UNIVERSITY OF MILANO – BICOCCA

Department of Psychology

Doctoral program in Social, Cognitive, and Clinical Psychology

XXVI CYCLE

THE SMELL OF EMOTIONS: OLFACTORY INFLUENCES ON EMOTIONS AND CONSUMER BEHAVIOUR

Supervisor: Dr. Nadia OLIVERO

PhD candidate: Emanuela MAGGIONI

N. 063871

Academic Year 2013/2014

"Odours have a power of persuasion stronger than that of words, appearances, emotions, or will. The persuasive power of an odour cannot be fended off, it enters into us like breath into our lungs, it fills us up, imbues us totally. There is no remedy for it."

Patrick Süskind(1985), Perfume: The Story of a Murderer, p.34

TABLE OF CONTENTS

ABSTRACT

Many studies in the field of consumer behaviour have highlighted the paramount role of emotions in determining our behaviour. In fact, much of our behaviour is driven by emotional responses to the environment. In order to better understand consumer behaviour, it is therefore crucial to investigate what emotions are, how they can be measured and elicited, and how they can directly influence behaviour. Emotions can be elicited by stimuli in different sensory modalities. However, previous psychological and neurophysiological studies have almost exclusively used visual affective stimuli to elicit emotions, while other sensory modalities received less attention. The present thesis, instead, focuses primarily on olfactory stimuli as unconscious emotional triggers. Olfaction has been studied for its direct connection to, and influence on, human emotions and cognitive processes, but crossmodal correspondences and interactions between smell and other senses have been barely investigated.

This thesis specifically addresses the theoretical issues of how emotions can be defined and measured, particularly how emotions can be trigged by olfactory cues, and how those olfactory cues influence consumers' willingness to consume. In relation to real store environments, another question addressed by the present work is how affectively (in-)congruent stimuli from different sensory modalities (i.e., visual, olfactory, and auditory) influence the emotional response and how smell perception can be influenced by crossmodal correspondences between the other senses. In three studies, implicit and self-report assessments of emotions, self-report behavioural questionnaires, implicit association tasks, and physiological measures (i.e., heart rate and skin conductance responses) were used to shed light on those issues.

The first study assessed how product-congruent smells (i.e., coffee and chocolate smells) stimulate willingness to consume. The results showed that product-related smells engaged the intention to consume through their effect on positive emotions and by facilitating the accessibility of product's information. The second study investigated the combined effects of arousing olfactory and auditory environmental stimuli (i.e., smell and music) on the processing of affective pictures. The results of this study revealed that arousal congruence differently affected self-reports versus physiological measures. The effect of co-occurring arousing stimulation across the auditory and olfactory modalities markedly enhanced the emotional experience evoked by affective pictures. In the third study crossmodal interactions between smell and different sensory modalities were investigated by means of an association task. The results suggested that common smells can be classified and identified using other sensory stimuli (e.g., pitch sound, colours), cross-modal associations (e.g., rounded or angular shapes), and emotions (e.g., arousing emotional state) as the main distinctive attributes.

Taken together, these results suggest that olfactory stimuli unconsciously influence consumer behaviour not only through the direct effects that smell have on emotions but also through priming. Ambient smell can drive the consumer to buy unplanned products because operates as unconscious reminder of shopping needs. These results are in line with previous research arguing that olfactory stimuli directly influence emotions. Moreover, those findings provide new knowledge on how congruence, in terms of affective arousal across sensory modalities, modulates emotional responses. Therefore, our results contribute to a better understanding of cross-modal interaction in smell perception. Smells can be classified using distinctive attributes of other sensory modalities. Theoretical and consumer behaviour implications of those results are also discussed.

INTRODUCTION

Emotions are fundamental to human survival. In fact, much of our behaviour is driven by emotional responses to the surrounding environment. Many previous studies in the field of consumer behaviour have highlighted the paramount role of emotions (e.g., hedonic experience) in the determination of that behaviour. However, in both the fields of affective science and of consumer behaviour, important research issues related to emotions are still unresolved. Some of these unresolved issues relate to the nature of emotion itself, while others pertain to the question of how emotions influence decision-making and choice—a process which is, as of yet, not fully understood.

Indeed, one of the toughest questions in the field of affective science is, at the same time, one of the simplest: What is an emotion? The etymology of the word "emotion" is based on the Latin verb *movere* ("to move"), intrinsically related to the word motivation ("something that moves someone"): Emotions frequently prompt action, primarily in order to increase the chance to survive ("motivation to act") (Cacioppo, Gardner, & Berntson, 1999). Thus, emotions represent one of the main motivational precursors of the behavioural intentions and the behaviour of humans. This extraordinary "power" of emotions can be strategically considered in the study of consumers.

The environments that consumers usually navigate in order to buy are clearly multisensory, and many retailers have widely employed and carefully designed ambient variables ("atmospherics") in their stores in an attempt to influence shoppers. Emotions can be elicited by stimuli in different sensory modalities. Although the links between olfaction and emotions are particularly strong, olfaction remains perhaps the least understood sense in the field of affective science when it comes to emotion elicitation (Keller & Vosshall, 2004).

In parallel, in the field of consumer behaviour, while the impact of visual and auditory store atmospherics (such as music or colour) on consumer behaviour has received considerable scholarly attention, the use of smell as a design element has received less attention by marketers. Nevertheless, even in academic marketing research, the effects of atmospherics on consumers' emotions have barely been investigated under laboratory conditions.

In an attempt to fill this gap in the literatures of both affective science and consumer behaviour research, the present thesis will focus on olfactory influences on emotions and consumer behaviour. The way in which olfaction affects consumer behaviour is multi-faceted: As mentioned above, olfaction is in fact the sense that is most closely linked to the centre of emotion processing in the brain (Castellucci, 1985), and olfactory stimuli could also work as a priming cue of shopping needs—either consciously or unconsciously. In addition, considering the olfactory influences on consumer behaviour, the link between memory and olfaction is another potentiality that should be further considered (Krishna, Lwin, & Morrin, 2010).

The present thesis attempts to make an innovative contribution to the field of consumer behaviour by applying classical emotion theories, measurements techniques, and elicitation methods (i.e., olfactory stimulation) in order to investigate consumers' intentions and behaviour. To this end, a fourfold goal is pursued: first, to highlight and to clarify the concept of emotions and the main related issues (i.e., definitions and causation theories, neural correlates, common methods of measurement); second, to identify the role of emotions in consumers' decision-making processes (i.e., cognitive heuristics), with particular attention to olfactory stimuli and their complexity (i.e., olfactory system, the "smell of emotion", olfactory stimulus issues); third, to empirically investigate how olfactory stimuli influence emotions and consumer behaviour (i.e., impulse buying); and fourth, to empirically investigate how affective information from different sensory modalities interactively influences emotional responses (i.e., physiological responses and self-reports), and additionally how crossmodal correspondences can be used to classify and to describe the main distinctive features of a smell.

In order to attain these goals, the present thesis starts with two theoretical chapters (Chapter 1 and 2) that introduce the general framework for the three experimental studies reported subsequently. Each study is presented and discussed in a separate chapter (Chapters 3, 4, and 5), and each chapter includes a detailed theoretical background that is specific to the particular issue addressed in the study.

The first chapter offers a critical literature review of the main issues related to emotions. In particular, this chapter presents an overview of controversial definitions of emotion, causation theories, neural correlates of emotional experience, and different approaches to measure emotions.

The second chapter introduces the literature on emotions and consumer behaviour. In this review, precedence is given to research in the laboratory, since the laboratory environment offers better control of the participants' emotions and of all other variables under investigation than field environments. The chapter begins with a critical review of methods that are commonly used to elicit emotions in the laboratory, with particular attention to the so-called "passive" methods of emotion elicitation. Specifically, the second chapter mainly focuses on olfactory stimuli as a tool to elicit emotions. An overview of the olfactory system and of its direct connection with emotions is presented, considering the complexity that is inherent to this kind of stimulus. Attention is also given to the effects of crossmodal interactions on emotions and consumer behaviour.

Hopefully, the critical issues that have been highlighted in the literature reviewed in the first two chapters will offer a detailed framework to understand the reasons that led to and motivated the three studies presented in the subsequent chapters (Chapters 3, 4, and 5).

Being the first empirical chapter, the third chapter describes and discusses two experiments investigating the effect of product-congruent smells on emotions and on the willingness to consume smell-congruent products. To this end, a double function of food smells (i.e., coffee and chocolate smells) on consumer behaviour is tested: (1) as a reminder or prime of a products' information (i.e., coffee cup and chocolate cake) and (2) as an inherently hedonic or pleasant atmospheric variable eliciting positive emotions.

The fourth chapter presents and discusses an experiment testing whether affective information from different sensory modalities can influence the processing of affective pictures. In particular, the effect of olfactory (i.e., orange and lavender smells) and auditory (i.e., fast-tempo and slow-tempo music) ambient stimuli, presented in (in)-congruent combinations, on the responses toward pictures with different emotional valences (i.e., pleasant, unpleasant, ad neutral valences) was tested.

The fifth chapter reports and discusses a preliminary experiment suggesting guidelines to categorize common smells in terms of emotions and distinctive characteristics from other sensory modalities. With this aim, crossmodal correspondences (e.g., pitch sound, colours, rounded or angular shapes, etc.) and emotions (e.g., arousing emotional state) were tested to be associated with certain smells. Therefore, using those attributes, which are commonly used to describe stimulus dimensions in other sensory modalities and emotions, could lead to a better classification of common smells.

Finally, in the last section, the combined results of the three studies are considered together in order to illustrate the contribution of this work to our understanding of olfactory influences on emotions in consumer behaviour, underlying the role of smell as ambient cue with a double role (i.e., emotion's trigger and priming cue). In doing so, the present work can be expected to stimulate further research in both neuropsychology and sensory marketing.

CHAPTER 1 − Emotions

1.1 Preface

"What is an emotion?" The answer to this question is still open. The concept of emotion has always been obscure, and thus extremely fascinating. Artists, philosophers, and poets have investigated the concept of emotion since the beginning of human culture. However, it was only during the second half of the 19^{th} century that emotions became the object of scientific inquiry. Amongst the first to scientifically study emotions were Charles Darwin (1872) and William James (1894), who have tried to investigate emotions from an evolutionary perspective (i.e., facial expression of emotions in animals and humans) and from a medical-psychological perspective (i.e., physiological change as explanation of the nature of emotions).

