal vs. sensitive) and task (imagery vs. sniff and imagery) on (a) Ad evaluation; (b) Product evaluation; (c) Likelihood to buy (LTB). (Experiment 4)

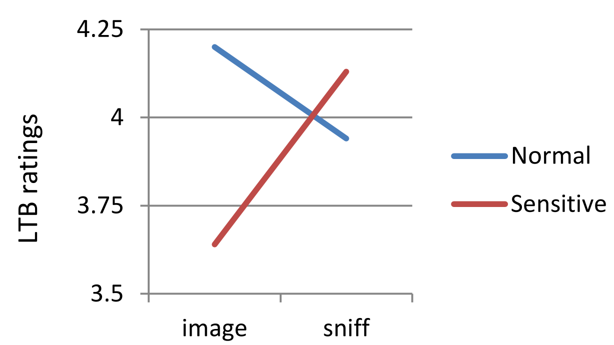
(a)



(b)



(c)



Overall results summary

In sum, results across the four experiments indicate that odors, whether in chemical form or imagery form, can induce emotions. In turn, odors could also have an impact on behavioral outcomes. However, odor valence and sensitivity to smell will influence the degree to which emotions are induced by odors, and its impact on behavioral outcomes. In individuals with a normal sense of smell, emotions are induced in the passive smell task (Experiment 1), but not in the identification task where the focus is on discerning what the odor is. Furthermore, olfactory imagery (Experiment 2) plays a role in enhancing emotions when viewing pleasant odor associated pictures. However, there is a negativity bias and emotions are induced just by viewing unpleasant odor associated pictures. Olfactory imagery does not further enhance emotions under an unpleasant odor conditions. In Experiment 3, ambient odors induce a level of arousal effect in both pleasant and unpleasant odors. This appears to induce variety seeking behavior and thus increase probability of choosing raisins over Snickers. Individuals also display a sign of negativity bias supported by increased report of solvent-related health symptoms. However, this arousal effect is not strong enough to influence product evaluation, moral judgment or personal ratings. The impact of sniffing motions (Experiment 4) on emotions is relevant. However, such physiological effects did not transfer to behavioral outcomes such as enhanced ad or product ratings.

On the other hand, individuals sensitive to smell did not appear to display enhanced emotions in the passive smell task in Experiment 1. Although speculating, I believe this is attenuated by cognitive activity, even when not instructed to discern the odor, occurring in sensitive individuals thus resulting in attenuated LPP. Olfactory imagery (Experiment 2) is also not as effective for sensitive individuals as it was for normal individuals during pleasant odor associated pictures. Negativity bias was present, as unpleasant odor associated pictures induced strong emotions. However, similar to normal individuals, olfactory imagery did not further enhance this effect. In Experiment 3, opposite to normal individuals, sensitive individuals reported slightly more health symptoms during pleasant ambient scent, while in comparison the effect of unpleasant ambient scent was not as relevant. However, behavioral outcomes seem to indicate contagion effects as moral judgment and personal ratings were more severe and negative during the unpleasant condition. Similar to normal individuals, ambient scent also had no significant impact on product evaluations in sensitive individuals. Similarly, an increase in healthy food choice behavior was observed along with increased reports of arousal emotions in both valence conditions. Sniffing effects on emotions were significant in Experiment 4. However unlike for normal individuals, this physiological sniffing effect in sensitive individuals transferred to behavioral outcomes, as product ratings and likelihood to buy ratings were increased.

CHAPTER 5: DISCUSSION

The four studies conducted in this dissertation have provided some insight and support to the hypotheses proposed. However, there were certain outcomes or results that were either unexpected or not hypothesized. I will discuss some of these topics and propose possible explanations in the discussion and limitations section. Next, I will propose future research possibilities and conclude with implications.

Discussion and limitations

Hot (emotion) and cool (rational) system

In experiment 1, we found that individuals sensitive to smell seemed to display stronger emotions during blank trials compared to odors trials. The increase of LPP during blank trials might be explained by subtle and lingering odors, despite the efforts made to minimize the scent, that could still possibly be picked up by sensitive individuals. Intentional efforts were made to reduce lingering scents by placing odor absorbing stones in the recording room and also allowing 5-10secs between trials for the odor to dissipate. Elevated LPP was found only for sensitive individuals, whereas in normal participants, LPP was much lower during control (blank) trials. It is highly possible that even with all the precautions in place, there were still low levels of odor chemicals picked up by sensitive individuals. Interestingly, during actual odor trials, LPP was attenuated which is representative of some suppression or emotional regulation involved in the process. These physiological reactions reflected in LPP are similar to emotional regulation studies (Moser, Hajcak, Bukay and Simons, 2006; Dennis and Hajcak, 2011). However, what is different from this study and theirs is that we did not instruct participants to suppress or reappraise the meaning of the odor- induced emotional stimuli. This implies that some form of automatically-induced mechanism is occurring during odor trials. In particular, odors trials induced emotions reflected in enhanced LPP in normal individuals as expected. A similar suppression reaction was also reported in another olfaction study examining individual differences using olfactory word stimuli (Lin, Cross, Jones and Childers 2014).

A possible trigger for the automatic suppression during odors trials is the possibility that individuals sensitive to smell having a higher “need for identification.” In other words, there is the automatic desire to figure out what the scent is. This is similar to the concept of need for cognition. Individuals sensitive to smell report paying more attention to smell (or scent is a more salient sensory factor to them) compared to normal individuals, as evidenced by a questionnaire study investing individual differences in sense of smell (Lin, Cross and Childers, 2014). This speculation is further supported by examining similar LPP effects during odor trials in normal individuals. A slight attenuation in LPP during the identification task (M=1.36) is observed in comparison to the passive smell task (M= 1.79) in individuals with a normal sense of smell. This pattern indicates the activation of a “cool system” or rational processing of odors that will attenuate or counteract the emotional “hot system” during the passive smell task (Matcalfe and Mischel 1999; Mischel, Ayduk and Mendoza-Denton 2003). Similarly, I believe this mechanism can explain the LPP attenuation occurring in sensitive individuals during the passive smell task.

Olfactory imagery- richness in olfactory memory

Experiment 2 investigates the impact of olfactory imagery in comparison with a passive view task. Both olfactory groups displayed stronger emotions during neutral conditions. Pictures used in the study were pre-tested to make sure they were not associated with odors. Thus, this does not exclude other sources of emotions associated with the neutral pictures. However, when attention was directed to the odor aspect of the images during olfactory imagery, LPP was attenuated (which confirms pretesting results). The imagery effect on emotions displayed opposite effects in the two olfactory groups. Olfactory imagery played a "boosting" role in positive emotions for normal individuals during pleasant conditions, but not during unpleasant conditions. As for individuals sensitive to smell, however, LPP was attenuated during the imagery task compared to passive view. A possible explanation could be that sensitive individuals have a much richer pool or network of memories associated with scents to draw from when asked to perform olfactory imagery. Indeed, this helps generate a more vivid olfactory imagery and is supported by VOIQ, which reflects higher vividness of olfactory imagery performed by individuals sensitive to smell. However, at the same time, as supported by commentaries from participants in our study, feedback indicated how it was difficult for them to come up with only one type of scent induced by olfactory images presented. More than one scent can be imagined and associated with the images presented to them. The richness of scent memories may prevent participants from quickly generating a single olfactory imagery for each image presented. This additional cognitive processing can contribute to the reduced levels of pleasure indicated by the attenuated LPP during the olfactory imagery task for sensitive individuals. Unpleasant odor conditions were not affected as much and were quickly processed, likely for survival purposes, and can be imagined with less effort. Thus, we see the expected enhancement in sensitive individuals. The attenuation of LPP observed in normal individuals during unpleasant conditions is difficult to explain, but may be the result of a natural human aversion to bad smells.

Product category and scent

Facial tissue and hand moisturizer were selected for understanding the impact of ambient scent on product evaluation in experiment 3. Results, in general, show that ambient scent can have a positive influence on the product, as people perceive products to be of higher quality under pleasant ambient scent. However, both products did not receive higher likeability ratings or LTB under pleasant scent conditions in comparison to neutral scented condition. A possibility is that hand cream is expected to be scented in the mindset of consumers today. Analyses of the open-ended thoughts revealed that 20 out of 162 individuals explicitly talked about a scented hand cream is preferred over the unscented hand cream used in the study. Equal number of individuals from the two olfactory groups gave this comment. In comparison, only one person mentioned scented facial tissue is preferred from the open-thought listing task. This strengthens the point that one of the main factors to consider for product scent depends on the product category. Hand cream received lower ratings overall compared to facial tissue possibly due to the lack of scent (or expectation of scent was not met).

One item LTB ratings were low across both products and all participants. This does not appear to be a good indicator for the purpose of the study. Purchase decisions are based on so many other factors, such as price, physical and psychological needs, thus I do not think this particular rating for LTB provides useful information for this study.

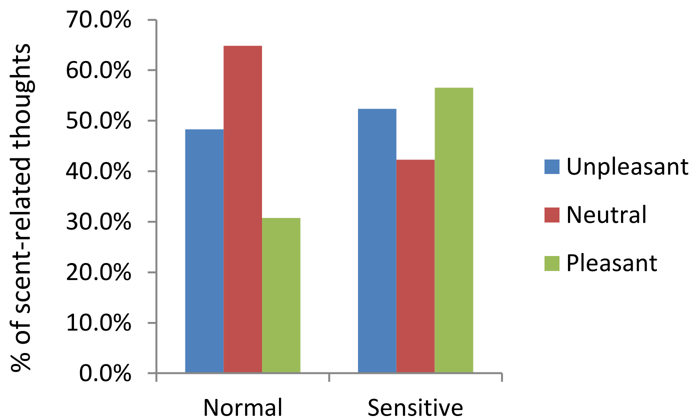
Contagion effects of ambient scent on health symptoms and product evaluation

Experiment 3 revealed that individuals sensitive to smell reported more health related symptoms during pleasant ambient scent conditions. This finding supports the need for awareness of concerns many individuals with heightened sensitivity to smell have: for example, physical irritation and allergic reactions to smell. Although the level of reactions varies across individuals, these issues and concerns, reported by sensitive individuals through in-depth interviews, have negatively affected the consumer experience in the marketplace (Cross, Lin and Childers, working paper). In this in-depth interview study, the authors noted that some highly sensitive individuals suffer from migraines when coming into contact with strong scents (such as perfumes worn by others or scented stores) which creates a negative impact on consumer well-being. This finding is not surprising. However, there is still lack of actions in the marketplace addressing these concerns. We believe it is worth showing that pleasant odors can in fact increase health symptoms and also have an impact on other behavioral outcomes. For example, individuals sensitive to smell rated both facial tissue and hand cream as most liked (highest likeability ratings) during neutral (control) ambient scent condition. This illustrates how ambient scent, whether it is pleasant or unpleasant, can have a "contagion effect" on the likeability of products. More specifically, a neutral ambient condition appears to be preferred for individuals sensitive to smell, as products received higher likeability ratings.

Further analyses of the open-thoughts listing revealed that a higher percentage of participants listed scent-related thoughts during the neutral (unscented) condition (55%) compared to the other two conditions (Figure 15). In particular, individuals with a normal sense of smell were more likely (65%) to mention scent in the neutral condition compared to unpleasant (48.3%) and pleasant (30.8%) conditions. Comments included a neutral statement of the lack of product scent or preference of scented product. This "need for sensory seeking behavior" appears to be more relevant for normal individuals, especially during unscented (ambient and product) conditions. For individuals who are not disturbed by scents, they appear to seek sensory stimuli when such is lacking, while this is not the case for individuals sensitive to smell.

Figure 15. Percentage of scent-related thoughts (Experiment 3)

	Unpleasant	Neutral	Pleasant
Normal	48.3%	64.9%	30.8%
Sensitive	52.4%	42.3%	56.5%
Total	50.0%	55.6%	42.9%



Food choices under the influence of ambient scent

The impact of ambient scent on food choices revealed no apparent individual differences. Both normal and sensitive individuals are more likely to choose a healthier food option over the unhealthy under the influence of ambient scent compared to neutral conditions. Interestingly, the valence of the odor, whether it was pleasant or unpleasant, did not seem to have an impact on the food choices. This outcome confirms that indeed odors can have an impact on consumer behavior. A possible explanation for this outcome is through an arousal effect. Odor conditions induced higher emotion ratings such as "surprise, "interest," and "enjoyment" in comparison to the neutral condition. The listed self-reported emotions indicate the odor condition was perhaps unusual and unexpected, which resulted in arousal effects. This arousal effect could be a trigger for "variety seeking behavior" thus increasing the likelihood of selecting a less commonly consumed item such as raisins (versus Snickers) used in the study. Another possible explanation is that the nature of the pleasant scent pretested and selected for the stimuli Pineapple Mango is a fruity scent that could be easily associated with food and perhaps triggered a desire for raisins. Other scents such as floral scents should be tested in the future.

Traits such as optimal stimulation levels (OSL) have been shown to be related to variety seeking behaviors (Steenkamp and Baumgartner 1992). Research efforts have been put forth to understand the impact of context on variety seeking behavior in product choice and has shown that need for stimulation, OSL can be manipulated or fulfilled by providing other product choices (Menon and Kahn 1995).This study contributes to the literature by showing sensory stimulation (ambient odors) as an antecedent to variety seeking behaviors (selecting a less commonly consumed item) and simultaneously showing evidence consistent with a possible arousal mechanism for this outcome.