Since these early attempts to conceptualize emotions, psychologists and neuroscientists have made enormous progress in understanding emotions. Specifically, researchers have extensively studied the nature, function, and elicitation of emotions. Over the years, the field of emotion research has steadily evolved into a comprehensive 'science of emotion'. Nevertheless, the 'science of emotion' has remained a controversial field until the present day. Many important questions on emotions are still largely unresolved; for instance, the very definition of emotions, whether it is possible to measure emotions, which the best tools are for doing so, and even whether emotions are real psychophysiological states. These are just some examples of the many vital issues that have not been clarified, and for which no common agreement has been reached in the scientific community (Oatley & Johnson-Laird, 2014).

The purpose of the current chapter is to give an overview of the main topics and current controversies in the field of emotion research. In particular, the chapter reviews definitions of emotions, causation theories, neural correlates of emotional experience, and different approaches to measure emotions. In order to reduce the complexity of the vast literature, the present work focuses on the emotional experience *tout court*, concerning only clear valence (i.e., positive and negative) and arousal (i.e., high-arousal/low-arousal) connotation of emotions rather than considering single subtype groups of them (e.g., anger, fear, disgust, affection, pride, relief, etc.).

1.2 Overview of different definitions of emotions

Despite the enormous literature on emotions that is available today, there is no general agreement among scientists on how an emotion should be defined. Indeed, the term 'emotion' is typically used as shorthand for 'emotional episode'—a broader concept that represents an individual's overall emotional experience. An emotional episode involves several components: cognitive component, affective component, somatic activation, motivation, and motor action (Moors, 2009). Because the concept of emotional episode is too broad defining the boundaries between emotions, feelings and moods may help (Fox, 2008). All these concepts (i.e., emotions, feelings and moods) are included under the general category of "affective science" (Davidson, Scherer & Goldsmith, 2003).

"Feelings" can be defined as the subjective representation of emotions; that is, as the private feeling related to the individual experience. Feelings are mental experiences of body states. The cognitive evaluation of an emotion produces an affective response that is absolutely personal and context-specific (Barrett, 2006; Clore & Ortony, 2013).

In contrast, "mood" is defined as a diffuse affective state, generally a less intense experience but lasting longer than an emotion (from hours to days). The nature of the antecedent events that trigger moods is often more general or non-specific compared to the ones that trigger emotions (Ellis & Moore, 1999; Ekman, 1992). Moods can also be distinguished from emotions based on neural substrates. While the neural circuits activated by emotions show rapid neurochemical changes, moods are typically associated with long lasting neurochemical changes (Fox, 2008; Rolls, 2005).

Kleinginna and Kleinginna (1981) conducted a large-scale literature review on studies that have investigated what an emotion is, with the aim to solve the terminological confusion related to the definition of emotion. These researchers created a classification panel based on functional categories by analysing 91 different theories of emotion (Denton, 2005). From this massive literature review, they suggested to define emotions as a complex interaction among various subjective and objective factors, mediated by neural/physiological systems (i.e., neural activations and hormonal production).

Emotions can be interpreted like affect experiences that are trigged by internal/external stimuli. They have a hedonic valence (i.e., positive and negative), involve cognitive processes (appraisal, labelling and emotionally relevant perceptual effects), psychological adaptive processes, and lead to behaviours. The emotions' definition proposed by Denton (2005) clarified which components con be part of emotions. In fact, the author argued that each emotion consists of a number of different components, such as subjective self-report experience, physiological response and cognitive appraisal. In this work those multi-component perspective of emotions is considered as one of the most appropriate perspective to understand what an emotion is.

The classification panel is schematically presented below (Table 1.1), based on the following functional categories: (1) The affective category contains definitions that are focused on feelings of arousal level and pleasure/displeasure; (2) the cognitive category is based on definitions emphasizing the perceptual aspects of emotion, with regard to appraisal and labelling process; the cognitive part is not only a component of the emotional process, but rather the main factor determining the emotional response; (3) the external stimuli category includes definitions underling external triggers of emotions, that are seen as the principal elicitor of emotions while in contrast the motivation has been trigged primarily by internal stimuli; (4) the physiological category contains definitions based on the biological mechanisms; it is currently under debate whether the identification of certain substrates of this physiological activation can be considered related only to the emotional response as an emotional in function; (5) the emotional/expressive behaviour category contains definitions focusing on externally observable emotional responses such as changes on surface skeletal muscles, breathing, vocal/sound production, hair, surface capillaries or exocrine glad secretions (some definitions that are part of this category refer to behaviour as a part of emotion); (6) the disruptive and adaptive categories contain definitions aiming at the functional effects of emotions (disorganizing/dysfunctional or organizing/functional); (7) the multi-aspect category refers to definitions that highlight several important components of emotions (affective, cognitive, physiological and emotional/expressive behaviour) and that components are not different from other basic psychological processes; (8) the restrictive category is based on definitions that try to distinguish the emotion definition from other psychological concepts (affective processes and motivation); (9) the latest category is the motivational category, which contrasts with some of the definitions presented in the restrictive category; here emotion is considered to be a primary behaviour-guiding motive in human. In the current work, the sceptical statements are not presented in the panel because they focus on classifications denying the usefulness of the emotions concept.

In Table 1, all the categories that have been mentioned by Kleinginna and Kleinginna (1981) were analysed in function of which components of emotions (i.e., subjective experience, physiological response, cognitive/motivational response, behavioural expression, and emotion causation) were taken into consideration in the definition of emotions themselves. Nevertheless, it should be recognized that these categories need not be mutually exclusive; the definition of emotion suggested by one author can be grouped in more than one category. For this reason, in the table only the main authors are presented, which were considered as representative. That is, not all the authors analysed in the work of Kleinginna and Kleinginna (1981) are classified in the present table.

Categories of emotions' definition	Authors	Emotional components						
		Subjective experience		**Physiological response**		**Cognitive/Motivational response**	**Behavioural expression**	**Emotion causation**
		Arousal/Pleasure	Affective	Activation	Basic Processes			
1. Affective	McDouguall (1921) Hebb (1966)	X	X					
2. Cognitive	Bowlby (1969) Peters (1970) Schachter (1970)	X				X	X	X
3. External stimuli	Plutchik (1980)					X		X
4. Physiological	Watson (1924) Simonov (1970)			X	X			
5. Emotional/ Expressive Behaviour	Darwin (1872)			X		X	X	
6. Disruptive/ Adaptive	Young (1943) Rado (1969) Carr (1929)	X	X			X	X	
7. Multi-aspect	Delgado (1973) Wolman (1973) Chaplin (1975) Morgan, King & Robison (1979)		X	X		X	X	
8. Restrictive	Jung (1923) Woodworth (1938) Young (1961) Gazzaniga, Steen, & Volpe (1979)	X					X	
9. Motivational	Leeper (1948) Ochs (1965) Milner (1970)	X	X			X	X	

Table 1.1 Classification of the emotion definitions by Kleinginna & Kleinginna (1981), adapted from Denton (2005).

One central on-going debate in emotion science pertains to the question of whether there are discrete, basic, universal emotions or whether emotions are best characterized as positions within a two-dimensional space (Ekman, 1992; Barrett & Russell, 1998; Lang, 1995).

A study by Russell (1980) based on introspective self-report data and from judgment data on the similarity between emotions names found that emotions could be plotted into a two-dimensional space, with one axis representing the level of arousal and the other one representing the hedonic value (positive–negative). This circumplex model of emotion (Figure 1.1) is supported by neuropsychological evidence aiming to demonstrate the existence of distinct brain structures for processing positive compared to negative emotional valence (Ochsner & Barrett, 2001; Lazarus, 1991). One of the main weaknesses of this theory is that it does not reflect the underlying structure of emotion itself (Izard, 1994), but only focuses on self-reported emotions and their language. That is, dimensionality can be also a matter of individual differences (Barrett, 1997). Cultural values and beliefs enormously influence the way in which emotions are labelled, learned, and experienced (Levenson, Ekman, Heider, & Friesen, 1992).

Fundamentally, the emotions are organized around two motivational systems (Bradley, Codispoti, Cuthbert, & Lang, 2001) the appetitive and the defensive systems, due to the primary role of the valence dimension of the emotional triggers. In addition to hedonic valence, arousal also represents another basic parameter in these two motivational systems. Unlike valence, arousal does not have a separate substrate but rather reflects variations in the activation (metabolic and neural) of one or both systems (see also Cacioppo & Berntson, 1994). Generally, valence determinates which system must be activated, while arousal determinates which of the internal/external stimuli could become an emotional trigger. On one side, pleasant emotions are associated with the activation of the appetitive system, the innate tendency to approach; whereas unpleasant emotions are more frequently associated with the activation of the defensive system, the innate tendency to escape. On the other side, the emotional arousal level modulates humans' attentional resources (Lang, Bradley, & Cuthbert, 1997) and the subsequent intensity of the emotional response (Sloboda & Juslin, 2001).

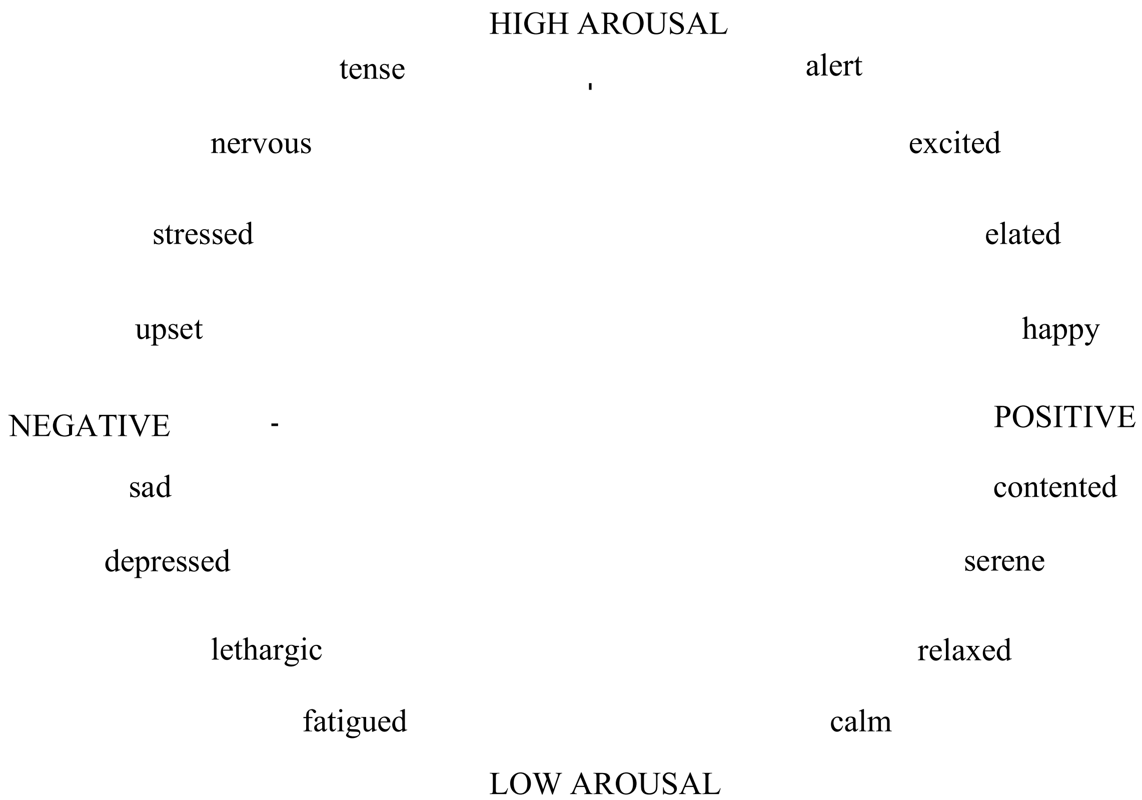


Figure 1.1 The emotion circumplex model suggested by Barrett and Russell (1998). Adapted from Mayne and Bonanno (2001, p. 4).