Olfactory embodied cognition effects

The effect of sniffing motions, in the absence of odor, was examined along with olfactory imagery in Experiment 4. Results revealed the impact of sniffing motions on behavioral outcomes, as evidenced through significant increases in product and ad ratings, in individuals sensitive to smell. This finding suggests differential effects in embodied cognition, particularly for olfactory sensitivity. Barsalou (2008) explains that cognition is "embodied," the body exerts a powerful influence on shaping a person's thoughts. Embodied cognition has recently become a topic of increasing interest with findings ranging from body movements such as muscle firmness to strengthen willpower (Hung and Labroo 2011) to exercising embody cognition through mental simulation in product orientation to increase purchase intentions (Elder and Krishna 2012). A recent Journal of Consumer Psychology special issue (2014) presents a series of research papers on sensory factors and embodied cognitions. Examples include how warmth from temperature (Zwebner, Lee and Goldenberg 2014), brightness from lighting (Xu and Labroo 2014), touching intimate pieces of clothing (Festjens, Bruyneel and Dewitte 2014), and other sensory inputs can result in consumer-relevant behaviors. These research articles present exciting and interesting connections between body movement and cognitive outcomes. However, the black box that explains the fundamental mechanism of the phenomenon embodied cognition has yet to be further discussed and explored. Reimann et al (2012) in his and his coauthor's review on embodiment discuss not only embodied cognitions but also embodied emotions and further suggest a framework using somatic marker theory to bridge cognition and emotions together in terms of embodied cognition. In their review, they have called for research discerning the underlying physiological and psychological processes involved in embodied cognition. I believe this dissertation has shed some light not only in terms of providing connection between body movements (sniffing) and judgment and choice (product and ad evaluation) but also providing evidence pointing to underlying mechanisms (emotional processing).

Future research

A topic for future research could involve understanding the impact of odors on variety seeking behavior. Experiment 3 reveals that interest and arousal was increased during odor conditions, which led to an increased percentage of individuals choosing a healthy snack (raisins) over an unhealthy snack (snickers). A possible explanation, which calls for future research, is variety seeking behavior and its interplay with the different senses, such as auditory, haptic and olfaction. Prior studies have shown that variety seeking behavior is increased in sensory domains such as food (Inman, 2001). Mitchell, Kahn and Knasko (1995) found a relationship between pleasant scent and increased variety seeking behavior. As we did not set out to test this phenomenon, our findings from this study might have provided a plausible explanation for the behavioral outcome, through increase in arousal or interest.

We also found that an increased percentage of normal individuals listed scent-related thoughts during a neutral scent condition, compared to the ambient scent conditions. Is this suggesting an individual difference in need for sensory stimulation? What about need for stimulation of other senses? Consumer experience is increasingly gaining attention and expectations are increased from the consumer side. One of the main sources contributing to consumer experience is through the involvement of all the different senses. In the entertainment industry, companies, such as Disney, have explored and incorporated different sensory experiences in their theme parks, shows and rides. How to create the right level of stimulation, with the right combination of stimulation, to perfect the consumer experience may be of importance to marketers. At the same time, it is important to take into consideration individual differences in perception and need for sensory stimuli. As we have found in our studies, pleasant scents, such as aromas and perfumes diffused in a retail store, mall or marketplace may create a negative experience for certain individuals. This attempt to create a positive experience using pleasant scents may, in fact, back-fire and result in low customer satisfaction and reduce the well-being of consumers.

On a similar note, customer experience is the focus of interest of marketers and there tends to be a view that more is better. Marketers have captured and tapped into the various senses of consumers, hoping to attract and capture the attention of consumers. However, the possibility of too much sensory stimulation in the marketplace may create a pushback or cognitive overload for individuals.

There are other individual characteristics that correlate with heightened sensitivity of olfaction in individuals. Researchers/writers, such as Elaine Aron, have studied children and adults that are considered a "highly sensitive person (HSP)" a term she uses in her series of books on sensitive individuals. In her books, she identifies traits of HSPs and provides remedies and tactics to overcome over-arousal experiences. Individuals who are sensitive to smell are likely to be sensitive in other senses as well. In her book titled, "Too loud, too bright, too fast and too tight- What to do if you are sensory defensive in an over-stimulating world?", developmental psychologist, Sharon Heller, talks about individuals who are sensitive to smell, as one of the many sensory stimuli that is too overpowering for sensitive individuals. She introduces the concept of "sensory defensive" and provides strategies for individuals with such a condition to cope by tapping into the brain. In consumer research, there is still much to be explored and understood about the purchase behaviors, concerns, and decision making of sensitive consumers. I believe only the tip of the iceberg has been revealed. There is still much to be discovered and researched on this topic of sensitive individuals.

Finally, findings from our studies have alluded to possible automatic emotion regulation in sensitive individuals reflected in attenuated LPP during odor conditions. We do not have direct evidence showing this was indeed occurring during our studies. Thus, future studies should be designed to test if what we term automatic emotional regulation is in fact occurring in sensitive individuals exposed to odor. This will provide us with a greater understanding of how individuals who are sensitive to smell process olfactory information and thus help marketers (re)design their sensory messages to cater to individuals in this segment.

Theoretical and methodological implications

Overall, findings reported in this dissertation provide contributions to consumer psychological, emotional processing, olfactory imagery and support for individual differences in sense of smell. Results showed that odors, whether in the form of actual odors or olfactory imagery, can play a significant role on influencing emotions. Our results revealed unexpected attenuation in odor-induced emotions which suggest interplay between hot (emotions) and cold (rational) systems. In addition, the relationship between odor valence and emotions is not as straight forward as expected, as it appears to be influenced by individual difference in sense of smell. Individuals sensitive to smell demonstrate possible emotional regulation activity, evidenced by attenuated emotions during exposure to odors which calls attention for further research.

Findings from behavioral experiments in this dissertation also demonstrate the impact of odor-induced emotions on moral judgment, evaluation of other individuals, self-reported health symptoms, healthy food choices. In addition to providing some support to the effect of olfactory imagery on emotional processing, embodied cognition theory helps explain the additive effect of sniffing motions on enhancing emotions. In turn, results showed that "sniffing-induced" emotions further increase advertised product ratings, and willing to buy in sensitive individuals.

Methodological implications include the use of multiple research approach, ERP methods and behavioral experiments, to tap into physiological, psychological and behavioral responses. This dissertation provides an example of the use of multiple research methods to study and address questions associated with the role of olfaction on consumer behavior and decision making. In particular, experiment 1 is a unique set up (Figure 4), designed to capture brain responses to odors presented. This chin rest with a slot for presenting scented pens was constructed and used in place of an olfactometer in which we did not have access to. The measurement and detection of emotions was reflected through LPP, an ERP component identified in the neuroscientific literature, to illustrate emotions detected during exposure to odor stimuli. The application of ERP methods in understanding consumer relevant topic, such as the impact of olfaction on emotions and decision making, has demonstrated the advantages of using real time recordings of brain activity and test theory. Linking behavioral reactions to manipulations, such the sniffing and imagery tasks resulting in differential ad and product preferences in Experiment 4, sets an example of how cause and effect relationship can be established in an experimental setting. Data captured during this process can further provide evidence and support for possible underlying mechanisms.

In sum, this dissertation provides theoretical and methodological implications for olfactory and emotional processes, its interrelationship and impact on consumer behavior, olfactory imagery on emotional processes and application of embodied cognition theory.

Marketing implications

Marketers and public policy acts acknowledge handicapped consumers and consumers with other sensory disabilities, such as vision and auditory, and have catered to these individuals through special retail store layouts, product packaging or services. Issues associated with sense of smell, because they are less detectable, are often overlooked and even neglected. Vulnerable consumers, not only individuals sensitive to smell but also individuals with an impaired sense of smell, call for an increased awareness and accommodation from marketers and the society.

Findings from this dissertation suggest possible application and use of scent can be effective in influencing consumer decisions and behaviors. First, detectable scents or odors can automatically induce emotions, as shown in Experiment 1 and 3, especially for normal individuals. As for sensitive individuals, they appear to pay attention and give more thought to the scents detected. This does not imply emotions are not induced, which may have been masked with multiple mechanisms occurring in aggregated data. Marketers should keep in mind that scent can induce emotions, and sensitive individuals may in fact be giving more thought to the scent, trying to discern what it is and where the course is. This may cause possible distraction from other promotional messages in the marketplace for these individuals.

This leads to the second point, i.e., that the shopping environment can be overwhelming for sensitive individuals. Especially with the visual signs, scents, sounds and abundant selection of products in a modern shopping environment, the level of enjoyment might, in fact, become lower for sensitive individuals. And as Experiment 3 shows, pleasant scents also increased reports of health symptoms for sensitive individuals. Marketers should keep in mind not to overuse scents or to minimize the use of overpowering scents in products and the shopping environment, due to the possible negative reactions and perceptions such use may receive.

Thirdly, marketers should also be aware and keep in mind the effect of scent or odor on consumer behavior. As found in Experiment 3, the power of the negativity bias is not to be neglected. The impact of this phenomenon resulted in increased skepticism towards moral judgment and personal ratings in sensitive individuals. Services and businesses that rely on salespeople and strive to create an ethical and positive corporate image should be aware that performance standards may be higher when sensitive individuals are under the influence of odors. This stresses the importance of maintaining a neutral ambient scent shopping environment. And perhaps even fragrance free retail environment or sales associate when interacting with individuals with sensitive sense of smell.

However, there are potential advantageous outcomes from the impact of ambient scent on consumer behavior that marketers may consider. Results revealed that ambient odor, irrelevant of valence, appear to increase healthy food selection behavior. Healthy food option (Raisin) was selected over unhealthy option (Snickers) more often under the influence of ambient odors in comparison to a neutral condition. Future research should be conducted to confirm this speculation. Marketers may be able to utilize scent to trigger variety seeking behavior or healthy eating behavior.

Finally, the role of olfactory imagery in consumer behavior has been overlooked by researchers and marketers. In this dissertation, we explored its role and the effect on consumer decision making. Among the different senses, unlike visual and auditory, olfaction is less controllable and cannot be easily contained and transferred via various media options. However, we found that olfactory imagery can be beneficial in triggering olfactory experiences through mental simulation. Associated emotions were triggered through olfactory imagery in normal individuals. What was even more exciting was that sniffing motions not only triggered emotions in sensitive individuals, but also increased product ratings (which were rated lower when only olfactory imagery was performed) and reported higher likelihood to buy. Marketers can take advantage of such tactics, inviting consumers to perform olfactory imagery in the absence of actual scent. Cues to imagine and sniff could be embedded in ads, commercials, online promotional messages offline or online environments. This small but simple technique can help overcome the physical reactions and health concerns associated with coming in contact with actual scents in shopping environments, particularly for sensitive individuals discussed above. In general, olfactory imagery is a tool to communicate olfaction information across various media until technology advancements figure out a way to transfer chemicals through indirect media like the Internet.

APPENDIX A

Description for Sniffin Sticks (stimuli)

15 different scents are included in the discrimination test, including: orange, leather, cinnamon, peppermint, banana, lemon, liquorice, turpentine, garlic, coffee, apple, cloves, pineapple, rose. (Fish was excluded because of its strong and unpleasant odor.)