In contrast to such a two-dimensional account of emotion, Ekman (1992) offered another possible interpretation of emotions, inspired by his studies on facial universal expressions of emotions (Ekman & Friesen, 1978). Ekman argued that there are discrete, basic and universal emotions rather than a two-dimensional emotional space, and that each of these basic emotions comes with specific physiological arousal patterns, behavioural display patterns, and affective perceptions (mental representation). The proponents of discrete emotion theories have suggested different numbers of so-called basic-primary emotions (Damasio, 1994; Scherer, 2005; Ekman, 1999). The basic emotions according to Ekman (Ekman, Friesen, & Ellsworth, 1972) are: happiness, surprise, fear, sadness, anger, and disgust. However, for instance, the discrete-emotion perspective contends that each emotion corresponds to a unique profile in experience, physiology and behaviour (Ekman, 1999; Panksepp, 2007). Basic emotions are a special subset of a broader class of discrete emotions—to distinguish these basic emotions from other discrete emotions (secondary emotions), some criteria are needed. In 1992, Ekman has suggested no less than nine criteria to distinguish basic emotions from secondary emotions. Recently, Levenson (2011) reduced these nine criteria to three larger groups: distinctness (physiological and behavioural profiles, of antecedents, signal and reactions), continuity (nervous system activations that humans have in common with animals), and functionality (survival-relevant automatic appraisal).

Furthermore, this marked division between theories that on one side have theorized emotions as discrete and on the other side have organized emotions around two-dimensional space was overpassed. In fact, as suggested by Bradley and Lang (1994), two-dimensional and discrete theories of emotion are not necessarily mutually exclusive. Rather, it seems possible to reconcile dimensional and discrete perspectives to some extensive theories, which propose that discrete emotions represent a combination of several dimensions (Mauss & Robinson, 2009). For instance, more recently, the structure of emotion has been conceptualised in both discrete and dimensional terms. According to such hybrid conceptualizations, basic emotions can be plotted on the valence-arousal dimensional model (Jerritta, Murugappan, Nagarajan, & Wan, 2011). In particular,

In conclusion, the complexity around the definition of emotion has incentivised the development of instrument based on mathematical function to investigate this concept. For instance, Mayne & Bonanno (2001) have suggested the application of nonlinear and dynamic systems to analyse emotions, which allow to qualitatively describe complex emotional phenomena and at the same time to explain emotions through mathematical functions.

1.3 Theoretical framework: A review of emotion causation theories

In this review, a selection of the most common theories of emotion causation is presented. The selection was compiled using the criteria suggested by Moors (2009).

However, since the main interest of this work is to investigate emotions considering the main issue of physiological activation, only theories focusing on emotion causation view from a perspective of automatic nervous system activation are discussed (Kreibig, 2010). The automatic nervous system activity is, in fact, assumed to be one of the major components of emotional responses, even in the oldest theories (see Kreibig, 2010 for a review). Consequentially, other theories such as the Network Theories and Affect Program Theory (Leventhal, 1980, 1984; Moors, 2009; Panksepp, 2000) will not be considered in this review.

The main differences between the various emotion causation theories discussed in the following are schematically shown in Figure 1.2. The theories are presented in temporal order, which illustrates the gradually increasing complexity of these theories. All the theories presented agree with the importance of emotion causation event, (Moors, 2009).

The first cue, that needs to be investigated, is related to the nature of triggers of emotion. Specifically, what can trigger an emotion and what cannot. To answer to this intricate point, it is necessary to consider the nature of the stimulus. Just like interoceptive stimuli (i.e., memories, recall of personal episodes), experiences related to the exteroceptive senses (i.e., vision, smell, or taste) can also cause emotions (Damasio & Carvalho, 2013) .

Another unresolved vital issue in emotion research is the “event or elicitation problem”, what happens between the stimulus (i.e., the input) and the emotion (i.e., affective reactions). The elicitation problem is considered to be just as important as the issue about the definition of emotion and about which component can be part of that concept (Moors, 2009; Power & Dalgleish, 2007).

To overcome the "elicitation problem", emotions may be conceptualised as constituted by two dimensions: quality and quantity (Moors, 2009). On the one hand, the quantity dimension refers to the emotional intensity of stimuli, that is, whether they can elicit weaker or stronger emotions (or none at all). A threshold of intensity is needed, below this threshold of intensity no emotion is trigged. On the other hand, the quality dimension refers to the valence of those stimuli. This dimension is used to underline which stimulus type arouses positive or negative emotions, and to further specify which kind of particular emotion is activated (i.e., anger, fear, happiness etc.). A parallelism can be drawn between the two motivational systems and the relative function of arousal and valence (Bradley et al., 2001; Lang et al., 1997). Specifically, the quantity dimension can be associated with arousal, whereas the quality dimension can be associated with valence.

1.3.1 The James-Lange theory vs. the Cannon-Bard theory

The James-Lange theory (1884, 1894) has strongly influenced the study of emotions for many years. William James and Carl Lange independently suggested that physiological responses are causal to emotional experience (i.e., "peripheral theory"). Indeed, emotional stimuli provoke visceral (i.e., automatic neural system activation) and somatic (i.e., cognitive interpretation) reactions. The perception of those activations evokes the feeling states of the emotion. In this view, we do not shudder because we feel fear but we feel fear due to the fact that we shudder. The physiological changes (automatic and somatic) due to an arousing cue (i.e., bear) allow humans to experience emotions (Jamesean hypothesis, Lang, 2014).

The James-Lange theory has raised considerable discussions, particularly about the temporal aspects of the emotional elicitation. That is, the physiological changes seem to be previous to the cognitive evaluation of the event that trigged these physiological changes (see Figure 1.2). Such issues have proven to be difficult to test, in fact results on the temporal issues are controversial (Friedman, 2010). In agreement with the Jamesean hypothesis, some studies showed how somatic muscles activity modulates emotional responses; the physiological activation seems to work in parallel with the cognitive processing of the emotion (Adelmann & Zajonc, 1989; Rutledge & Hupka, 1985). In contrast, other research did not replicate the same results (Tourangeau & Ellsworth, 1979). Recently, Damasio and colleagues (2000) confirmed that peripheral physiological changes precede the experience of emotion generated by the recall of personal episodes. The emotion definition given by James (1884) can be summarized in the affective definitions previously presented: bodily changes and the feelings of such changes constitute emotions. That is, emotions are identified by the feeling component (Moors, 2009).

Later, some scholars have criticized the James-Lange theory (Cannon, 1987). Amongst the most influential critics were Cannon and Bard with their investigations of the effects of brain lesions on emotional behaviour in cats (Bard & Rioch, 1937; Dalgleish, 2004). In particular, Cannon and Bard found that removing the cat's cortex did not cancel emotions. This indicates that emotions cannot be a mere perception of bodily change. From this evidence, the two researchers inferred that emotions arise from subcortical centres (i.e."central theory")—a hypothesis completely in contrast with the James-Lange theory. According to the Cannon-Bard theory, we feel fear after the cognitive evaluation of the external stimulus (see Figure 1.2). Therefore we feel the correspondent emotion in response to this type of cognitive evaluation, the somatic information is not always necessary to trigger the emotional response (Friedman, 2010).

Moreover, Cannon (1987) held that the viscera and the innervation of muscles were not the sources of the subjective quality of emotions, but rather that different emotions produce different automatic physiological patterns (Larsen et al., 2008). Cannon's theory replaced the James-Lange theory in most textbooks (Cannon, 1987). However, Cannon's theory did not include an extensive definition of emotion, but rather focused on the internal physiological mechanisms: Emotions are produced by a direct input emerging from the thalamus (Cannon, 1939).

1.3.2 The Schachter's theory

Later, Schachter and Singer (1962) proposed an alternative to both the James-Lange and the Cannon-Bard theories, arising from their famous experiment on cognitive, social, and physiological determinants of emotional states (Schachter & Singer, 1962). In this study, which Schachter ran together with his student Singer (1962), the participants' emotion was manipulated by means of an epinephrine injection that provoked a strong arousal activation in participants (i.e., physiological manipulation). Interesting, environmental cues (i.e., social and cognitive manipulated situational factors) have been used to search and give a potential emotional label, and to justify the otherwise incomprehensible emotional arousal. The study results suggested that neither physiological nor psychological factors can individually explain causes of emotion experiences and their reactions. Specifically, these findings suggested that both physiological information and cognitive processing are fundamental to experience emotions.

The main limitation of these type of laboratory studies is their lack of ecological validity, issue that was already noted by Schachter and his collaborators (Cotton, 1981;

Deonna & Scherer, 2010). However, the main goal of these two researchers was not to propose a general emotional theory (which would be affected by a lack of ecological validity) but rather to investigate the mechanisms that drive the attribution of specific emotions labelling in humans. Moreover, Schachter and Singer (1962) did not formally define emotion; they were basically concerned with understanding under which circumstances the categorization and the labelling of the emotional experience takes place. Like James, for Schachter emotions labelling/processing corresponds with the feeling component.

Despite of subsequent criticism (Cotton, 1981), this so called 'cognitive-physiological', "two-factor," or "jukebox" (Mandler, 1962) approach led to the assumption that even undifferentiated somato-visceral activity can produce distinct emotions, depending on the situational context (e.g., a kiss can elicit different emotions in function of whom is kissing you). According to this Schachter's theory, the emotional experience is the result of the interaction between two factors in parallel (see Figure 1.2): physiological arousal and cognitive processing related to the arousing situation (Reisenzein, 1983). The cognitive evaluation determines which emotions (quality) will be experienced, while the physiological arousal defines the intensity. Both aspects (i.e., cognitive evaluation and physiological arousal) are considered to be fundamental and necessary conditions for the occurrence of an emotion (Reisenzein, 1983).