Detection task-

Pen	*Set 1*	*Set 2*
1	Octylacetat	Cinnamonaldehyd
2	n-Butanol	2-Phenylethanol
3	Isoamylacetat	Anethol
4	Anethol	Eugenol
5	Geraniol	Octylacetat
6	2-Phenylethanol	Isoamylacetat
7	(+)-Limonen	(+)-Fenchon
8	(-)-Carvon	(+)-Carvon
9	(-)-Limonen	Citronellal
10	2-Phenylethanol	(+)-Menthol
11	(+)-Carvon	Geraniol
12	n-Butanol	(+)-Fenchon
13	Citronellal	Linalool
14	Pyridin	(-)-Limonen
15	Eugenol	Cinnamonaldehyd
16	Eucalyptol	lono

Identification task-

Pen	*Odour*
1	Orange
2	Leather
3	Cinnamon
4	Peppermint
5	Banana
6	Lemon
7	Liquorice
8	Turpentine
9	Garlic
10	Coffee
11	Apple
12	Cloves
13	Pineapple
14	Rose
15	Anise
16	Fish

Detection trials-

Trial #	Condition	Scented Pens
1	odor1	octylacetat
2	blank1	blank
3	odor1	nbutanol
4	blank1	blank
5	blank1	blank
6	odor1	isoamlyacetat
7	blank1	blank
8	odor1	geraniol
9	blank1	blank
10	odor1	2-phnylethanol
11	blank1	blank
12	blank1	blank
13	odor1	limonen+-
14	odor1	carvon
15	blank1	blank
16	odor1	limonen--
17	blank1	blank
18	odor1	carvon+-
19	odor1	citronellel
20	odor1	pyridin
21	blank1	blank
22	blank1	blank
23	odor1	eugenol
24	blank1	blank
25	odor1	eucalyptol
26	odor1	fenchon++
27	blank1	blank
28	blank1	blank
29	blank1	blank
30	odor1	menthol+-
31	blank1	blank
32	odor1	linalool
33	odor1	a-lonon
34	blank1	blank
35	odor1	anethanol
36	odor1	2-phnylethanol
37	blank1	blank
38	odor1	n-butanol
39	blank1	blank
40	blank1	blank

Identification trials-

Trial #	Condition	Scented Pens	Options				
			Option1	Option2	Option3	Option4	Option5
1	blank2	blank	orange	blackberry	strawberry	pineapple	blank
2	odor2	orange	orange	blackberry	strawberry	pineapple	blank
3	blank2	blank	smoke	glue	leather	grass	blank
4	odor2	leather	smoke	glue	leather	grass	blank
5	odor2	cinnamon	honey	vanilla	chocolate	cinnamon	blank
6	blank2	blank	honey	vanilla	chocolate	cinnamon	blank
7	odor2	peppermint	chive	Peppermint	fir	onion	blank
8	odor2	banana	coconut	banana	walnut	cherry	blank
9	odor2	lemon	peach	apple	lemon	grapefruit	blank
10	blank2	blank	chive	Peppermint	fir	onion	blank
11	blank2	blank	coconut	banana	walnut	cherry	blank
12	odor2	liquorice	liquorice	cherry	spearmint	cookies	blank
13	blank2	blank	peach	apple	lemon	grapefruit	blank
14	odor2	turpentine	mustard	gum	menthol	turpentine	blank
15	blank2	blank	liquorice	cherry	spearmint	cookies	blank
16	blank2	blank	mustard	gum	menthol	turpentine	blank
17	blank2	blank	onion	sauerkraut	garlic	carrot	blank
18	odor2	coffee	cigarette	Coffee	wine	smoke	blank
19	odor2	apple	melon	peach	orange	apple	blank
20	blank2	blank	cigarette	coffee	wine	smoke	blank
21	odor2	cloves	clove	pepper	cinnamon	mustard	blank
22	blank2	blank	melon	peach	orange	apple	blank
23	odor2	pineapple	pear	plum	peach	pineapple	blank
24	blank2	blank	clove	pepper	cinnamon	mustard	blank
25	blank2	blank	pear	plum	peach	pineapple	blank
26	odor2	rose	camomile	raspberry	rose	cherry	blank
27	blank2	blank	camomile	raspberry	rose	cherry	blank
28	odor2	anise	anise	rum	honey	fir	blank
29	blank2	blank	melon	peach	orange	apple	blank
30	blank2	blank	cigarette	coffee	wine	smoke	blank
31	odor2	turpentine	mustard	gum	menthol	turpentine	blank
32	blank2	blank	onion	sauerkraut	garlic	carrot	blank
33	odor2	liquorice	liquorice	cherry	spearmint	cookies	blank
34	blank2	blank	pear	plum	peach	pineapple	blank
35	blank2	blank	camomile	raspberry	rose	cherry	blank
36	odor2	lemon	peach	apple	lemon	grapefruit	blank
37	odor2	banana	coconut	banana	walnut	cherry	blank
38	odor2	peppermint	chive	peppermint	fir	onion	blank
39	blank2	blank	pear	plum	peach	pineapple	blank
40	odor2	cinnamon	honey	vanilla	chocolate	cinnamon	blank

APPENDIX B

Chemical Odor Sensitivity Scale (COSS)

(Nordin, Millqvist, Lowhagen and Bende 2003)

Please rate the level of agreement of the following statements.

Strongly agree (0), agree (1), agree mildly (2), disagree mildly (3), disagree (4), disagree strongly (5)

1. I would not mind living on a street with odorous/pungent car exhausts if the apartment I had was nice.
2. I am more aware of odorous/pungent substances than I used to be.
3. No one should mind much if someone opens up cans with strong odorous/pungent chemicals once in a while.
4. At movies, other persons' perfume and aftershave disturb me.
5. I am easily alerted by odorous/pungent substances.
6. I get annoyed when my neighbors pollute with odorous/pungent substances (paint, etc.).
7. I get used to most odorous/pungent substances without much difficulty.
8. Even food odors I normally like will bother me if I am trying to concentrate.
9. It would not bother me to perceive smells/pungency of everyday living from neighbors (e.g. smell of cooking, weak cigarette smoke, etc.)
10. When I want to be alone, it disturbs me to perceive odourus/pungent substances in the surrounding.

11. I am good at concentrating no matter what smell there is around me.
12. In public places, I do not mind some smell of cigarette smoke.
13. There are often times when I want a complete odor-free environment.
14. Motor vehicles ought to be required to have exhaust purifiers not to emit odorous/pungent substances.
15. I get mad at people who spread odorous/pungent substances that keep me from relaxing or getting work done.
16. I would not mind living in an apartment that has a weak smell.
17. I am sensitive to odorous/pungent substances.

Please rate the frequency of the following statements occurring.

Always (0), very often (1), often (2), occasionally (3), seldom (4), never (5)

18. If it is smelly/pungent where I am studying, I try to shut it out or move someplace else.
19. Sometimes odorous/pungent substances get on my nerves and get me irritated.
20. I find it hard to relax in a place that evokes odor/pungent sensations.

Please rate the importance of the following statement.

Completely deter me (0), very important (1), important (2), slightly important (3), not at all important (4)

21. How much would it matter to you if an apartment you were interested in renting was located close to a factory that emits odorus/pungent substances?

APPENDIX C

Stimuli and picture ratings for Experiment 2

Each picture is rated on the following questions. Pretest ratings for each picture are listed.

1) Does the item in the picture have a smell to you? (Yes, No)
2) If yes, please rate the following:
   a. How familiar is the associated smell? (unfamiliar 1 to familiar 7)
   b. How pleasant is the associated smell? (unpleasant 1 to pleasant 7)
   c. How strong is the associated smell? (weak 1 to strong 7)

Picture database ratings (n=70)

Picture	**Category**	**Odor-association (% rated this item as "associated with an odor")**	**Pleasantness**	**Familiarity**	**Strength**
Cellphone*	neutral	12%	--	--	--
Pocketwatch	neutral	32%	--	--	--
Car 1	neutral	46%	--	--	--
Watch*	neutral	10%	--	--	--
Earphones	neutral	10%	--	--	--
Bike*	neutral	10%	--	--	--
Utensils*	neutral	19%	--	--	--
Computer	neutral	24%	--	--	--
Violin	neutral	26%	--	--	--
Cupandsaucer*	neutral	6%	--	--	--
Airplane	neutral	29%	--	--	--
Chair	neutral	31%	--	--	--
Potsandpans*	neutral	18%	--	--	--
Mouse*	neutral	9%	--	--	--
Bench	neutral	25%	--	--	--
Cddisk*	neutral	9%	--	--	--
Ceilingfan*	neutral	4%	--	--	--
Key	neutral	53%	--	--	--
Notebook	neutral	35%	--	--	--
Ipodplayer*	neutral	5%	--	--	--
Piano	neutral	28%	--	--	--

Bike	neutral	20%	--	--	--
Watercan	neutral	43%	--	--	--
Iphone*	neutral	3%	--	--	--
Wagon*	neutral	0%	--	--	--
Ring*	neutral	3%	--	--	--
Watergun*	neutral	20%	--	--	--
Remotecontrol*	neutral	13%	--	--	--
Keyboard*	neutral	13%	--	--	--
Flatscreen*	neutral	8%	--	--	--
Lightbulb*	neutral	8%	--	--	--
Fan*	neutral	10%	--	--	--
Orange*	pleasant	99%	6.27	6.55	5.84
Steak1*	pleasant	99%	6.68	6.59	6.03
Popcorn*	pleasant	97%	6.23	6.67	6.17
Daisy 1*	pleasant	97%	6.06	5.33	4.42
Coffee*	pleasant	99%	5.9	6.56	6.53
Pie*	pleasant	93%	6.37	5.9	5.84
Pizza*	pleasant	96%	6.46	6.65	5.89
Peppermint*	pleasant	87%	6.15	6.16	5.24
Cinnamonroll*	pleasant	94%	6.27	6.3	5.52
Lavender*	pleasant	94%	6.16	5.15	5.2
Pineapple	pleasant	97%	6.22	6.09	5.17
Cookies	pleasant	76%	6.06	5.92	3.25
Rose*	pleasant	94%	6.27	5.83	4.98
Candy	pleasant	62%	5.44	4.93	3.55
Donut*	pleasant	88%	5.98	5.73	4.42
Chocolate*	pleasant	79%	6	5.69	4.15
Cupcake*	pleasant	84%	5.98	5.6	4.35
Limecake*	pleasant	87%	6.19	5.73	4.42
Apple*	pleasant	76%	6.23	6.35	3.71
Cherry*	pleasant	76%	6.21	5.86	3.73
Bananabread*	pleasant	96%	6.52	6.45	5.32
Icecream*	pleasant	82%	6.16	5.36	4.14
Banana*	pleasant	82%	5.67	6.29	4.24
Burger1*	pleasant	96%	5.88	6.29	5.6
Limetarts	pleasant	81%	5.62	4.56	4.62
Pasta*	pleasant	93%	6.11	5.89	5.1
Jello	pleasant	65%	5.23	4.98	3.67
Flower*	pleasant	93%	5.95	5.21	4.7
Leather sofa	pleasant	72%	5.35	5.71	4.45
Rose2*	pleasant	94%	6.27	5.58	5.08
Cinnamon	pleasant	88%	5.85	5.83	5.77
Strawberrytart*	pleasant	84%	6.23	5.26	4.81
Steak2*	pleasant	96%	6.63	6.49	6.05
Strawberrytart2*	pleasant	91%	6.45	6.25	4.94
Burger2*	pleasant	96%	6	6.2	5.55
Melon*	pleasant	88%	5.85	5.8	4.98

Shoes*	unpleasant	90%	1.49	5	5.41
Garbage*	unpleasant	79%	1.48	3.76	5.3
Spoiled meat*	unpleasant	84%	2.58	3.77	5
Pig*	unpleasant	94%	2.23	5.03	6.2
Temp toilet*	unpleasant	93%	1.52	5.49	5.94
Factory1	unpleasant	65%	1.95	4.11	4.93
Cigarette1*	unpleasant	99%	1.72	5.88	6.46
Dirty dishes	unpleasant	72%	2.22	4.52	4.47
Cat litter 1*	unpleasant	94%	1.23	4.52	5.72
Dead fish1*	unpleasant	91%	1.42	4.47	6.27
Socks*	unpleasant	85%	2.45	5.21	4.83
Garbage can*	unpleasant	93%	1.48	4.97	5.48
Burnt pan	unpleasant	69%	2.23	4.3	4.45
Molded fruit	unpleasant	66%	1.71	3.91	4.87
Armpit	unpleasant	94%	1.53	5.16	5.69
Pigs*	unpleasant	94%	2.14	5.36	5.84
Fresh fish*	unpleasant	93%	1.81	4.47	6
Onion	unpleasant	97%	3.06	6.17	6.3
Clean diaper*	unpleasant	74%	1.96	4.6	5.48
Sulfur	unpleasant	35%	2.54	3.46	5.08
Fire*	unpleasant	93%	2.06	4.52	6.22
Skunk*	unpleasant	85%	1.26	5.31	6.67
Dirty socks*	unpleasant	97%	1.45	4.83	5.97
Cigarette1*	unpleasant	97%	1.5	5.92	6.41
Toilet*	unpleasant	96%	1.12	4.29	6.14
Molded fruit	unpleasant	54%	1.38	3.68	4.97
Litterbox*	unpleasant	96%	1.48	4.91	5.66
Dumpster*	unpleasant	88%	1.35	5.22	5.57
Feces*	unpleasant	96%	1.22	5.09	6.31
Deadfish*	unpleasant	91%	1.23	4.92	6.53
Garbage*	unpleasant	81%	1.55	4.51	5.47
Factory2	unpleasant	62%	1.88	4.29	4.9
Vomit*	unpleasant	95%	1	4.66	6.47
Burnthouse*	unpleasant	93%	1.54	3.41	5.78
Fire*	unpleasant	95%	2.24	3.92	6.45
Leftovers*	unpleasant	98%	2.26	4.1	5.72
Polluted water*	unpleasant	93%	1.51	3.14	5.84
Carexhaust*	unpleasant	95%	2.92	5.34	5.62
Landfill*	unpleasant	98%	1.05	4.59	6.66

* Are images included in the final experiment stimuli set

APPENDIX D

Vividness of Olfactory Imagery Questionnaire (VOIQ)

(Gilbert, Crouch and Kemp 1998)

The following part of the questionnaire contains four sections. In each section, you will be given a description of a scene followed by four statements related to the scenario given. After reading each question, please close your eyes to construct a mental image of how the described object or scene would SMELL. Once your image of this SMELL has been formed, open your eyes to rate the mental image you constructed. You will do this for each SMELL based mental image requested.