The Schachter's theory has been supported by studies underlying the importance of cognitive factors in the processing of the emotional experience (Cotton, 1981; Larsen et al., 2008; Schachter, 1964). For instance, situational contexts (e.g., seeing a bear in a zoo) elicit an information search (e.g., zoo is a controlled and protected condition) and a self-attribution process that lead to the experience of specific emotions (e.g., excitement instead of fear) (Deonna & Scherer, 2010). Therefore, humans can feel different emotional states in function of the situational stimulus. The first stage in the experience of an emotion is an arousal activation, while the second one is a social construction or interpretation of the arousal in line with learned norms (Oatley & Johnson-Laird, 2014). Indeed, events are not intrinsically pleasant or unpleasant, like seeing a bear it is an event that can produce different emotional reaction in function to the context in which the bear has been seen. Furthermore, valence has a meaning only in function of the way in which the individual evaluates the particular event or stimulus. In addition, negative events do not automatically produce motor reactions with particular aims. Oatley & Johnson-Laird (2014) argued for the existence of emotion prototypes (i.e., fear, anger, etc.) which include an event (e.g., seeing a bear), the affective perception of it (e.g., bears can attack you), the attribution of a principal object, and an action directed toward the object (e.g., fight or flight). These prototypes are not universally recognized: emotional experience is constructed from social norms and cultural ideas.

1.3.3 Appraisal theories

In order to explain the reason why different emotions may emerge from the same event in different individuals, the Appraisal Theory was developed at the beginning of the 1960s. This theory was inspired by classical works of Aristotle (1954), Hume (1969), Spinoza (1989), Sartre (1939), Arnold (1960), and Lazarus (1966). The New Appraisal Theory defines emotions as processes rather than mind states, with adaptive functions to the environment, reflecting significant appraisal features for human survival. Moreover, appraisal theory differs from Schachter's theory (1964) in that it places the cognitive component at the beginning of the emotional episode. Before the occurrence of any bodily responses, the cognitive process is activated on the unconsciousness level (Moors, 2009). Appraisal is actually seen as a basic component of the emotional episode; emotions are conceptualized as episodes trigged by stimuli that are relevant for a central goal/aim, and that contain an action tendency with synchronizing components.

Furthermore, Appraisal theories have proposed two modalities to define and understand what appraisal is: (1) Dual mode views, where a rule-based mechanism, an on-line computation of one or more appraisal values at the same time, and an associative mechanism, an activation of learned associations between stimuli and previously stored appraisal outputs, coexist, and (2) triple mode views, which added a sensory-motor mechanism, an activation of unrelated associations between sensory characteristics, hedonic feelings and motor responses (Moors, Ellsworth, Scherer, & Frijda, 2013). The appraisal itself determines the quality and the intensity of action, behaviour, feelings and physiological responses (Frijda, 2007). Recently, Moors (2014) argued for two “flavours” of appraisal theories. These flavours demarcate the emotional episode sets, as well as organize the variety of those episodes: A first flavor divides the emotional episodes into limited subsets, corresponding to the specific emotions expressed in natural language (Roseman, 2013). A second flavor divides emotional episodes into a potential infinite number of subsets, each associated with a unique situation and a unique pattern of appraisal values (Scherer, 2009). As Schachter’s Theory presented above, this theory includes individual, cultural, and developmental differences (Imada & Ellsworth, 2011; Moors et al., 2013).

Given the dichotomous premises described by Moors (2009), one of the main goals of the present work is to bridge the gap between Social Science and Neuroscience by strengthening the idea that emotions consist of a number of heterogeneous components, that, when linked together, create the emotion appraisal itself.

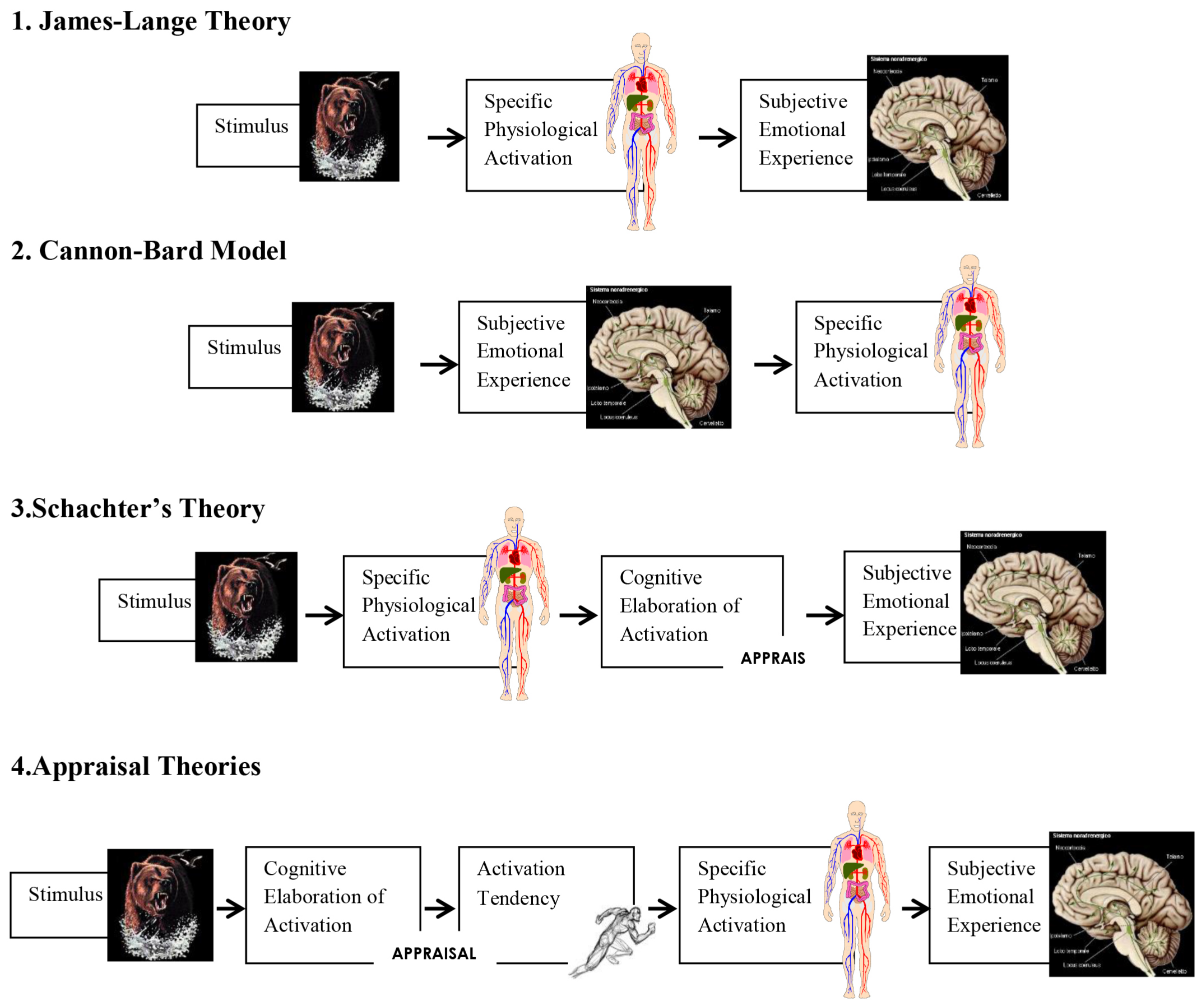


Figure 1.2 Illustration of different emotion causation theories and their main components. In the James-Lange theory **(1)**, the quality of the emotion is determined by the patterns of physiological activation; no cognitive process is taken into account. In contrast, in the Cannon-Bard model **(2)** the order of the emotional process is inverted: the conscious emotional experience is antecedent to the physiological activation (arousal). The third model, Schachter's theory **(3)**, similar to the first one, argues that the physiological activation pattern (arousal) is subsequently evaluated by the conscious cognitive process (appraisal); the cognitive process cannot determinate which stimuli elicit arousal but can give an interpretation to this arousal (appraisal). In the last theory, Appraisal theories **(4)**, the cognitive process is placed at the onset of the emotional experience. An unconscious appraisal process seems to determinate a threshold; if the stimulus exceeds this threshold it leads to emotion activations, if it stays below the threshold no emotions are activated. This process, together with the motivational component (action tendency), can improve the emotion manifestation toward the physiological activation (arousal) that leads to the emotional experience and then to the behavioural occurrence.

1.4 Emotional networks in the brain: The affective brain

Over the last century, the understanding of the brain mechanisms underlying emotions has radically changed (Ledoux, 2012; James, 1884; Cannon, 1939). For a long time, the limbic system was considered to be the centre of emotion codification (LeDoux, 1992). The limbic system, named by McLean (1952), included amygdala, septal nuclei, orbitofrontal cortex, parts of the basal ganglia, and the so-called 'Papez circuit' (Papez, 1937). In particular, the 'Papez circuit' referred to pathways between midbrain areas, such as the hypothalamus, the anterior thalamus, the cingulate gyrus, and the hippocampus.

However, some studies have suggested that referring to the 'limbic system' as the only emotional brain centre leads to limitations and imprecisions, on both a structural and a functional level. Several works have tried to define the limbic system more precisely (Squire & Zola, 1996; Cohen & Eichenbaum, 1993), although the debate about which brain areas are part of the limbic system is still open (LeDoux, 2012).

Nevertheless, one area of the limbic system that has been implicated in emotional response by several studies is the amygdala (Damasio, 1994). The amygdala seems to have a central function in the emotional processing. Interestingly, LeDoux (1992) argued that the limbic system hypothesis has been evaluated for so long only thanks to the inclusion of the amygdala in the system. In the next paragraph (1.4.1) the function of the amygdala in processing of emotions will be discussed.

Recently, the role of the brain areas constituting the limbic system in processing the emotional experience has been tested using functional neuroimaging techniques (i.e., positron emission tomography [PET] and functional magnetic resonance imaging [fMRI]) (Phan, Wager, Taylor, & Liberzon, 2002). Thanks to these innovative technologies, recent research indicated that different brain circuits control different aspects of emotion. Phan and collegues

(2002) reviewed 55 PET and fMRI studies in healthy individuals. Their review suggests that separate brain regions are involved in different aspects of emotions. However, the validity of Phan and colleagues' meta-analysis has to some extent limited by the large heterogeneity of the included studies. Specifically, the included studies greatly differ in terms of study design, analysis types and, more importantly, imaging methodology; it should be noted that this is a general problem that applies to most meta-analyses. Furthermore, unfortunately, many brain areas involved in emotions are involved also in a wide range of other functions (Lane & Nadel, 2002). The involvement of brain areas of emotions in some other basic functions makes it difficult to link specific emotions to specific brain regions.

The non-integration of studies in the field of neuroscience and psychology shows a need to investigate emotions from a combined perspective. Therefore, a better integration of studies on emotion and studies on cognition is needed, with the aim to fully understand the 'affective brain'. As suggested by LeDoux (2000), this integration does not simply correspond to a link between research on the limbic system and research on the cortex, but a real integration between different knowledge.

Emotional processes involve conscious and unconscious processes. Nowadays, brain research in the neuroimaging field seems to provide a marked distinction between cognition and unconscious primary process of emotions (Panksepp, 2007): The Prefrontal Cortex (PFC) can be defined as the 'rational' brain centre of emotional responses (experience of secondary emotions under cognitive control, Damasio, 1994), as opposed to the 'irrational' emotional regulation centre, the Amygdala (mainly related to primary emotion experience, Damasio, 1994). The following paragraphs discuss the role of PFC and Amygdala in human emotional responses, taking always in consideration the main limitations on the neural emotion circuits' knowledge provided above.

1.4.1 Amygdala and Prefrontal Cortex

Investigating behavioural dysfunctions in primates, Klüver and Bucy (1937) were the first to implicate the amygdala in emotion processing. Specifically, damage to the primates' temporal lobe provoked behavioural changes (i.e., fear lose, feeding with unusual substances like rocks)—a condition coined the Klüver-Bucy syndrome. Later, Weiskrantz (1956) proposed that the amygdala lesions in that syndrome might cause abnormal detection of both internal and external stimuli.

This and following studies established that the amygdala has a fundamental function in emotional processes; each nucleus of amygdala has a different function (Etkin, Egner, & Kalisch, 2011). In particular, the amygdala has a primary role in the assignment of affective meaning to sensory events (Emery & Amaral, 2000).

However, the majority of experimental studies in this area have used animals or lesioned patients, and placed a particular interest on the basic neural circuit of fear responses. These studies on the neural pathways involved in fear processing/conditioning (for a review see LeDoux, 2000) gave information about the function of the amygdala's different sub-regions (Young, Scannell, Burns, & Blakemore, 1994).

In the 1996, LeDoux introduced the theory of the two pathways (i.e., "high road" and "low road") to processing the emotion of fear. This conceptualization of the two-level road for the codification of fear stimuli is fundamental to understand the mechanisms of emotional processing in general. In this view, the emotional stimulus is processed by the sensory thalamus and/or the sensory cortex; the amygdala receives inputs from two different sensory processing regions—the thalamus and the cortex. The "low road" involves mostly unconscious, conditioned and unconditioned stimuli that evoke direct response, while the "high road" involves conscious processing of stimuli and all its contextual associations.

Specifically, the "low road" of emotional stimulus processing through thalamic paths is rapid but transfers only raw representations. Instead, the "high road" of the cortical paths is slower but more accurate. The subcortical way permits to codify stimuli in the environment quickly; the authors suggested that this path can prime the amygdala to following information from the cortex. Interestingly, both pathways (i.e., "high and low roads") may process emotional stimuli unconsciously. Indeed, as de Gelder (2006) hypothesised, the amygdala may have a double role: a primary role in the subcortical structures' network and a secondary role in a network of cortical structures.

Recently, Pessoa and Adolphs (2011) proposed a multi-level processing pathway that transmits emotional stimulus information toward the whole brain's areas, rather than a dichotomy between 'low road' versus 'high road' (de Gelder, van Honk & Tamietto, 2011). The evidences reviewed in the paper of Pessoa and Adolphs (2011) suggested the idea that emotional-relevant stimuli should not be understood in terms of "low road" vs. "high road" but in terms of "multiple roads" that lead to expression of the consequent actions and behaviours. This new perspective could be an interesting starting point for future investigations.

Evidence of the involvement of the amygdala in aversive stimulus processing has been provided mostly through animals studies (Phan et al., 2002). However, some studies have also investigated positive emotions in animals (Baxter & Murray, 2002) and in humans (Anderson et al., 2003).

Furthermore, it seems that the amygdala is involved in the vigilance mechanisms, for both negative and positive emotional stimuli (Hamann, Ely, Hoffman, & Kilts, 2002). From an evolutionary perspective, emotions can be grouped into negative and positive emotions \ to form the basis of the motivational approach–avoidance system—a system present in both humans and animals (Cacioppo et al., 1999). Interestingly, the amygdala has been proposed to mediate emotional influences of some social and cognitive functions (e.g., social norms, attention and memory) on the processing of emotions; this topic will be discussed in the second chapter.

The PFC seems to have a role in the regulation of both bottom-up and top-down systems (e.g., appraisal and regulation of affective state). Neuroimaging studies have found that the cognitive control of emotional stimuli corresponds to an increase of the activity in prefrontal brain areas, together with a deactivation of the amygdala. Furthermore, a literature review (Ochsner et al., 2004) suggests that the PFC is primarily involved in the cognitive regulation of negative emotions, governing the up-down regulatory system; nevertheless, other studies showed that both regulation systems (i.e., bottom-up and top-down) are controlled by PFC (Ochsner & Gross, 2005).

In summary, for some authors the main difference and relation between the PFC and the amygdala activation is the level of consciousness in the processing of external stimuli: PFC is mainly activated during conscious processing of those stimuli, while amygdala is mainly activated when those stimuli are not consciously perceived (Ledoux & Phelps, 2011). However, a network of interconnected brain areas seems to be a better approach to investigate emotion processing in humans (Pessoa & Adolphs; 2011).

1.5 Emotions measurement

According to the multitude of emotion definitions, several means to measure human emotions can be employed too, which allow analysing the primary components of emotions. These components are: subjective perception (i.e., self-report effectiveness), a behavioural/cognitive component and a neurophysiological dimension (Larsen & Prizimic-

Larsen, 2006; Frijda, 1986). Methods used to measure emotional responses are presented reflecting the model suggested by Mauss and Robinson (2009).

1.5.1 Self-report

The subjective experience measure represents, basically, the feeling that could be primarily reported in the first place by people (Barrett, Mesquita, Ochsner, & Gross, 2007). When people explicitly evaluate their emotions, they appraise the meaning of their feeling in a conscious and deliberate way and verbalize their response. Explicit evaluation of emotions allows people to label their emotions and to express/report current or past emotions, so that they can explain their emotions and share them with other people. However, many researchers argue that emotions cannot be completely described and understood by relying only upon subjective reports (Fox, 2008). The validity of self-report measurements is arguable; it seems to be more accurate for current emotional experiences (e.g., 'online' emotion reports, Mauss & Robinson, 2009) than for experiences somewhat distant in time. In addition, cognitive biases such as social desirability can influence participants' awareness of and capability / willingness to report negative emotional states (Welte & Russell, 1993). There are also still concerns that individuals high in alexithymia may be unable to conceptualize their emotional experiences and may give less valid reports of these (Lane, Ahern, Schwartz & Kaszniak, 1997). Generally, by using self-report methods it is possible to find in cultural differences (emotion ideologies, knowledge, vocabularies, feeling and displaying rules; Stearns & Parrot, 2012).

In the following, a list of some common instruments to reveal felt emotions and feeling states are mentioned: *Beck Depression Inventory* (BDI, Beck, Ward, & Mendelson, 1961), the *Beck Anxiety Inventory* (BAI, Beck, 1988), the *Spielberger Trait-State Inventory* (STAI, Spielberger et al., 1983), the *Profile of Mood States Questionnaire* (POMS, McNair, Lorr, & Droppleman, 1992), the *Positive and Negative Affect Scales* (PANS, Watson, Clark & Telligent, 1988), the *Multiple Affect Adjective Checklist* (MAACL, Zuckerman & Lublin, 1965), the *Self-Assessment Manikin* (SAM, Bradley & Lang, 1994), implicit tests of emotions measurements and evaluation of ideographs (Murphy & Zajonc, 1993).

1.5.2 Behavioural/cognitive measurements

One component of emotions on which most emotion investigators agree is that, in an emotional stimulation/episode/situation, the body acts. It therefore should be possible to infer the emotional state of a person from vocal (Planalp, 1998), facial (Ekman et al., 1972) and whole-body expressions (Tracy & Matsumoto, 2008). Emotions can be also interpreted as a primary motivation to act, like the primordial and primed tendency to approach or avoid the stimulus eliciting the emotional reaction (i.e., 'fight or flight', Frijda, 1986; Lang et al., 1997). From this perspective, we can easily argue that emotions could trigger directly-observable behaviour. Similar to self-reports, such behavioural measurement may be biased by culture, gender differences, personality traits, and the unclear causational link between emotional elicitation and bodily reactions.

Some behavioural tasks used to investigate internal cognitive processes in emotion research are (Fox, 2008): the emotional Stroop task (for a review, see Williams, Mathews, & MacLeod, 1996), visual search/attentional cueing paradigms (Compton, 2003; Phelps, Ling & Carrasco, 2006), dot-probe (Mather & Carstensen, 2003), and simple recall and recognition memory/implicit memory tasks (Charles, Mather, & Carstensen, 2003).

Recently, a new software called FaceReader (©Noldus Information Technology, 2014) has been developed to automatically analyse the complete spectrum of human facial expressions. This system is based on the Facial Action Coding System (Ekman & Friesen, 1978) and is able to detect the six basic emotions proposed by Ekman (1992).

1.5.3 Physiological measurements (biomarkers)

The central neural system (CNS) is constantly checking our internal environment (internal body activity, interoceptive perception) and external environment (sensory activity, exteroceptive perception) to keep homeostatic balance. In contrast, the autonomic nervous system (ANS) is the physiological system responsible for modulating peripheral functions (Mauss & Robinson, 2009) and for reacting to emotional stimulation with physiological responses. It is composed by the sympathetic and the parasympathetic systems; they regulate body activity under arousal ('fight' or 'flight'; Damasio, 1994) and rest (restoring 'homeostatic' balance, Bradley & Lang, 1994) conditions, respectively examples of these different activities are shown in Table 1.2.

The most common biomarker indices assessing ANS activation are focused on electrodermal or cardiovascular responses. Common techniques for measuring physiological response in emotion science are: skin conductance level (SCL), heart rate (HR), cardiac output (CO), heart rate variability (HRV), blood pressure (BP), total peripheral resistance (TPR), cortisol level, electromyography (EMG), and respiration rate (RR). However, these types of indices may reflect other body activities not related to emotional reactions. Indeed, the physiological measures have limits due to the nature of the nervous system that can react to emotional events but also to visceral events, and also to noise in signal registration.