1- Perfectly clear and as vivid as normal vision

2- Clear and reasonably vivid

3- Moderately clear and vivid

4- Vague and dim

5- No image at all (only "knowing" that you are thinking of the object)

1. Think of a time when you really need to take a bath or shower - your clothes are smelly and you need to wash your hair.
    a. The smell of your shirt or blouse when you remove it
    b. The fragrance of the soap or shampoo you use to wash
    c. The smell of fresh clothes you put on
    d. The odor of an aftershave, perfume, or cologne you use after wards

2. Think of an outdoor cookout or barbecue. Consider the smells that occur.
    a. The charcoal or wood has just been lit and is beginning to burn
    b. The food has been cooking on the grill and is almost done
    c. The smell of the food as you savor the first bite
    d. The stench as leftover garbage is burned on the fire

3. Think of someone you know who smokes tobacco. Bring to mind the smells associated with it.
    a. The odor of unlit tobacco - a cigarette, cigar or pouch of pipe tobacco
    b. A dense cloud of tobacco smoke fills the room
    c. The odor of stale cigarette or cigar butts in an ashtray
    d. The lingering smell of tobacco smoke on your clothes after you leave the room
4. **Think of a familiar car and getting into it and going for a ride**
    a. The odor inside the car - the upholstery and other items
    b. The smell of exhaust from a passing truck
    c. You smell gasoline as the tank is being filled
    d. Inside a service station - the smell of new rubber tires and grease

APPENDIX E

Disgust Sensitivity Scale- Revised (DSS-R)

(Haidt, McCauley and Rozin 1994)

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

1. I might be willing to try eating monkey meat, under some circumstances.
2. It would bother me to be in a science class and to see a human hand preserved in a jar.
3. It bothers me to hear someone clear a throat full of mucus.
4. I never let any part of my body touch the toilet seat in public restrooms.
5. I would go out of my way to avoid walking through a graveyard.
6. Seeing a cockroach in someone else's house doesn't bother me.
7. It would bother me tremendously to touch a dead body.
8. If I see someone vomit, it makes me sick to my stomach.
9. I probably would not go to my favorite restaurant if I found out that the cook had a cold.
10. It probably would not upset me at all to watch a person with a glass eye take the eye out of the socket.
11. It would bother me to see a rat run across my path in a park.
12. I would rather at a piece of fruit than a piece of paper.
13. Even if I was hungry, I would not drink a bowl of my favorite soup if it had been stirred by a used but thoroughly washed flyswatter.

14. It would bother me to sleep in a nice hotel room if I know that a man had died of a heart attack in that room the night before.

How disgusting would you find each of the following experiences?

15. You see maggots on a piece of meat in an outdoor garbage pail.
16. You see a person earing an apple with a knife and fork.
17. While you are walking through a tunnel under a railroad track, you smell urine.
18. You take a sip of soda, and then realize that you drank from the glass that an acquaintance of yours had been drinking from.
19. Your friend's pet cat dies, and you have to pick up the dead body with your bare hands.
20. You see someone put ketchup on vanilla ice-cream and eat it.
21. You see a man with his intestines exposed after an accident.
22. You discover that a friend of yours changes underwear only one a week.
23. A friend offers you a piece of chocolate shaped like dog-doo.
24. You accidently touch the ashes of a person who has been cremated.
25. You are about to drink a glass of milk when you smell that it is spoiled.
26. As part of a sex education class, you are required to inflate a new unlubricated condom, using your mouth.
27. You are walking barefoot on concrete, and you step on an earthworm.

APPENDIX F

Stimuli and pretest results for Experiment 3

- **Pleasant scent (rated on 1-7 scale):**

Pleasant Scent	Name	Pleasantness	Familiarity	Strength
#1	Lemon	20.68	7	6.16
#2	Warm vanilla sugar	19	5.84	4.79
#3	Lavendar and Vanilla	20.58	6.63	6.11
#4	Pineapple mango	23.58	6.95	6.47
#5	Japanese cherry blossom	22.11	6.84	5.84
#6	Lemon Mint Leaf	18.58	7.16	6.74
#7	Orange blossom	14.89	6.26	7.95

	Emotions (counts)							
Pleasant Scent	Excited	Awake	Irritated	Happy	Energized	Calm	Discomfort	Other
#1	1	4	1	2	5	5	1	cleaner product
#2	0	1	1	2	0	11	3	not interested
#3	2	1	0	4	2	7	1	dislike candy/hungry
#4	0	2	0	7	4	6	0	
#5	1	1	1	4	1	10	0	clean
#6	0	2	1	4	4	4	2	busy/fresh
#7	1	5	5	1	0	3	2	fresh/dirty

- **Unpleasant odor (rated on 1-7 scale):**

Unpleasant Odor	Chemical name	Pleasantness	Familiarity	Strength
#1	acetone	3.43	5.57	4.71
#2	H2S(flatulence)	2	6.71	6.43
#3	haxane	3	4.43	3.57
#4	toluene	3.50	6.29	5.86

- **Food choices (rated on 1-7 scale):**

Healthy-	**Healthy**	**Nutritious**	**Comfort**
Nature Valley	5.5	5.43	4.47
Sun Maid Raisins	5.57	5.5	3.8
Nutri Grain	5.3	5.2	4.37
Unhealthy-	**Healthy**	**Nutritious**	**Comfort**
Snickers	1.97	1.97	5.53
Rice Krispies Treat	2.03	1.83	4.5

APPENDIX G

Health symptom list

(Dalton, Wysocki, Brody and Lawley 1997)

Labeled magnitude scale (LMS): 0, no sensation; 1.37, barely detectable; 5.46, weak; 15.75 moderate; 33.57, strong; 50.47, very strong; 90.45, strongest imaginable

Solvent-associated symptoms:

Throat irritation, eye irritation, nasal irritation, lightheadedness, headache, nausea and drowsiness

Somatic-associated symptoms (control):

Skin irritation, bad taste, nasal congestion, cough, sneeze, stomachache, shortness of breath, heart palpitations, numbness/tingling, ear ringing, leg cramps, back pain, sweating, itching, current irritation

APPENDIX H

Differential emotions scale (DES)

Izard (1972) - Consists of 30 adjectives covering 10 emotion categories.

Rate from 1 (not felt) to 5 (very strongly felt)

1. Interest (attentive, concentrating, alert)
2. Enjoyment (delighted, happy, joyful)
3. Surprise (surprise, amazed, astonished)
4. Distress (downhearted, sad, discouraged)
5. Anger (enraged, angry, mad)
6. Disgust (feeling of distaste, disgusted, feeling of revulsion)
7. Fear (scared, fearful, afraid)
8. Shame/shyness (sheepish, bashful, shy)
9. Contempt (contemptuous, scornful, disdainful)
10. Guilt (repentant, guilty, blame-worthy)

APPENDIX I

Moral judgment vignettes

(Schnall, Haidt, Clore and Jordan 2008)

1. **Your plane was crashed in Himalayas. The only survivors are yourself, another man, and a young boy. The three of you travel for days, battling extreme cold and wind. Your only chance of survival is to find your way to a small village on the other side of the mountain, several days away. The boy has a broken leg and cannot move very quickly. His chances of surviving the journey are essentially zero. Without food, you and the other man will probably die as well. The other man suggests that you sacrifice the boy and eat his remains over the next few days. How wrong is it to kill this boy so that you and the other man may survive your journey to safety?**

Rate degree of moral severity on a scale of: Perfectly OK (1) to Extremely wrong (9)

2. **You have a friend who has been trying to find a job lately without much success. He figured that he would be more likely to get hired if he had a more impressive resume. He decided to put some false information on his resume in order to make it more impressive. By doing this, he ultimately managed to get hired, beating out several candidates who were actually more qualified than he. How wrong was it for your friend to put false information on his resume in order to help him find employment?**

Rate degree of moral severity on a scale of: Perfectly OK (1) to Extremely wrong (9)

3. **Some US states allow first cousins to marry each other. The state you live on does not currently permit first-cousin marriages but is considering legalizing them. What do you think about such legislation?**

Rate degree of oppose legalization on a scale of: Strongly (1) to Strongly support legalization (9)

4. **You are walking down the street when you come across a wallet lying on the ground. You open the wallet and find that it contains several hundred dollars in cash as well as the owner's driver license. From the credit cards and other items in the wallet, it's very clear that the wallet's owner is wealthy. You, on the other hand, have been hit by hard times recently and could really use some extra money. You consider sending the wallet back to the owner without the cash, keeping the cash for yourself. How wrong is it for you to keep the money you found in the wallet in order to have more money for yourself?**

Rate degree of moral severity on a scale of: Perfectly OK (1) to Extremely wrong (9)

Pretest (n= 7)

	Scenario	Severity
1	Plane	5.86
2	Job	6.57
3	Cousin	2
4	Wallet	8.57

APPENDIX J

Construction of ads selected for Experiment 4

Odor association ratings, ad evaluation, product evaluation and vividness ratings

Picture ad database ratings (n=61)

Each ad is rated on the following questions. Pretest ratings for each ad are listed.

1) Does the product in the ad have a smell to you? (Yes, No)
2) If yes, please rate the following:
    a. How familiar is the associated smell? (unfamiliar 1 to familiar 7)
    b. How pleasant is the associated smell? (unpleasant 1 to pleasant 7)
    c. How strong is the associated smell? (weak 1 to strong 7)
3) Please evaluate the ad:
    a. Bad (1) – good (7)
    b. Unfavorable (1) – favorable (7)
    c. Negative (1) -positive (7)
4) Please evaluate the product/service promoted in the ad:
    a. Bad (1) – good (7)
    b. Dislike very much (1)– like very much (7)
    c. Unfavorable (1) - favorable (7)
5) How likely are you to purchase the product or service in the ad:

    Not likely at all (1) – very likely (7)
6) Please rate the following for the ad:

a. Not vivid (1) – vivid (7)

b. Not personal (1) – personal (7)

c. Not concrete (1) – concrete (7)

d. No easy to relate to (1) – easy to relate to (7)

* Ads included in the final experiment stimuli set

Picture	Label	Brand	Category	Odor ratings				Ad Eval.			Product Eval.			Likelihood to buy	Vividness ratings				
				Odor-association	Familiarity	Pleasantness	Strength	a.	b.	c.	a.	b.	c.		a.	b.	c.	d.	mean
Golfcourse			neutral	41%	5.96	5.71	4.88	6	5.97	6.05	5.87	5.59	5.66	4.84	--	--	--	--	--
Lightbulb*	2	Direction	neutral	8%	5	5.6	5	5.13	5.15	5.26	4.72	4.7	4.66	3.9	4.97	3.91	4.12	3.86	4.22
Water bottle*	3	Pacifism	neutral	5%	4.7	4.3	4.7	4.98	4.97	5.1	5.02	4.89	4.93	4.21	4.52	3.64	4.34	3.91	4.10
Plane*	11	Capacity	neutral	29%	4.76	5.71	5.44	5.9	5.75	5.87	5.75	5.67	5.65	5.23	5.14	3.88	4.71	4.60	4.58
Car repair			neutral	75%	3.43	5.18	5.07	3.02	3.03	3.3	3.59	3.48	3.39	2.77					
Pots&pans*	6	Franchise	neutral	24%	5.14	5.43	4.64	4.23	4.23	4.54	4.46	4.16	4.25	3.7	3.60	3.78	4.16	4.16	3.92
Fork*	7	Maker	neutral	8%	5	6	4.4	5.02	4.98	4.95	4.84	4.56	4.66	3.82	4.33	3.79	4.98	4.28	4.34
Car 1*	9	Length	neutral	36%	5.29	5.05	5.1	5.36	5.34	5.46	5.18	4.95	5	3.54	4.19	3.64	4.19	3.79	3.95
Car 2			neutral	10%	4.83	5.67	4.83	4.43	4.36	4.34	4.31	3.98	4.11	2.97	--	--	--	--	--
Cellphone*	22	Context	neutral	8%	5.8	6.4	5.8	4.03	4.08	4.11	3.93	3.85	3.85	2.8	5.28	5.10	5.53	5.60	5.38
Plane*	4	Upkeep	neutral	27%	4.56	4.69	4.81	5.26	5.3	5.38	5.3	5.23	5.26	4.69	5.71	4.52	5.22	5.14	5.15
Camera*	12	Citation	neutral	15%	5.11	5	4.67	5.72	5.7	5.79	5.62	5.61	5.54	4.75	5.59	5.10	5.33	5.26	5.32
Airplane*	13	Velocity	neutral	34%	4.4	5.15	4.4	5.3	5.31	5.52	5.36	5.33	5.28	4.44	5.60	3.69	5.16	5.03	4.87
Basketball Game			neutral	51%	4.23	5.2	5.33	5.05	5.07	5.16	5.05	5	5.1	4.07	--	--	--	--	--
Tablet*	15	Maker	neutral	15%	5.11	5.67	5.44	5.8	5.79	5.9	5.77	5.64	5.69	4.97	4.98	5.16	5.07	5.52	5.18
Basketball			neutral	53%	4.65	5.84	4.45	3.95	3.95	4.48	4.77	4.61	4.59	3.79	--	--	--	--	--
Tissue*	17	Disclosure	neutral	29%	5.69	6.02	5.49	5.23	5.11	5.3	5.48	5.23	5.3	4.95	4.98	5.21	4.88	4.88	4.99
Toothbrush*	18	Length	neutral	24%	5.07	5.79	4.36	5.3	5.2	5.39	5.08	4.85	4.98	4.3	5.59	5.74	5.71	5.60	5.66
Table*	19	Gravity	neutral	8%	5.4	5.4	5.2	4.8	4.77	4.67	4.85	4.7	4.7	3.8	3.72	4.29	4.28	4.26	4.14
Car shop			neutral	64%	4.05	5.29	5.05	4.98	5.05	5.05	5.13	5	5	4.7	--	--	--	--	--
Cellphone 1*	10	Facility	neutral	8%	6.2	6.4	5.4	5.44	5.3	5.23	5.34	5.28	5.28	4.38	5.28	5.31	5.19	5.12	5.22
Cellphone 2*	21	Functionary	neutral	8%	5.8	6.4	5.4	5.38	5.47	5.45	5.22	5.17	5.15	4.57	5.69	5.12	5.22	5.09	5.28
Coffeetable*	23	Patent	neutral	22%	4.85	4.85	4.23	4.26	4.3	4.43	4.49	4.34	4.39	3.57	3.74	3.48	3.86	3.66	3.69
Cruise 1*	25	Tendency	neutral	37%	5.38	4.88	5.06	6.07	6.05	6.08	6.1	5.97	5.95	5.33	5.24	4.72	5.10	4.78	4.96
Cruise 2			neutral	27%	6.03	5.19	4.71	5.6	5.57	5.67	5.65	5.67	5.68	5.05	--	--	--	--	--
Fitness center 1			neutral	49%	3.63	5.66	5.27	5.58	5.63	5.77	5.72	5.53	5.55	5	--	--	--	--	--
Gym			neutral	41%	4.13	5.33	5.08	5.27	5.23	5.35	5.17	5.1	5.2	4.8	--	--	--	--	--
Fitness center 2			neutral	54%	3.41	5.41	4.75	4.95	5.02	5.48	5.2	5.07	5.07	3.36	--	--	--	--	--
Screen*	29	Tendency	neutral	10%	5.5	5.67	4.83	4.72	4.84	4.79	5.11	5.03	5.11	4.25	4.09	3.78	4.57	4.84	4.32
Flatscreen*	30	Rating	neutral	12%	5.71	5.57	4.43	5.38	5.39	5.39	5.74	5.66	5.64		4.48	4.26	4.97	5.34	4.76
Flatscreentv*	31	Contents	neutral	12%	6.43	5.71	5.14	5.3	5.39	5.38	5.66	5.61	5.52	4.84	4.26	3.97	4.50	4.90	4.41