Among the various instruments that are available to reveal the electrodermal activity, one source of detailed information regarding neural activity is the measure of the electrophysiological signals on the scalp, thus allowing recording directly of the central nervous system activity (Mauss & Robison, 2009).

Sympathetic ANS responses (dominant during arousal):	Parasympathetic ANS responses (dominant during rest):
- pupil dilatation	- pupil constriction
- inhibition of saliva production	- flow of saliva stimulation
- acceleration of the heart rate	- heart rate slowing
- bronchial tube dilation	- bronchial tube constriction
- digestion inhibition	- digestion stimulation
-adrenaline and noradrenaline release	--
- increased conversion of glycogen into bile	- stimulation of bile release
- bladder contraction inhibition	- bladder contracted stimulation

Table 1.2 A summery of ANS emotional responses divided into sympathetic and parasympathetic system responses (adapted to Fox, 2008).

On one side, the instruments to measure the ANS activity are not only focused on electrodermal or cardiovascular responses, rapid eye closure for example it is another relevant tool. The rapid eye closure is one of the most reliable components of the emotional cascade reaction that constitutes the Startle Reflex. In the past, this reflex was measured by placing electrodes below the eyelid. Today, thanks to the arrival of non-invasive technology, eye-tracking systems (De Lemos, Sadeghnia, Ólafsdóttir & Jensen, 2008) the lid closure can be measured unobtrusively. In addition, eye-tracking system can detect also pupil dilation, which can be used as a measure of physiological arousal. Besides eye movement tracking, this method may also register fixation points; these data allow for inferring immediate unconscious and uncontrollable emotional responses before they are cognitively perceived, interpreted, and biased by higher-order processes.

On the other side, common neurophysiological tools to measure central system activity (Mauss & Robison, 2009) can be divided into: 1) electrophysiological approaches, such as electroencephalogram (EEG) (Ahern & Schwartz, 1985); 2) event-related potentials (ERP) (Vanderploeg, Brown & Marsh, 1987); 3) magnetoencephalogram (MEG) (Peyk, Schupp, Elbert & Junghöfer, 2008); and 4) neuroimaging methods (Panksepp, 1998) like PET and fMRI (for a review on the functional neuroanatomy of emotion, see Phan et al., 2002).

1.6 Conclusion and discussion

In order to reduce the complexity around the emotion concept, the main issues concerning this concept have been discussed in the present chapter. Specifically, in the light of the many controversies surrounding the study of emotion, the aim of the current chapter was to establish a sound conceptual basis of emotions.

While many studies have attempted to categorize and investigate different subtypes of emotions (e.g., fear, anger, and disgust), a more general vision of emotion has not been investigated so exhaustively (i.e., emotion in general without a specification of which subtype). As a short cut to this problem some of the studies in that area have approached the investigation of emotions in strictly behavioural, physiological, or cognitive terms. From this literature review emerges only limited unanimity in the 'science of emotion'; however, one aspect of emotion seems to be accepted by all accounts of emotion—this regulatory function of emotions. As already suggested by Darwin (1872), emotions play a fundamental role in adaptive processes, and this adaptive purpose permits interaction between humans and the surrounding environment. Later, Lang argued that in particular basic emotions serve to perform this function (Finger, 1994). Depending on the theoretical perspective, action is mainly considered as either an adaptive consequence (i.e., output) of or cause (i.e., trigger) of emotional events. For instance, Lang's (1979) bio-informational theory emphasises the importance of action units, which code associated behaviours (i.e., running) and relevant autonomic support (i.e., heart rate acceleration). Indeed, emotional reactions in humans often primarily involve a disposition or preparation to action, instead of a clear overt expression of that action (Frijda, 1986; Lang, 1995).

Moreover, as discussed in the second paragraph (1.2), the conceptualization of the two motivational systems (appetitive vs. defensive) perfectly matches this primarily adaptive role of emotions in humans, and may lead to a general and common definition of emotions in the future. Consistently, previous research has shown that variance in emotional meaning/labelling is mainly due to those two principal emotional dimensions (pleasure and arousal), which are naturally a simply reflection of motivation (Mehrabian & Russell, 1974).

In the present work, emotion is seen as a process in which the activation of one of its components (i.e., physiological arousal, conscious/unconscious appraisal, action tendency and behavioural occurrence) causes the change and the stimulation of subsequent components. Indeed, from this perspective emotion is a multi-components phenomenon; despite of this, in literature for example there is still no one-to-one relationship between emotions and changes in ANS. Apparently, to generalise and label emotion categories in function of ANS changes, a 'modal emotions' (Scherer, 2005) or 'emotions families' (Ekman, 1999) conceptualization can be used as more general concept, like an umbrella concept. Such concepts may help to group subtypes of emotions in function of their main differences in appraisal outcomes (Kreibig, 2010). Nevertheless, in empirical emotion induction, the selection of adequate ANS reactions measures is even more fundamental than the employed emotion definitions in order to identify emotion-specific ANS activation (Kreibig, 2010).

The literature on emotion causation theories reviewed in the third paragraph (1.3) highlighted agreement with the neo-Jamesian view: Our emotional experience is constructed by interoceptive information and proprioceptive information that becomes available when emotions produce changes in ANC activity (Levenson, 2011). However, this theory still does not account properly for the cognitive component of emotion. The starting point of the cognitive process is a basic part in the determination of the emotional experience. Thus, identifying the moment in which the cognitive process starts is important to select the appropriate measurement method. Road supremacy (i.e., high road vs. low road) was not considered in the present work, and no arguments in favour of a subcorticocentric view or a corticocentric view of emotional processing were discussed (Pessoa & Adolphs, 2011). Stating the predominance of either the PFC (the 'rational brain'), or the amygdala ('the irrational brain'), would lead to a stance on the supremacy of cognition or of instinct. This statement can be done only considering the contextual condition in which the emotion is trigged and the type of trigger. In the present chapter the multi-level processing pathway of emotions is corroborated. The vision of a multi-level processing pathway of emotions (Pessoa & Adolphs, 2011) accounts for the potential parallel activation of both part of the brain ('rational' vs. 'irrational') and the predominance of one of each in function of the contextual factors.

To fully understand the psychophysiology of emotion, the context of the emotional induction and the stimulus types must be specified; this is obviously simplified under laboratory conditions. Indeed, in the laboratory condition all the variables that may influence the emotion experience are potentially controlled. The most common emotion induction paradigms in psychophysiological studies will be discussed and presented in Chapter 2.

Generally, every theoretical perspective or instrument adopted to measure emotions may change completely the interpretation given to the emotion itself. For example, the self-report measures of emotions are totally based on the introspective evaluation of people feelings. The most common self-report questionnaires in emotion research have been developed in clinical psychology. This shows how defining and describing emotions is paramount in that area to outline pathological disorders. If on one side, a self-report questionnaire gives very detailed information about the effective state of a subjective experience; on the other side, unfortunately this instrument is unable to identify and generalise such a complex construct as emotion is. Thus, the used of this kind of self-report instruments can have limitations. In fact, one of the most important limitation is the incapacity of humans to faithfully report their emotional states (Zillmann, 1978; Kreibig, 2010). To simplify this complex reality, it has been suggested to look at the emotion in terms of dimensions (i.e., pleasant/unpleasant vs. high arousal/low arousal), referring to the simplified view of the circumplex model, basically focusing only at the extremes of each axis that could synthesise biphasic and discrete views. For instance, the SAM test (Bradley & Lang, 1994) allows for overcoming all linguistic/cultural biases produced by self-report methods but at the same time, simplifies all information about emotional term shades.

Moreover, to simplify and to reduce the complexity of the emotions' stimulation using different sensory modalities, several self-report scales have been created *ad hoc* for each sense (i.e., the Geneva Emotional Music Scales, Zentner, Grandjean, & Scherer, 2008; the Geneva Emotion and Odour Scale; Chrea, et al., 2009). These scales are used to more accurately measure the effects of sensory stimulation on emotions but they have the same limitation of the other common self-report questionnaires.

What does the term "emotion" mean? How can emotions be categorized? Those questions surrounding the definition and categorization of emotions are still unresolved—a unique answer is still lacking. Self-report and physiological measurements could give the general idea of activation and valence of the emotional episode.

Nevertheless, the only way to delineate a precise schema of emotional activation in humans appears to be a combined use of more recent neurophysiological approaches and self-report and behavioural measurements. Such a schema may define at least the basic emotions, from both a neurological and a behavioural perspective. However, an important issue that has not received any attention in the literature is whether specific receptors of emotions can be identified in the human body. Particularly, pain and pleasure can be conceptualised as the extremes of a continuum defining the emotional experience. While pain receptors have been extensively investigated in previous research (e.g., see Hagelberg et al., 2004, for a review; Woolf, 2011), to the best of our knowledge, research has not been conducted on pleasure receptors (see Gallace & Spence, 2014; Kringelbach, & Berridge, 2009). Interestingly, neuroimaging studies have shown that positive and negative emotions can share networks of activation in the human brain, the amygdala appears to be involved in both these antipodes emotions (Hamann et al., 2002).

In conclusion, despite the enormous literature on the topic of emotion, the gap between knowledge from the methodologies of investigation of Social Science and Neuroscience still stifles the enormous potential of an integrated, multidisciplinary research on emotions.

CHAPTER 2 − Emotions and Consumer Behaviour

2.1 Preface

Since the dawn of the western philosophy, Greek philosophers have tried to explain not only emotions but also the intricate relation between emotions and cognition. Aristotle, for example, claimed that cognition is a structural part of emotion, whereas the extreme fringes of the Aristotelian interpreters suggested that emotions are an integral part of adaptive cognitive processing (Ogren, 2004; Sadler, 2007). Currently, this intricate relation still remains an engaging issue for scientists; in fact the number of studies on this topic is constantly increasing (Angie, Connelly, Waples, & Kligyte, 2011; Isen, 2000, 2001). Nowadays, the role of emotions in cognitive processes is widely accepted but it is still unclear whether this influence is disruptive or facilitative (Miller, Galanter & Pribram, 1960; Grecucci & Sanfey, 2013; Sanfey, 2007). Indeed, how cognition, which is usually associated with "rationality", can interact with emotions and influence behaviour is not completely understood.

The purpose of this chapter is to describe the role of emotions in decision-making processes related to consumer behaviour, highlighting the role of olfactory influences on them. The literature on emotions and decision-making in consumer behaviour is vast (cf., Han, Lerner, & Keltner, 2007; Shiv, & Fedorikhin, 1999). However, theoretical framework applied to the study of emotions in consumers is variegated and frequently based only on field studies. Moreover, laboratory studies have mainly focused on visual and auditory stimulation to elicit emotions and even few studies investigated the interactions among senses and emotions. With the aim to shed light on this topic, in this chapter, first a critical review of the most commonly used methods to elicit emotions in laboratory is presented. Thereafter, the relation between olfaction and emotion is discussed. In particular, the olfactory system, the common neural networks between emotions and olfaction, the issues concerning the complexity of olfactory stimuli (i.e., odorants), and the issues related with the administration of those stimuli will be synthetically presented.

2.2 The role of emotions in decision-making and consumer behaviour

Since the beginning of the nineteenth century, the consumer has been considered to be a rational decision-maker, a "logical thinker" or "homo economicus", attempting to maximize utility (Lebergott, 1993). However, it has become evident over the years that, in many contexts and in particular when emotions are involved, humans appear to be "irrational", since they violate the assumptions that underlie the model of the homo economicus. Consequently, this early concept of a rational consumer gave way to new theorizations of consumers, singling out for the first time the concept of "bounded rationality" (Simon, 1972; 1986) to account to consumer choices. In fact, humans have limited computational/cognitive ability; therefore, in the decision-making process, consumers are often unable to evaluate and consider all the information at their disposal, and thus to act in a controlled rational way. In this new perspective of the consumers' bounded rationality, the affective\emotional side of decision-making starts to receive more attention. Hence, the theoretical framework of consumer behaviour is currently focused on the "experiential view" of consumption, developed within the classic "human information processing" approach that, however, has been also widely criticized (Bettman, 1979). In this line, recent work provided both theoretical and empirical accounts about how affect influences consume choices (Shiv & Fedorikhin, 1999). For instance, Holbrook and Hirschman (1982) suggested, for the first time, the importance of this "experiential view". The experiential aspects of consumption are crucial in the attempt to predict consumer behaviour, since they focus on the symbolic, hedonic, and aesthetic nature of consumption (Pine & Gilmore, 1999, 2004; Schmitt, 2006;). Indeed, the "experiential view" is based on the paramount importance of emotions in consumer behaviour and consequently the role played by ambient variables acquired importance as well.

As already discussed in Chapter 1, emotions drive humans' behaviour. Clearly, consumption is part of humans' behaviour. Figure 2.1 schematically depicts the model of consumer behaviour introduced by Chaudhuri (2006). This model is based on a simplification of factors that intervene in consumer decision-making, distinguishing between individual (i.e., personal) variables and contextual external (i.e., environmental) variables. Interestingly, this model positioned emotional and rational responses toward a stimulus (e.g., a product) at the same level. In fact, decision-making is frequently determined by an interaction between rational and emotional factors. Since the traditional models that were developed to explain behaviour (Ajzen, 1991; Fishbein & Ajzen, 1975) clearly showed that the best predictor of behaviour is the intention to act, it was added to the model proposed by Chaudhuri (2006) to fully explain consumer behaviour.

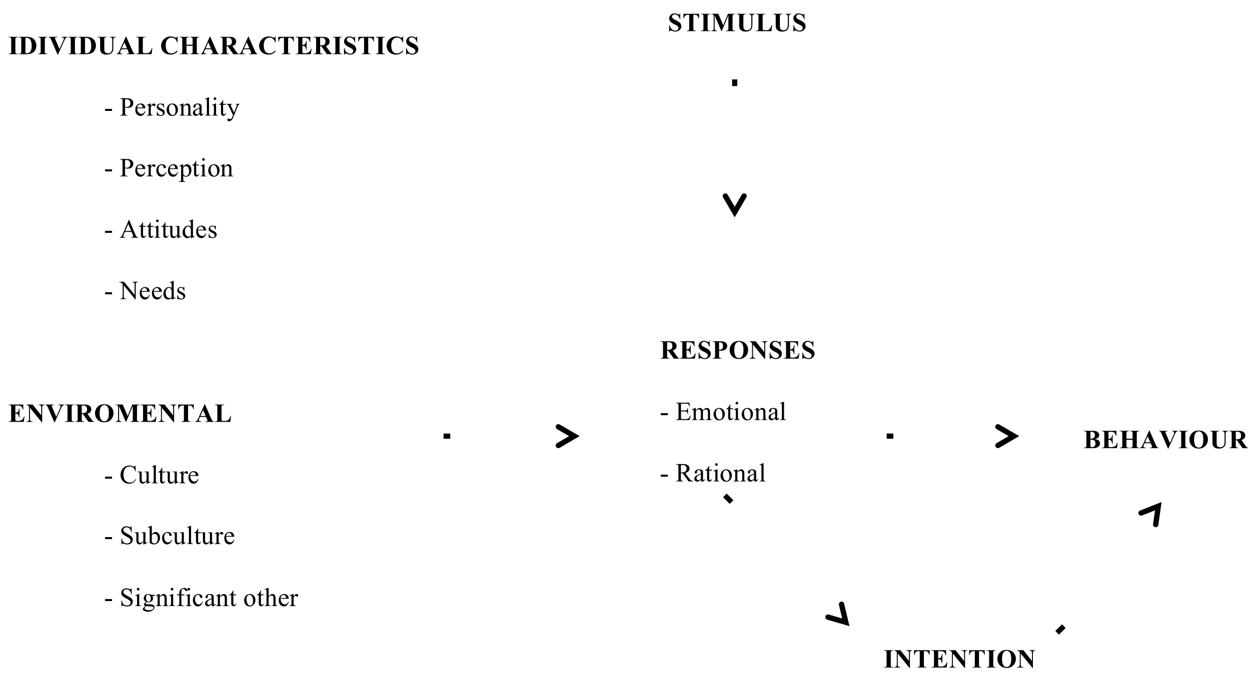


Figure 2.1 Model of factors intervening in consumer behaviour prediction (adapted from Chaudhuri 2006, p. 2 with the addition of "intention").

Another interesting perspective highlighting the importance of the interaction between emotions and reasoning in the decision-making process was suggested by Kahneman (2003). Kahneman distinguished between "effortless intuition" and "deliberative rationality". On one side, the "effortless intuition" is represented by highly accessible concepts related with the context (e.g., information coming from perception), which helps to explain some of the heuristic processes he described (Kahneman, 2003) and the effects they produce (e.g., the framing effect). This intuitive judgment frequently leads to biased choices. On the other side, "deliberative rationality" is represented by high-level cognitive processes of reasoning that operates on less-immediately accessible concepts (e.g., evaluation of alternative information or application of rules). In the "effortless intuition" concept more than in the "deliberative rationality", emotions can frequently influence and promote/impair decision-making (Dommermuch & Millard, 1967; Isen, Shalker, Clark, & Karp, 1978; Donovan & Rossiter, 1982). However, those two concepts (i.e., intuition and rationality) can interact and act in synergy to help the decision-making process.

The literature on emotions and decision-making in consumer behaviour is vast (cf., Han et al., 2007; Shiv, & Fedorikhin, 1999) and frequently it focuses on specific behaviours, such as decision under risk (e.g., monetary risk) (Lerner, & Keltner, 2001). In the present paragraph, the role of emotions in decision-making and behaviour will be sketched out in general terms, without focusing on a particular process or behaviour nor on a specific emotion.

Recently, an increasing number of studies have investigated the decision-making process, with an emphasis on the impact of emotions from a neuroscience perspective (Sanfey, 2007). Emotions can influence human goals, attitudes, and social decision-making (Forgas, 2003; Zajonc, 2000). The limbic system is connected with the prefrontal cortex (PFC) (see Chapter 1, paragraph 1.4) by the cingulate cortex. It has been stated that this connection between limbic system and PFC allows for encoding the somatic markers of the automatic nervous system associated with emotions and, in parallel, for integrating those emotional responses into cognition in decision-making (Bechara, Damasio, & Damasio, 2000). However, even with the employment of advanced neuroimaging techniques, the difficulty in isolating the neural substrates related with emotional reactions from the neural substrates related with decision-making is still problematic. This complexity gives more credit to the high interconnection between emotions and decision-making from a neural activation perspective (Phan et al., 2002).

The function of emotions in decision-making has been explained not only from a neuroscience perspective but also through a cognitive perspective, including, for example, the above-mentioned somatic marker theory proposed by Damasio (Damasio, 1994; Reimann &

Bechara, 2010). So-called "somatic markers" (i.e., automatic physiological responses to emotional stimuli) stimulate cognitive processes and prompt decisions. This theory describes how the information coming from the somatic markers plays a role in the determination of cognitive processes and behaviour. Interestingly, these somatic markers can bias behaviour even unconsciously (Damasio, 1994; Damasio, Everitt, & Bishop, 1996). The somatic markers theory clearly represents an effort to integrate neurophysiological knowledge and cognitive/behavioural knowledge.

Generally, marketers and psychologists have long known that consumers behave differently in good moods in comparison to bad moods; the main dimension of emotions that affect judgment seems to be, in fact, the valence (i.e., positive vs. negative emotions) rather than the specific emotion (e.g., fear, happiness, sadness, etc.) (Han et al., 2007). A recent work by Han, Lerner, and Keltner (2007) presented a new emotional framework (Appraisal-Tendency) as a starting point to predict the impact of different emotions on consumer choices. In particular, this framework is based on appraisal dimensions, and not only on the valence dimension, of emotions and distinguishes two emotional influences on choice: (1) integral emotion, that is emotions raising directly and intrinsically from the judgement or the decision processes, for example the fear or anticipatory regret in gambling task that influences the willingness to gamble (see Loewenstein & Lerner, 2003 for an example); (2) incidental emotion, that is emotions raising from external and irrelevant to the task variables, such as, for example, listening to music while making a judgment. The emotions elicited by music and unrelated to judgments, nevertheless have an influence on it (see Schwarz & Clore, 1983 for an example). The suggested distinction between these two type of emotion effects on choices is comparable to the distinction made by Berkowitz (1993) between lower-order emotional reactions, raising from automatic and spontaneous processes (e.g., external stimuli like music), and high-order emotional reactions, raising from reasoned and more high-level cognitive processes (e.g., conscious thinking) and they have different influences on choices (Shiv & Fedorikhin, 1999). As discussed above, processing resources are limited, so spontaneously-evoked emotions rather than cognitively-evoked emotions tend to have a greater impact on choices.

In the present thesis, only these incidental emotions or lower-order emotional reactions are considered as factor promoting and influencing consumer behaviour. In particular, impulse buying of food products (see Chapter, 3) will be investigated as an instance of consumer behaviour. For example, it has been shown that, when this type of emotions comes into play, consumers are more likely to choose the alternative that is superior on the emotional dimensions directly related with a product of the store (e.g., ambient variables in the store such as music or smell) (Shiv & Fedorikhin, 1999).