Cupcake 2*	30_1	Idiom	pleasant	66%	6.15	5.27	4.9	6.08	6.08	5.98	6.03	5.93	5.93	5.43	5.40	5.19	5.33	5.50	5.35
Tulip			pleasant	54%	6.15	5.27	4.9	5.57	5.63	5.75	5.43	5.33	5.35	4.63	--	--	--	--	--
Dining center*	32_1	Vocation	pleasant	78%	5.93	5.28	5.09	6	5.95	6.05	5.89	5.79	5.85	5.08	5.36	3.88	4.76	4.45	4.61
Mango			pleasant	66%	5.87	5.05	4.31	4.87	4.98	4.97	5.13	4.98	5.07	4.33	--	--	--	--	--
Garden 1*	34_1	Namesake	pleasant	73%	5.98	5.49	5.07	6.08	6.18	6.21	5.82	5.87	5.87	5.1	6.02	4.53	4.66	4.69	4.97
Garden 2			pleasant	51%	6.13	5.43	5.27	5.38	5.43	5.49	5.51	5.44	5.33	4.57	--	--	--	--	--
Burger*	36_1	Disparity	pleasant	81%	5.75	6.13	5.88	5.43	5.43	5.33	5.48	5.42	5.42	5.08	5.55	5.36	5.40	5.84	5.54
Handsoap			pleasant	69%	5.48	4.57	4.86	5.8	5.75	5.75	5.74	5.74	5.74	5.31	--	--	--	--	--
Lasagna*``	38_1	Theory	pleasant	85%	5.8	5.77	5.37	6.1	5.92	6.03	6.16	6.02	6.03	5.64	5.22	4.55	4.78	5.26	4.95
Mac&cheese			pleasant	64%	5.68	5.55	5	5	4.87	4.92	5.28	5.23	5.31	4.79	--	--	--	--	--
Cinnamon roll*	40_1	Deduction	pleasant	81%	6.19	5.47	5.38	5.69	5.66	5.54	5.52	5.33	5.43	4.85	5.48	4.57	5.10	5.05	5.05
Perfume 1*	42_1	Hypothesis	pleasant	80%	5.55	4.68	5.83	5.03	4.95	4.88	4.58	4.43	4.5	3.68	4.62	4.53	4.57	4.48	4.55
Perfume 2			pleasant	85%	5.26	4.56	5.84	4.82	4.8	4.93	4.74	4.61	4.56	3.74	--	--	--	--	--
Perfume 3			pleasant	73%	5.21	4.37	5.84	4.27	4.23	4.22	4.05	3.95	4.07	3.25	--	--	--	--	--
Perfume 4			pleasant	81%	5.21	4.65	5.83	4.43	4.33	4.44	4.39	4.16	4.05	3.07	--	--	--	--	--
Pizza 1*	44_1	Anecdote	pleasant	86%	5.92	6.31	6.04	5.97	5.93	5.93	6.1	6.03	6.08	5.82	5.69	5.22	5.52	5.95	5.59
Pizza 2*	45_1	Dalliance	pleasant	86%	5.88	6.12	5.76	6.02	5.98	5.93	6.05	5.92	5.95	5.67	5.69	4.98	5.26	5.62	5.39
Pizza 3*	46_1	Hanker	pleasant	83%	6	6.16	5.63	5.57	5.61	5.56	5.7	5.61	5.61	5.31	5.24	4.90	5.05	5.41	5.15
Popcorn*	47_1	Amount	pleasant	85%	5.81	6.29	5.63	4.75	4.88	4.83	5.12	4.98	4.93	4.6	5.24	5.02	5.19	5.62	5.27
Pool			pleasant	56%	6.15	5.52	5.21	6.69	6.69	6.67	6.52	6.44	6.39	5.74	--	--	--	--	--
Dining center*	49_1	Hearing	pleasant	68%	5.7	5.13	4.63	6.02	6.05	6.05	5.97	5.93	5.92	5.49	5.41	4.47	4.76	4.72	4.84
Sandwich			pleasant	63%	5.23	4.19	4.12	5.46	5.38	5.39	5.23	5.07	5.13	4.59	--	--	--	--	--
Soap			pleasant	29%	5.06	4.29	4.53	3.93	3.82	3.97	3.73	3.7	3.68	3.08	--	--	--	--	--
Bread*	42_1	Figment	pleasant	80%	5.96	5.89	5.19	5.48	5.36	5.57	5.74	5.59	5.48	5.21	4.59	4.36	4.98	5.12	4.76
Spa			pleasant	80%	5.15	5.72	5.57	6.21	6.18	6.28	6.28	6.34	6.26	5.61	--	--	--	--	--
Restaurant			pleasant	29%	5.47	5.29	4.59	6.02	5.95	5.92	5.97	5.95	5.97	5.18	--	--	--	--	--
Steaksalad*	55_1	Supplication	pleasant	83%	5.71	5.2	5.16	5.56	5.54	5.51	5.62	5.36	5.46	4.93	5.34	4.76	4.81	5.00	4.98
Strawberry			pleasant	53%				6.25	6.25	6.33	6.08	6.07	6.05	5.79	--	--	--	--	--
Watermelon*	57_1	Kine	pleasant	64%	5.97	5.89	4.39	6.07	5.98	6.13	5.89	5.82	5.87	5.15	5.72	5.86	4.86	4.86	5.33
Wine*	58_1	Elaboration	pleasant	69%	5.66	5.15	5.15	5.95	5.82	5.78	5.6	5.53	5.53	5.05	5.90	5.88	5.55	5.90	5.81
Winery			pleasant	46%	5.74	4.63	4.85	5.84	5.87	5.97	5.61	5.44	5.61	4.72	--	--	--	--	--

Golf course 1			neutral	46%	6.22	5.78	5	5.75	5.7	5.77	5.72	5.46	5.54	4.75	--	--	--	--	--
Golfcourse 2			neutral	42%	6.32	6.04	5.2	5.8	5.83	5.97	5.87	5.77	5.82	5.08	--	--	--	--	--
Golfcourse 3			neutral	36%	6	5.71	4.9	5.55	5.55	5.68	5.47	5.35	5.33	4.72	--	--	--	--	--
Salon			neutral	36%	4.76	5.67	5.38	5.82	5.75	5.72	5.62	5.53	5.48	5.02	--	--	--	--	--
Hotel*	36	Proxy	neutral	7%	4.75	4.75	4.25	5.12	5.22	5.17	5.3	5.18	5.27	4.73	4.76	3.98	4.24	4.40	4.34
Laptop*	37	Exactitude	neutral	8%	5.4	5.4	5.4								--	--	--	--	--
Coat*	38	Loquacity	neutral	8%	6	5.8	5.8	4.75	4.75	4.7	4.82	4.68	4.75	4.23	4.48	4.93	5.02	5.07	4.88
Baseball*	39	Edition	neutral	24%	5.21	5.57	5.36	5.42	5.45	5.4	5.38	5.33	5.35	4.83	5.05	4.43	4.95	5.29	4.93
Tennis*	40	Gist	neutral	25%	4.4	4.73	4.53	5.02	4.95	4.97	5.23	5.03	5.03	4.22	4.45	4.47	4.64	4.69	4.56
Track*	41	Osculation	neutral	24%	4.57	4.93	4.86	5.37	5.35	5.38	5.3	5.33	5.3	4.68	4.90	4.14	4.45	4.38	4.47
Watch*	42	Edition	neutral	12%	5.14	4.71	5	5.53	5.45	5.4	5.22	5.12	5.17	3.98	5.52	5.16	5.50	5.00	5.29
Bouquet*	1_1	Context	pleasant	81%	6.02	5.63	5.17	5.84	5.84	6.02	5.59	5.62	5.62	4.51	5.64	5.76	5.24	5.12	5.44
Cookie&milk			pleasant	49%	5.86	6.03	4.41	6.2	6.1	6.08	6.15	6.07	6.11	5.87	--	--	--	--	--
Perfume*	3_1	Session	pleasant	86%	5.73	4.39	5.84	5.64	5.49	5.56	5.07	4.9	5.07	3.95	4.59	4.22	4.36	3.88	4.26
Coffee*	4_1	Magnitude	pleasant	93%	5.96	6.05	5.87	5.85	5.87	5.84	5.64	5.38	5.48	4.9	5.48	5.10	5.10	5.33	5.25
Bread*	5_1	Decree	pleasant	76%	6.18	6.11	5.41								--	--	--	--	--
Cake*	6_1	Hypothesis	pleasant	64%	6.05	5.97	5.53	5.98	6.05	6.05	6.03	6.03	6	5.65	6.00	5.62	5.38	5.91	5.73
Brownie*	7_1	Fact	pleasant	88%	6.12	5.48	5.13	6.38	6.43	6.3	6.26	6.21	6.18	5.84	5.97	5.16	5.55	5.43	5.53
Burger*	8_1	Quantity	pleasant	86%	5.69	6.02	5.49	5.56	5.46	5.3	5.38	5.31	5.3	4.82	5.95	5.00	5.74	5.60	5.57
BBQ*	9_1	Steerage	pleasant	98%	6.33	6.31	6.03	6.3	6.38	6.43	6.43	6.36	6.38	5.84	5.95	5.60	5.38	5.98	5.73
Popcorn*	10_1	Subtraction	pleasant	90%	6.17	6.51	6.19	5.75	5.74	5.82	5.74	5.61	5.67	5.34	5.02	5.03	5.53	5.86	5.36
Garden			pleasant	58%	6.24	5.74	5.56	5.78	5.88	6	5.58	5.57	5.57	5.03	--	--	--	--	--
Chocolate*	12_1	Concept	pleasant	69%	5.68	4.88	4.59	6.03	6.1	6.1	6.03	5.97	6.03	5.39	5.31	4.84	4.76	4.52	4.86
Chocoberries	13_1	Allegory	pleasant	75%	6.27	5.75	4.98	6.16	6.1	6.08	6.15	6.02	6.11	5.7	6.05	5.36	5.64	5.52	5.64
Orange			pleasant	49%	5.86	6.07	5.66	5.5	5.57	5.47	5.42	5.48	5.53	4.92	--	--	--	--	--
Applesideup*	15_1	Upkeep	pleasant	80%	5.6	4.38	4.89	5.18	5.13	5.26	5.18	5.08	5.18	4.49	5.17	4.62	4.95	4.57	4.83
Beach resort			pleasant	44%	6.31	5.5	5.15	6.53	6.58	6.55	6.5	6.5	6.5	6.22	--	--	--	--	--
Steak*	17_1	Unit	pleasant	92%	6.06	5.87	5.53	5.89	5.79	5.8	6	5.95	5.8	5.51	5.91	5.36	5.53	5.74	5.64
Beer*	18_1	Situation	pleasant	78%	5	5.98	4.83	6	5.84	5.79	5.69	5.62	5.67	5.51	5.67	5.48	5.29	5.93	5.59
Bakery*	19_1	Functionary	pleasant	75%	6.02	5.68	5.5	5.7	5.67	5.7	5.75	5.72	5.72	5.42	5.10	4.67	4.76	4.90	4.86
Winery			pleasant	63%	5.35	4.22	4.76	5.28	5.21	5.21	5.21	5.21	5.15	4.57	--	--	--	--	--
Spa*	21_1	Aberration	pleasant	54%	6.25	4.91	5.06	6.33	6.43	6.44	6.31	6.28	6.28	5.75	5.72	6.12	5.47	4.97	5.57
Weddingcake			pleasant	42%	5.68	5.24	4.68	5	4.97	5.07	5.08	4.85	4.97	3.98	--	--	--	--	--
Candles*	23_1	Instance	pleasant	80%	6.04	5.36	5.51	5.16	5.08	5.11	5.21	5.15	5.11	4.44	3.93	4.14	4.36	3.95	4.09
Coffee 1*	24_1	Criteria	pleasant	95%	6.21	6.02	6.04	6.18	6.15	6.15	5.89	5.79	5.87	5.46	5.98	5.33	5.41	5.34	5.52
Coffee 2*	25_1	Disclosure	pleasant	98%	6.02	6.17	6.04	6.43	6.43	6.43	6.07	6.07	6.1	5.74	5.84	5.60	5.45	5.71	5.65
Cologne			pleasant	58%	5.44	4.38	6.09	4.08	4.12	4.13	4.13	4.05	4.1	3.28	--	--	--	--	--
Cookie 1*	27_1	Arbiter	pleasant	78%	6.09	6.28	5.5	5.43	5.3	5.25	5.52	5.3	5.3	5.15	5.47	5.64	5.16	5.90	5.54
Cookie 2*	28_1	Disconnection	pleasant	81%	6.48	6.52	6.06	6.07	6.15	6.15	6.13	6.1	6.08	5.9	5.78	5.47	5.66	6.00	5.72
Cupcake 1*	29_1	Capacity	pleasant	66%	5.77	5.54	5.21	5.58	5.68	5.67	5.65	5.7	5.72	5.18	5.50	4.79	4.97	4.95	5.05

References

Adkins, N. R., Ozanne, J. L. (2005), "The low literate consumer," Journal of Consumer Research, 32 (1), 93-105.

Alfano, K. M., Cimino, C. R. (2008), "Alteration of expected hemispheric asymmetries: Valence and arousal effects in neuropsychological models of emotion," Brain and Cognition, 66 (3), 213-220.

Anderson, A. K., Phelps, E. A. (2001), “Lesions of the human amygdala impair enhanced perception of emotionally salient events,” Nature, 411(6835), 305-309.

Aquino, K., Reed II, A. (2002), "The self-importance of moral identity," Journal of Personality and Social Psychology, 83 (6), 1423-1440.

Aron, Elaine N. (1998) *The highly sensitive person: How to thrive when the world overwhelms you.* New York, NY: Three Rivers Press.

Arshamian, A., Willander, J., Larsson, M. (2011), "Olfactory awareness is positively associated to odour memory," Journal of Cognitive Psychology, 23 (2), 220-226.

Babin, Laurie A. and Alvin C. Burns (1997), "Effects of Print Ad Pictures and Copy Containing Instructions to Imagine on Mental Imagery That Mediates Attitudes," Journal of Advertising, 26 (3), 33-44.

Bagozzi, R. P., Baumgartner, H., Pieters, R., Zeelenberg, M. (2000), “The role of emotions in goal-directed behavior,” The why of consumption: Contemporary perspectives on consumer motives, goals, and desires, 36-58.

Baker, S. M. (2006), "Consumer normalcy: Understanding the value of shopping through narratives of consumers with visual impairments," Journal of Retailing, 1, 37-50.

Barrett, L. F., Tugade, M. M., Engle, R. W. (2004), "Individual differences in working memory capacity and dual-process theories of the mind," Psychological Bulletin, 130 (4), 553-573.

Barsalou, L. W. (2008), “Grounded cognition,” Annual Review of Psychology, 59, 617-645.

Bechara, Antoine (2004), "The role of emotion in decision-making: Evidence from neurological patients with orbitofrontal damage," Brain and Cognition, 55 (1), 30-40.

Bechara, A. (2005), “Decision making, impulse control and loss of willpower to resist drugs: a neurocognitive perspective,” Nature Neuroscience, 8(11), 1458-1463.

Bensafi, M., Pouliot, S., Sobel, N. (2005), "Odorant-specific patters of sniffing during imagery distinguish 'bad' and 'good' olfactory imagers," Chemical Senses, 30 (6), 521-529.

Bensafi, M., Rouby, C. (2007), "Individual differences in odor imaging ability reflect differences in olfactory and emotional perception," Chemical Senses, 32(3), 237-244.

Bensafi, M., Sobel, N., Khan, R. M. (2007), "Hedonic-specific activity in piriform cortex during odor imagery mimics that during odor perception," Journal of Neurophysiology, 98 (6), 3254-3262.

Bernhardson, B. M., Tishelman, C., Rutqvist, L. E. (2008), "Self-reported taste and smell changes during cancer chemotherapy," Supportive Care in Cancer, 16(3), 275-283.

Bernhardson, B. M., Tishelman, C., Rutqvist, L. E. (2009), "Taste and smell changes in patients receiving cancer chemotherapy: Distress, impact on daily life, and self-care strategies," Cancer Nursing, 32(1), 45-54.

Bosmans, A. (2006), "Scents and sensibility: when do (in) congruent ambient scents influence product evaluations?" Journal of Marketing, 32-43.

Bradley, M. M., Codispoti, M., Cuthbert, B. N., Lang, P. J. (2001), "Emotion and motivation I: defensive and appetitive reactions in picture processing," Emotion, 1(3), 276-298.

Bradley, M. M., Lang, P. J. (2000), "Measuring emotion: Behavior, feeling, and physiology," Cognitive Neuroscience of Emotion, 25, 49-59.

Bromley, S. M. (2000), "Smell and taste disorders: A primary care approach," American Family Physican, 61 (2), 427-436.

Bulsing, P. J., Smeets, M. A., Gemeinhardt, C., Laverman, M., Schuster, B., Van den Hout, M. A., Hummel, T. (2010), "Irritancy expectancy alters odor perception: evidence from olfactory event-related potential research," Journal of Neurophysiology, 104(5), 2749-2756.

Bulsing, P. J., Smeets, M. A. M., Van den Hout, M. A. (2009), "The implicit association between odors and illness," Chemical Senses, 34 (2), 111-119.

Burns, Alvin C., Abhijit Biswas, and Laurie A. Babin (1993), "The Operation of Visual Imagery as a Mediator of Advertising Effects," Journal of Advertising, 22 (2), 71-85.

Bushdid C., Magnasco M. O., Vosshall L. B., and Keller A. (2014), "Humans can discriminate more than 1 trillion olfactory stimuli," Science, 343 (6177), 1370-1372.

Cahill, L., Babinsky, R., Markowitsch, H. J., McGaugh, J. L. (1995). "The amygdala and emotional memory," Nature, 337, 295-296.

Cain, W. S., Gent, J. F. (1991), "Olfactory sensitivity: Reliability, generality, and association with aging," Journal of Experimental Psychology: Human Perception and Performance, 17 (2), 382-391.

Cameron, E. L. (2007) “Measures of human olfactory perception during pregnancy,” Chemical Senses, 32(8), 775-782.

Cardinal, Rudolf N., John A. Parkinson, Jeremy Hall, and Barry J. Everitt (2002), "Emotion and motivation: the role of the amygdala, ventral striatum, and prefrontal cortex," Neuroscience & Biobehavioral Reviews, 26 (3), 321-352.

Carrasco, M., Ridout, J. B. (1993), "Olfactory perception and olfactory imagery: A multidimensional analysis," Journal of Experimental Psychology: Human Perception and Performance, 19 (2), 287-301.

Chebat, Jean-Charles and Richard Michon (2003), "Impact of ambient odors on mall shoppers' emotions, cognition, and spending: A test of competitive causal theories," Journal of Business Research, 56 (7), 529-539.

Childers, Terry L. and Carol Kaufman-Scarborough (2009), "Expanding opportunities for online shoppers with disabilities," Journal of Business Research, 62 (5), 572-578.

Chrea, C., Grandjean, D., Delplanque, S., Cayeux, I., Le Calve, B., Aymard, L., Velazco, M. I., Sander, D., Scherer, K. R. (2009), "Mapping the semantic space for the subjective experience of emotional responses to odors," Chemical Senses, 34 (1), 49-62.

Clark, James M., and Paivio, Allan (2004), “Extensions of the Paivio, Yuille, and Madigan (1968) norms,” Behavior Research Methods, Instruments & Computers, 36 (3), 371-383.

Comeau, T. B., Epstein, J. B., Migas, C. (2001), “Taste and smell dysfunction in patients receiving chemotherapy: a review of current knowledge,” Supportive Care in Cancer, 9(8), 575-580.

Conway, M. A., Pleydell-Pearce, C. W. (2000), "The Construction of Autobiographical Memories in the Self-Memory System," Psychological Review, 107 (2), 261-288.

Cross, Samantha N.N., Meng-Hsien Lin, Terry Childers, “Stumbling blocks: Individual differences in olfaction and its impact on consumer well-being,” working paper.

Crowder, R. G., Schab, F. R. (1995), “Imagery for odors,” Memory for Odors, 93-107.

Croy, I., Olgun, S., Joraschky, P. (2011), "Basic emotions elicited by odors and pictures," Emotion, 11 (6), 1331-1335.

Dalton, P. (1999), “Cognitive influences on health symptoms from acute chemical exposure,” Health Psychology, 18(6), 579-590.

Dalton, P., Hummel, T. (2000), “Chemosensory function and response in idiopathic environmental intolerance,” Occupational Medicine-Philadelphia, 15(3), 539-556.

Dalton, P., Wysocki, C. J., Brody, M. J., Lawley, H. J. (1997), “The influence of cognitive bias on the perceived odor, irritation and health symptoms from chemical exposure,” International Archives of Occupational and Environmental Health, 69(6), 407-417.

D'Argembeau, A., Van der Linden, M. (2006), "Individual differences in the phenomenology of mental time travel: The effect of vivid visual imagery and emotion regulation strategies," Consciousness and Cognition, 15 (2), 342-350.

Dahl, D. W., Chattopadhyay, A., Gorn, G. J. (1999), "The use of visual mental imagery in new product design," Journal of Marketing Research, 36 (1), 18-28.

Dalton, P. (1996a), "Odor Perception and Beliefs about Risk," Chemical Senses, 21 (4), 447-458.

---- (1996b), "Odor perception and beliefs about risk," Chemical Senses, 21 (4), 447-458.

---- (2002), "Odor, irritation and perception of health risk," International Archives of Occupational and Environmental Health, 75 (5), 283-390.

De Volder, A. G., Toyama, H., Kimura, Y., Kiyosawa, M., Nakano, H., Vanlierde, A., & Senda, M. (2001), “Auditory triggered mental imagery of shape involves visual association areas in early blind humans,” Neuroimage, 14(1), 129-139.

Djordjevic, J., R. J. Zatorre, M. Petrides, J. A. Boyle, and M. Jones-Gotman (2005), "Functional neuroimaging of odor imagery," Neuroimage, 24 (3), 791-801.

Djordjevic, J., Zatorre, R. J., Petrides, M., Jones-Gotman, M. (2004), "The mind's nose: Effects of odor and visual imagery on odor detection," Psychological Science, 15 (3), 143-148.

Doty, Richard L., Paul Shaman, and Michael Dann (1984), "Development of the university of pennsylvania smell identification test: A standardized microencapsulated test of olfactory function," Physiology & Behavior, 32 (3), 489-502.

Ehrlichman, H., Halpern, J. N. (1988), "Affect and memory: Effects of pleasant and unpleasant odors on retrieval of happy and unhappy memories," Journal of Personality and Social Psycholgy, 55 (5), 769-779.

Ekman, P. (1992) “An argument for basic emotions,” Cognition & Emotion, 6(3-4), 169-200.

Elder, Ryan S., and Aradhna Krishna (2012), "The "Visual depiction effect" in advertising: Facilitating embodied mental simulation through product orientation," Journal of Consumer Research, 38 (6), 988-1003.

Engen, T. (1972), "The effect of expectation on judgments of odor," Acta Psychologica, 36(6), 450-458.

Ferdenzi C., Schirmer A., Roberts S. C., Delplanque S., Porcherot C., Cayeux I., Velazco M. I., Sander D., Scherer K. R., Grandjean D. (2011), "Affective dimensions of odor perception: A comparison between Swiss, British, and Singaporean populations," Emotion, 11 (5), 1168-1181.

Festjens, Anouk, Sabrina Bruyneel and Siegfried Dewitte (2014), "What a feeling! Touching sexually laden stimuli makes women seek rewards," Journal of Consumer Psychology, 24 (2),

Floch, J. L., M. Paul, G. L. Lievre, R. Peynegre, M. Labroue, and L. Perlemuter (1993), "Smell dysfunction and related factors in diabetic patients," Diabetes Care, 16 (6), 934-937.

Frye, R. E., Schwartz, B. S., Doty, R. L. (1990), "Dose-related effects of cigarette smoking on olfactory function," JAMA: the journal of the American Medical Association, 263(9), 1233-1236.

Geisler, M. W., Murphy, C. (2000), "Event-related brain potentials to attended and ignored olfactory and trigeminal stimuli," International Journal of Psychophysiology, 37(3), 309-315.

Gilbert, A. N., Crouch, M., Kemp, S. E. (1998), "Olfactory and visual mental imagery," Journal of Mental Imagery, 22 (3-4), 137-146.

Goldin, Philippe R., Kateri McRae, Wiveka Ramel, and James J. Gross (2008), "The neural bases of emotion regulation: reappraisal and suppression of negative emotion," Biological Psychiatry, 63 (6), 577-586.

Gollwitzer, P. M., Sheeran, P. (2009), "Self-regulation of consumer decision making and behavior: The role of implementation intentions," Journal of Consumer Psychology, 19 (4), 593-607.

González, J., Barros-Loscertales, A., Pulvermüller, F., Meseguer, V., Sanjuán, A., Belloch, V., Ávila, C. (2006), "Reading "cinnamon" activates olfactory brain regions," Neuroimage, 32(2), 906-912.

Gottfried, J. A., Dolan, R. J. (2003), "The nose smells what the eye sees: Crossmodal visual facilitation of human olfactory perception," Neuron, 39 (2), 375-386.

Goukens, C., Dewitte, S., Pandelaere, M., Warlop, L. (2007), "Wanting a bit(e) of everything: Extending the valuation effect to variety seeking," Journal of Consumer Research, 34 (3), 386-394.

Gross, J. J. (1998), "The emerging field of emotion regulation: An integrative review," Review of General Psychology, 2 (3), 271-299.

Gross, James J. (2002), "Emotion regulation: Affective, cognitive, and social consequences," Psychophysiology, 39 (3), 281-291.

Gyurak, A., Gross, J. J., Etkin, A. (2011), "Explicit and implicit emotion regulation: A dual-process framework," Cognition and Emotion, 25 (3), 400-412.

Haidt, J., McCauley, C., Rozin, P. (1994), "Individual differences in sensitivity to disgust: A scale sampling seven domains of disgust elicitors," Personality and Individual Differences, 16 (5), 701-713.

Hajcak, G., MacNamara, A., Olvet, D. M. (2010), "Event-related potentials, emotion, and emotion regulation: An integrative review," Developmental Neuropsychology, 35 (2), 129-155.

Hajcak, G., Nieuwenhuis, S. (2006), "Reappraisal modulates the electrocortical response to unpleasant pictures," Cognitive, Affective, & Behavioral Neuroscience, 6(4), 291-297.

Hajcak, G., Weinberg, A., MacNamara, A., Foti, D. (2012), "ERPs and the study of emotion," Oxford Handbook of ERP Components, 441-474.

Hamann, S. (2003), "Nosing in on the emotional brain," Nature Neuroscience, 6 (2), 106-108.

Hart, D., Atkins, R., Ford, D. (1999), "Family influences on the formation of moral identity in adolescence: longitudinal analysis," Journal of Moral Education, 28 (3), 375-386.

Heller, Sharon (2002) *Too loud, too bright, too fast, too tight*. New York, NY: Harper.

Henkin, R. I., Levy, L. M. (2002), "Functional MRI of congenital hyposmia: brain activation to odors and imagination of odors and tastes," Journal of computer assisted tomography, 26(1), 39-61.

Herman, C.P., Polivy, J. (1980), "Restrained Eating," In A.J. Stunkard (Ed.), Obesity (pp. 208-225). Philadelphia: Sauders.

Herz, R. S., Engen, T. (1996), "Odor memory: Review and analysis," Psychonomic Bulletin & Review, 3 (3), 300-313.

Herz, R. S., McCall, C., Cahill, L. (1999), "Hemispheric lateralization in the processing of odor pleasantness versus odor names," Chemical Senses, 24 (6), 691-695.

Herz, R. S., Schankler, C., Beland, S. (2004), "Olfaction, emotion and associative learning: Effects on motivated behavior," Motivation and Emotion, 28 (4), 363-383.

Holland, R. W., Hendriks, M., Aarts, H. (2005), "Smells like clean spirit: Nonconscious effects of scent on cognition and behavior," Psychological Science, 16 (9), 689-693.

Holmes, E. A., Mathews, A., Mackintosh, B., Dalgleish, T. (2008), "The causal effect of mental imagery on emotion assessed using picture-word cues," Emotion, 3, 395-409.

Horberg, E. J., Oveis, C., Keltner, D., Cohen, A. B. (2009), "Disgust and the moralization of purity," Journal of Personality and Social Psychology, 97 (6), 963-976.

Hummel, T., Nordin, S. (2005), "Olfactory disorders and their consequences for quality of life," Acta Oto-Laryngologica, 125 (2), 116-121.

Hung, Iris W., and Aparna A. Labroo, (2011), "From firm muscles to firm willpower: Understanding the role of embodied cognition in self-regulation," Journal of Consumer Research 37 (6), 1046-1064.

Inbar, Y., Pizarro, D. A., Bloom, P. (2012), "Disgusting smells cause decreased liking of gay men," Emotion, 12 (1), 23-27.

Inbar, Y., Pizarro, D. A., Knobe, J., Bloom, P. (2009), "Disgust sensitivity predicts intuitive disapproval of gays," Emotion, 9(3), 435-439.

Inman, Jeffrey J. (2001), "The role of sensory specific satiety in attribute-level variety seeking," Journal of Consumer Research 28 (1), 105-120.

Ito, T. A., Larsen, J. T., Smith, N. K., Cacioppo, J. T. (1998), "Negative information weighs more heavily on the brain: the negativity bias in evaluative categorizations," Journal of personality and social psychology, 75(4), 887-900.

Izard, C. E. (1972), "Patterns of emotions: A new analysis of anxiety and depression," San Diego, CA: Academic Press.

John, O. P., Gross, J. J. (2004), "Healthy and unhealthy emotion regulation: Personality processes, individual differences, and life span development," Journal of Personality, 72 (6), 1301-1334.

Katotomichelakis, M., Balatsouras, D., Tripsianis, G., Davris, S., Maroudias, N., Danielides, V., Simopoulos, C. (2007), "The effect of smoking on the olfactory function," Rhinology, 45(4), 273-280.

Keil, A., Bradley, M. M., Hauk, O., Rockstroh, B., Elbert, T., Lang, P. J. (2002), "Large-scale neural correlates of affective picture processing," Psychophysiology, 39(5), 641-649.

Kosslyn, S. M., Ganis, G., Thompson, W. L. (2001), “Neural foundations of imagery,” Nature Reviews Neuroscience, 2(9), 635-642.

Kosslyn, S. M., Thompson, W. L. (2003), “When is early visual cortex activated during visual mental imagery?” Psychological Bulletin, 129(5), 723-746.

Krishna, A. (2011), “An integrative review of sensory marketing: Engaging the senses to affect perception, judgment and behavior,” Journal of Consumer Psychology, 22, 332-351.

Krishna, A., Morrin, M. (2008), “Does touch affect taste? The perceptual transfer of product container haptic cues,” Journal of Consumer Research, 34(6), 807-818.

Krishna, A., Lwin, M. O., Morrin, M. (2010), “Product scent and memory,” Journal of Consumer Research, 37(1), 57-67.

Krompinger, J. W., Moser, J. S., Simons, R. F. (2008), “Modulations of the electrophysiological response to pleasant stimuli by cognitive reappraisal,” Emotion, 8(1), 132-137.

Laeng, B., Teodorescu, D. S. (2002), “Eye scanpaths during visual imagery reenact those of perception of the same visual scene,” Cognitive Science, 26(2), 207-231.

Lang, P., Bradley, M. M. (2007), “The International Affective Picture System (IAPS) in the study of emotion and attention,” Handbook of emotion elicitation and assessment, 29-46.

Lang, P. J., Bradley, M. M., Cuthbert, B. N. (1998), “Emotion, motivation, and anxiety: Brain mechanisms and psychophysiology,” Biological Psychiatry, 44(12), 1248-1263.

Lang, P. J., Bradley, M. M., Cuthbert, B. N. (1998), “Emotion and motivation: measuring affective perception,” Journal of Clinical Neurophysiology, 15(5), 397-408.

Larsson, M., Finkel, D., Pedersen, N. L. (2000), "Odor identification influences of age, gender, cognition, and personality," The Journals of Gerontology: Series B, 55 (5), 304-310.

Lazarus, R. S. (1991), “Progress on a cognitive-motivational-relational theory of emotion,” American Psychologist, 46(8), 819-834.

Lee, S. W. S., Schwarz, N. (2010a), "Dirty hands and dirty mouths: Embodiment of the moral-purity metaphor is specific to the motor modality involved in moral transgression," Psychological Science, 21 (10), 1423-1425.

---- (2010b), "Washing away postdecisional dissonance," Science, 328 (5979), 709.

Le Floch, J. P., Le Lièvre, G., Labroue, M., Paul, M., Peynegre, R., Perlemuter, L. (1993), “Smell dysfunction and related factors in diabetic patients,” Diabetes Care, 16(6), 934-937.

Lerner, J. S., Keltner, D. (2000), “Beyond valence: Toward a model of emotion-specific influences on judgment and choice,” Cognition & Emotion, 14(4), 473-493.

Lerner, J. S., Keltner, D. (2001), “Fear, anger, and risk,” Journal of Personality and Social Psychology, 81(1), 146-159.

Lerner, J. S., Tiedens, L. Z. (2006), “Portrait of the angry decision maker: How appraisal tendencies shape anger's influence on cognition,” Journal of Behavioral Decision Making, 19(2), 115-137.

Levy, L. M., Henkin, R. I., Lin, C. S., Hutter, A., Schellinger, D. (1999), “Odor memory induces brain activation as measured by functional MRI,” Journal of Computer Assisted Tomography, 23(4), 487-498.

Lewis, P. A., Critchley, H. D., Rotshtein, P., Dolan, R. J. (2007), "Neural correlates of processing valence and arousal in affective words," Cerebral Cortex, 17 (3), 742-748.

Lim, J., Urban, L., Green, B. G. (2008), “Measures of individual differences in taste and creaminess perception,” Chemical Senses, 33(6), 493-501.

Lundström, J. N., Seven, S., Olsson, M. J., Schaal, B., Hummel, T. (2006), “Olfactory event-related potentials reflect individual differences in odor valence perception,” Chemical Senses, 31(8), 705-711.

Lyman, B. J., McDaniel, M. A. (1990), "Memory for odors and odor names: Modalities of elaboration and imagery," Journal of Experimental Psychology: Learning, Memory, and Cognition, 16 (4), 656-664.

MacInnis, Deborah J. and Linda L. Price (1987), "The Role of Imagery in Information Processing: Review and Extensions," Journal of Consumer Research, 13 (4), 473-491.

Marzillier, S., Davey, G. (2005), "Anxiety and disgust: Evidence for an undirectional relationship," Cognition and Emotion, 19 (5), 729-750.

Metcalfe, Janet and Walter Mischel (1999), “A hot/cool-system analyses of delay of gratification: Dynamics of willpower,” Psychological Review, 106 (1), 3-19.

Menon Satya and Barbara E. Kahn (1995), “The impact of context on variety seeking in product choices,” Journal of Consumer Behavior, 22 (3), 285-295.

Michon, R., Chebat, J. C., & Turley, L. W. (2005), “Mall atmospherics: the interaction effects of the mall environment on shopping behavior,” Journal of Business Research, 58(5), 576-583.

Mischel, Walter, Ozlem Ayduk, and Rodolfo Mendoza-Denton (2003), “Sustaining Delay of Gratification over Time: A Hot-Cool Systems Perspective,” in *Time and Decision*, ed. George Lowenstein, Daniel Read, and Roy Baumeister, New York: Russell Sage Foundation, 175–200.

Mitchell, Deborah J., Barbara E. Kahn, and Susan C. Knasko (1995), “There’s something in the air: Effects of congruent or incongruent ambient odor on consumer decision making,” Journal Consumer Research, 22 (2), 229-238.

Morales, A. C., Fitzsimons, G. J. (2007), "Product contagion: Changing consumer evaluations with physical contact through "disgusting" products," Journal of Marketing Research, 44 (2), 272-283.

Morrin, M., Krishna, A., Lwin, M. O. (2011), “Is scent-enhanced memory immune to retroactive interference?” Journal of Consumer Psychology, 21(3), 354-361.

Morrin, M., & Chebat, J. C. (2005), “Person-place congruency the interactive effects of shopper style and atmospherics on consumer expenditures,” Journal of Service Research, 8(2), 181-191.

Morrot, G., Brochet, F., & Dubourdieu, D. (2001)l “The color of odors,” Brain and language, 79(2), 309-320.

Murphy, C., C. R. Schubert, K. J. Cruickshanks, B. E. K. Klein, Ronald Klein, and D. M. Nondahl (2002), "Prevalence of olfactory impairment in older adults," The Journal of the American Medical Association, 288 (18), 2307-2312.

Murphy, Claire, Charlie D. Morgan, Mark W. Geisler, Spencer Wetter, James W. Covington, Michael D. Madowitz, Steven Nordin, and John M. Polich (2000), "Olfactory event-related potentials and aging: normative data," International Journal of Psychophysiology, 36 (2), 133-145.

Nordin, S., Broman, D. A., Olofsson, J. K., Wulff, M. (2004), "A longitudinal descriptive study of self-reported abnormal smell and taste perception in pregnant women," Chemical Senses, 29 (5), 391-402.

Nordin, S., Millqvist, E., Lowhagen, O., Bende, M. (2003), "The chemical sensitivity scale: Psychometric properties and comparison with the noise sensitivity scale," Journal of Environmental Psychology, 23 (4), 359-367.

Oaten, M., Stevenson, R. J., Case, T. I. (2009), "Disgust as a disease-avoidance mechanism," Psychological Bulletin, 135 (2), 303-321.

Ochsner, K. N., Bunge, S. A., Gross, J. J., Gabrieli, J. D. (2002), “Rethinking feelings: An fMRI study of the cognitive regulation of emotion,” Journal of cognitive neuroscience, 14(8), 1215-1229.

Ochsner, K. N., Ray, R. D., Cooper, J. C., Robertson, E. R., Chopra, S., Gabrieli, J. D., Gross, J. J. (2004), “For better or for worse: neural systems supporting the cognitive down-and up-regulation of negative emotion,” Neuroimage, 23(2), 483-499.

Olatunji, B. O., Williams, N. L., Tolin, D. F., Abramowitz, J. S., Sawchuk, C. N., Lohr, J. M., Elwood, L. S. (2007), "The disgust scale: Item analysis, factor structure, and suggestions for refinement," Psychological Assessment, 19 (3), 281-297.

Pause, B. M., Krauel, K. (2000), "Chemosensory event-related potentials (CSERP) as a key to the psychology of odors," International Journal of Psychophysiology, 36 (2), 105-122.

Peck, J., Childers, T. L. (2003), “Individual differences in haptic information processing: The “need for touch” scale,” Journal of Consumer Research, 30(3), 430-442.

Peretz, I. (2008), “Musical disorders from behavior to genes,” Current Directions in Psychological Science, 17(5), 329-333.

Peretz, I., Brattico, E., Järvenpää, M., Tervaniemi, M. (2009), “The amusic brain: in tune, out of key, and unaware,” Brain, 132(5), 1277-1286.

Poldrack, R. A., Wagner, A. D., Ochsner, K. N., Gross, J. J. (2008), "Cognitive emotion regulation insights from social cognitive and affective neuroscience," Current Directions in Psychological Science, 17 (2), 153-158.

Pollatos, O., Kopietz, R., Linn, J., Albrecht, J., Sakar, V. Anzinger, A., Schandry, R., Wiesmann, M. (2007), "Emotional stimulation alters olfactory sensitivity and odor judgment," Chemical Senses, 32 (6), 583-589.

Porcherot, C., Delplanque, S., Raviot-Derrien, S., Le Calve, B., Chrea, c., Gaudreau, N., Cayeux, I. (2010), "How do you feel when you smell this? Optimization of a verbal measurement of odor-elicited emotions," Food Quality and Preference, 21 (8), 938-947.

Pylyshyn, Z. (2003), “Return of the mental image: are there really pictures in the brain?” Trends in cognitive sciences, 7(3), 113-118.

Ray, R., Ochsner, K. N., Cooper, J. C., Robertson, E. R., Gabrieli, J. D. E., Gross, J. J. (2005), "Individual differences in trait rumination and the neural systems supporting cognitive reappraisal," Cognitive, Affect, and & Behavioral Neuroscience, 5 (2), 156-168.

Reimann, M., Feye, W., Malter, A. J., Ackerman, J. M., Castaño, R., Garg, N., Kreuzbauer, R., Labroo, A. A., Lee, A. Y., Morrin, M., Nenkov, G.Y., Nielsen, J. H., Perez, M., Pol, G., Rosa, J.A., Yoon, C., Zhong, C., (2012), "Embodiment in judgment and choice," Journal of Neuroscience, Psychology, and Economics, 5(2), 104-123.

Rinck, F., Rouby, C., Bensafi, M. (2009), "Which format for odor images?," Chemical Senses, 34 (1), 11-13.

Rolls, E. T., Grabenhorst, F., Margot, C., Silva, M. A. A. P., Velazco, M. I. (2008), "Selective attention to affective value alters how the brain processes olfactory stimuli," Journal of Cognitive Neuroscience, 20 (10), 1815-1826.

Royet, J. P., Delon-Martin, C., Kareken, D. A., Seqebarth, C. (2003), "fMRI of emotional responses to odors: Infuence of hedonic valence and judgment, handedness, and gender," NeuroImage, 20 (2), 713-728.

Royet, J. P., Zald, D., Versace, R., Costes, N., Lavenne, F., Koenig, O., Gervais, R. (2000), "Emotional responses to pleasant and unpleasant olfactory, visual, and auditory stimuli: A positron emission tomography study," The Journal of Neuroscience, 20 (20), 7752-7759.

Russell, J. A. (2003), "Core affect and the psychological construction of emotion," Psychological Review, 110(1), 145-172.

Russell, R., Duchaine, B., Nakayama, K. (2009) "Super-recognizers: People with extraordinary face recognition ability," Psychonomic Bulletin & Review, 16(2), 252-257.

Schnall, S., Benton, J., Harvey, S. (2008a), "With a clean conscience cleanliness reduces the severity of moral judgments," Psychological Science, 19 (12), 1219-1222.

Schnall, S., Haldt, J., Clore, G. L., Jordan, A. H. (2008b), "Disgust as Embodied Moral Judgment," Personality and Social Psychology Bulletin, 34 (8), 1096-1109.

Schupp, H. T., Flaisch, T., Stockburger, J., Junghofer, M. (2006) "Emotion and attention: event-related brain potential studies," Progress in Brain Research, 156, 31-51.

Schwarz, N. (1990), "Feelings as information: informational and motivational functions of affective states," Guilford Press.

Segal, S. J., Fusella, V. (1970), "Influence of imaged pictures and sounds on detection of visual and auditory signals," Journal of Experimental Psychology, 83(31), 458-464.

Semal, C., Demany, L. (2006), "Individual differences in the sensitivity to pitch direction," The Journal of the Acoustical Society of America, 120, 3907-3915.

Seubert, J., Rea, A. F., Loughead, J., Habel, U. (2009), "Mood induction with olfactory stimuli reveals differential affective responses in males and females," Chemical Senses, 34 (1), 77-84.

Shimp, T. A., Stuart, E. W. (2004), "The role of disgust as an emotional mediator of advertising effects," Journal of Advertising, 33 (1), 43-53.

Shiv, B., Fedorikhin, A. (1999), "Heart and Mind in Conflict: The Interplay of Affect and Cognition in Consumer Decision Making," Journal of Consumer Research, 26 (3), 278-292.

Simmons, W. K., Martin, A., Barsalou, L. W. (2005) "Pictures of appetizing foods activate gustatory cortices for taste and reward," Cerebral Cortex, 15(10), 1602-1608.

Sloboda, J. A., Wise, K. J., Peretz, I. (2005), "Quantifying tone deafness in the general population," Annals of the New York Academy of Sciences, 1060(1), 255-261.

Smith, C. A., Ellsworth, P. C. (1985), "Patterns of cognitive appraisal in emotion," Journal of Personality and Social Psychology, 48(4), 813-838.

Sobel, N., Prabhakaran, V., Hartley, C. A., Desmond, J. E., Zhao, Z., Glover, G. H., Sullivan, E. V. (1998), "Odorant-induced and sniff-induced activation in the cerebellum of the human," The Journal of Neuroscience, 18(21), 8990-9001.

Spangenberg, E. R., Crowley, A. E., Henderson, P. W. (1996). "Improving the store environment: do olfactory cues affect evaluations and behaviors?" The Journal of Marketing, 60(2), 67-80.

Spence, C. (2002), "Multisensory attention and tactile information-processing," Behavioral Brain Research, 135 (1), 57-64.

Spence, C., Kettenmann, B., Kobal, G., McGlone, F. P. (2001), "Shared attentional resources for processing visual and chemosensory information," The Quarterly Journal of Experimental Psychology, 54A (3), 775-783.

Spivey, M. J., Geng, J. J. (2001), "Oculomotor mechanisms activated by imagery and memory: Eye movements to absent objects," Psychological research, 65(4), 235-241.

Steenkamp, Jan-Benedict E., and Hans Baumgartner (1992), "The role of optimum stimulation level in exploratory consumer behavior," Journal of Consumer Behavior, 19 (3), 434-448.

Steinbach, S., Hummel, T., Böhner, C., Berktold, S., Hundt, W., Kriner, M., Harbeck, N. (2009), "Qualitative and quantitative assessment of taste and smell changes in patients undergoing chemotherapy for breast cancer or gynecologic malignancies," Journal of Clinical Oncology, 27(11), 1899-1905.

Stevenson, R. J. (2010), “An initial evaluation of the functions of human olfaction,” Chemical Senses, 35(1), 3-20.

Stevenson, R. J., Case, T. I. (2005), "Olfactory imagery: A review," Psychonomic Bulletin & Review, 12 (2), 244-264.

Tetlock, P. E., Kristel, O. V., Elson, S. B., Green, M. C., Lerner, J. S. (2000), "The psychology of the unthinkable: taboo trade-offs, forbidden base rates, and heretical counterfactuals," Journal of Personality and Social Psychology, 78 (5), 853-870.

Tiggemann, M., Kemps, E. (2005), "The phenomenology of food cravings: The role of mental imagery," Appetite, 45 (3), 305-313.

Uhl, F., Kretschmer, T., Lindinger, G., Goldenberg, G., Lang, W., Oder, W., Deecke, L. (1994), "Tactile mental imagery in sighted persons and in patients suffering from peripheral blindness early in life," Electroencephalography and Clinical Neurophysiology, 91 (4), 249-255.

Vennemann, M. M., T. Hummel, and K. Berger (2008), "The association between smoking and smell and taste impairment in the general population," Journal of Neurology, 255, 1121-1126.

Verplanken, B., Faes, S. (1999), "Good intentions, bad habits, and effects of forming implementation intentions on healthy eating," European Journal of Social Psychology, 29 (5-6), 591-604.

Wack, J. T., Rodin, J. (1982), “Smoking and its effects on body weight and the systems of caloric regulation,” The American journal of clinical nutrition, 35(2), 366-380.

Warrenburg, S. (2005), "Effects of Fragrance on Emotions: Moods and Physiology," Chemical Senses, 30 (1), 248-249.

Whalen, P. J., Rauch, S. L., Etcoff, N. L., McInerney, S. C., Lee, M. B., Jenike, M. A. (1998), “Masked presentations of emotional facial expressions modulate amygdala activity without explicit knowledge,” The Journal of Neuroscience, 18(1), 411-418.

Weinberg, P., Gottwald, W. (1982), "Impulsive consumer buying as a result of emotions," Journal of Business Research, 10 (1), 43-57.

Winkielman, P., Zajonc, R. B., Schwarz, N. (1997), “Subliminal affective priming resists attributional interventions, “Cognition & Emotion, 11(4), 433-465.

Winston, J. S., Gottfried, J. A., Kilner, J. M., Dolan, R. J. (2005), "Integrated neural representations of odor intensity and affective valence in human amygdala," The Journal of Neuroscience, 25 (39), 8903-8907.

Wrzesniewski, A., McCauley, C., Rozin, P. (1999), "Odor and affect: Individual differences in the impact of odor on liking for places, things and people," Chemical Senses, 24 (6), 713-721.

Xu, Alison J., and Aparna A. Labroo (2014), “Incandescent affect: Turning on the hot emotional system with bright light,” 24 (2), 205-216.

Yeshurun, Y., Sobel, N. (2010), “An odor is not worth a thousand words: From multidimensional odors to unidimensional odor objects,” Annual Review of Psychology, 61, 219-241.

Yoo, S. S., Freeman, D. K., McCarthy III, J. J., Jolesz, F. A. (2003), “Neural substrates of tactile imagery: a functional MRI study,” Neuroreport, 14(4), 581-585.

Zald, David H. and Jose V. Pardo (1997), "Emotion, olfaction, and the human amygdala: amygdala activation during aversive olfactory stimulation," Proceedings of the National Academy of Sciences of the United States of America, 94 (8), 4119-4124.

Zellner, D. A., Kautz, M. A. (1990), “Color affects perceived odor intensity,” Journal of Experimental Psychology: Human Perception and Performance, 16(2), 391-397.

Zhong, Chen-Bo and Katie Liljenquist (2006), "Washing away your sins: threatened morality and physical cleansing," Science, 313 (5792), 1451-1452.

Zwebner, Yonat, Leonard Lee, and Jacob Goldenberg (2014), “The temperature premium: Warm temperatures increase product valuation,” Journal of Consumer Psychology, 24 (2), 251-259.

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