2.3 Emotion elicitation methods in laboratory conditions

Emotions can be evoked by a large variety of stimuli. Consequently, a considerable number of strategies for eliciting emotions have been developed. Indeed, emotions can arise through a variety of modalities, though the present thesis agrees the perspective that all sensory domains are equally effective, with no predominance of any single sense (Coan & Allen, 2007).

The concept of emotions elicitation can be discussed from different perspectives. For example, focusing on the type of emotions that would be evoked (e.g., happiness, sadness, fear, angriness, etc.), or focusing on the type of stimulus (e.g., sensory vs. memories). However, in the present work, only methods to elicit emotions in laboratory settings are discussed. Considering laboratory conditions, the most common emotion elicitation methods can be divided into two main categories: (1) perception-based or passive methods and (2) expression-based or active methods (Kory & D'Mello, 2014). Passive methods are constituted by the presentation of external stimuli (e.g., images, film clips, music, putting a hand in ice-cold water, etc.) to participants; those external stimuli are specifically designed to evoke particular emotional states or moods. In contrast, in the context of active methods participants are instructed to interact with other people in order to recall emotionally relevant private episodes (e.g., the loss of a beloved person, scary or anxiety-inducing situations, etc.), or to perform particular behaviours that are spontaneously related to specific emotions (e.g., body postures, using certain facial muscles, etc.).

In the present thesis, attention is focused exclusively on discussing the passive methods due to the fact that passive methods are more adequate in the field of consumer behaviour research. In fact, those methods allow for perfectly controlling the administration of the stimuli in addition to be more similar to what can happen in a real situation of consumption (e.g., think about the environment in a point of purchase). In particular, the great variety of laboratory contexts in which emotions can be induced (Lacey, 1967) are investigated only in terms of olfactory stimuli (e.g., food-related smells), auditory stimuli (e.g., arousing and relaxing music) and affective images (e.g., pictures with different contents of valence; see Chapters 3 and 4).

The most common paradigms used to induce emotional reactions in psychophysiological studies have involved perception, anticipation, imagination, or action (not necessarily in a mutually exclusive way; see Bradley & Lang, 2000, p. 583). Paradigms involving perception and anticipation belong to the category of passive methods, whereas imagination and action are part of the active methods. With regard to the passive methods, perception-related elicitation refers primarily to affective responses triggered by sensory information (i.e., vision, audition, olfaction, touch and taste) that is presented to participants.

Anticipation-related elicitation refers to the emotional reactions that are elicited during an interval (anticipatory cue) in which participants are waiting for the presentation of an affective target stimulus (e.g., lights or pictures or cued rewards or gambling tasks). Those anticipatory cues have a critical role in modulating conditioning effects (Stern, 1972) (e.g., by increasing attention toward affective target stimulus) and the specificity of the anticipation can directly affect the anticipatory reactions. Indeed the anticipatory cue can be related/specific or non-related/non-specific to the upcoming affective stimulus.

With regard to the active methods, imagery-related elicitation refers to the mental retrieval or the mental creation of emotional events. Those events can be either completely fictional (i.e., they have not been experienced by the participants in real life) or non-fictional (i.e., they have been personally experienced by the participants). Previous research suggests that imaginary cues (Jones & Johnson, 1978) produce stronger physiological responses in participants than exposure to passive scenes (Miller et al., 1987; Lang et al., 1980). Not surprisingly, participants typically exhibit stronger physiological responses after retrieving events that they have personally experienced compared to when they imagine events that are not personally relevant (Miller et al., 1987).

Moreover, passive methods to elicit emotions could be used without the awareness of participants. In fact, it is important to mention that emotions can be elicited by subliminally presented stimuli that do not reach consciousness of the participants (Flykt, Esteves, & Öhman, 2007; Öhman, Carlsson, Lundqvist, & Ingvar, 2007; Wiens, Peira, Golkar, & Öhman, 2008).

Next, a review of the most commonly used typology of emotion induction methods is presented. This review is based on an extensive work done by Kreibig (2010) that reviewed 134 experimental studies on automatic nervous system responses to emotion elicitation. From this review and from other works on emotion elicitation (Coan & Allen, 2007; Martin, 1990; Kory, & D'Mello, 2014), it became clear that the passive method – perception- or anticipation-related elicitation – most commonly used for inducing emotions in the laboratory are: (1) emotional film clips (Adamson et al., 1972; Averill, 1968; Baldaro et al. 1996, 2001; Boiten, 1998; Rottenberg, Ray, & Gross, 2007; Britton et al., 2006; Christie & Friedman, 2004; Codispoti, Surcinelli, Baldaro, 2008; Demaree, Schmeichel, Robinson, & Everhart, 2004; Eisenberg et al., 1988; Fredrickson & Levenson, 1998; Gilissen et al., 2008; Gilissen et al., 2007; Gross, 1998; Gross, Fredrickson, & Levenson , 1994; Gross & Levenson, 1993, 1997; Gruber, Johnson, Oveis, & Keltner, 2008; Harrison et al., 2000; Hubert & de Jong-Meyer, 1990, 1991; Kaiser & Roessler, 1970; Kreibig, Wilhelm, Roth, & Gross, 2007; Kring & Gordon, 1998; Kring & Neale, 1996; Kunzmann & Grühn, 2005; Kunzmann, Kupperbusch, & Levenson, 2005; Luminet, Rimé, Bagby, & Taylor, 2004; Marsh, Beauchaine, & Williams, 2008; Montoya, Campos, & Schandry, 2005; Palomba et al., 2000; Palomba & Stegagno, 1993; Rimm-Kaufman & Kagan, 1996; Ritz, George, & Dahme, 2000; Ritz et al., 2005; Rohrmann & Hopp, 2008; Rottenberg, Salomon, Gross, & Gotlib, 2005; Rottenberg, Wilhelm, Gross, & Gotlib, 2003; Sternbach, 1962; Theall-Honey & Schmidt, 2006; Tourangeau & Ellsworth, 1979; Tsai, Levenson, & Carstensen, 2000; Tsai et al., 2003; Vianna & Tranel, 2006; Waldstein et al., 2000); (2) pictures viewing (Aue, Flykt, & Scherer, 2007; Lang & Bradley, 2007; Bernat, Patrick, Benning, & Telligent, 2006; Bradley et al., 2001; Codispoti & De Cesarei, 2000; Collet, Vernet-Maury, Delhomme, & Dittmar, 1997; Dimberg, 1986; Dimberg & Thunberg, 2007; Jönsson & Sonnby-Borgström, 2003; Klorman Weissberg, & Wiesenfeld, 1997; Lang, Bradley, & Cuthbert, 1993; Ritz, George, & Dahme, 2000; Ritz, Thöns, Fahrenkrug, & Dahme, 2005; Sokhadze, 2007; Vrana & Gross, 2004; Williams et al., 2005; Winton, Putnam, & Krauss, 1984); (3) odorants (Alaoui-Ismaïli et al.

1997a; Robin, Alaoui-Ismaïli, Dittmar, & Vernet-Maury, 1998); (4) music (Etzel et al., 2006; Khalfa et al., 2008; Krumhansl, 1997; Nyklicek, Thayer, & Van Doornen, 1997).

The use of passive methodologies to elicit emotions in laboratory settings allows for controlling many details about the stimulus, for example, the duration of the stimulus presentation, and the number of repetitions. For this reason, Rottenberg et al. (2007) suggested that procedures to induce emotions differ from each other in terms of seven key dimensions: (1) intensity (e.g., how strong and varied are the response strength and breadth); (2) complexity of the stimulus (e.g., film clips would be stimuli with high complexity); (3) attentional capture (e.g., masked or subliminal stimuli request limited demands from participants instead of complex stimuli such as film clips vision); (4) demand characteristics (e.g., pictures with erotic content differs from pictures with puppies); (5) standardization (e.g., the potential replication of the stimulus in the same manner by studies done by different experimenters or using various paradigms); (6) temporal consideration (e.g., emotions are rapid phenomenon but emotional reactions timing is highly correlated with stimulus type); (7) ecological validity (e.g., stimuli that can elicit emotions in everyday life).

For instance, the picture stimuli commonly used as emotional triggers were classified and standardized in the International Affective Pictures System (IAPS, Lang, Bradley, & Cuthbert, 2005). This large set of coloured pictures currently includes around 1000 prototypes of human experience that refer to pleasure, arousal, and dominance. The IAPS pictures were selected and standardized based on female and male ratings in different countries; each picture of the IAPS is numbered (using 4 digits) and catalogued according to the mean and standard deviation of the affective rating (i.e., valence, arousal, and dominance). Unfortunately, this classification and standardization process turns out to be different and often more complex in case of other sensory modalities. For instance, some studies have shown that, when using music as an emotional trigger (Scherer, et al., 2013; see Scherer & Zentner, 2001 for a review), certain structural properties of music can be regulated and controlled to elicit specific emotions (Gabrielsson & Lindström, 2010). For example, characteristics such as tempo can be varied to affect emotional valence and arousal response (Balch & Lewis, 1999; Gabrielsson & Lindström, 2001; Thompson & Robitaille, 1992). With the aim to create a set of affective stimuli comparable to the visual stimuli in the IAPS, emotion researchers have developed the International Affective Digitized Sound System (IADS) (Bradley, & Lang, 1999). This system provides a set of acoustic emotional stimuli for experimental studies and consists of 111 sounds varying along the affective dimensions of valence, arousal, and dominance. In the emotion literature, music has been generally assumed to convey emotional meaning (see Juslin & Laukka, 2003 or Juslin & Sloboda, 2010 for reviews). In an attempt to mirror the IADS, other studies have tried to classify and group music as a function of the emotion it primarily induces. A series of music features are manipulated with this aim: (1) the listening context (e.g., location), (2) the performing features (e.g., type of instrument, interpretation of the player, volume or pitch of the sound), (3) the listener features (e.g., expert or non-expert), and (4) the contextual features (e.g., aspects of performance) (Scherer et al., 2013). However, with olfactory stimuli the classification is more complex and the experimental control of affective olfactory stimuli is more difficult because of the more complex nature of odorants and odour perception. We are still far away from a classification or standardization of those types of stimuli (see section 2.4.3 for a detailed discussion).

2.4 The smell of emotions

Olfaction has been defined as the "poet" of sensory systems (Kay, 2011); it is much more than the simple detection of the stimulus in the surrounding ambient. Primarily, the detection of the chemicals present in the environment is a critical function for the survival of animals and humans. Secondly, odours can be viewed as a combination of chemical components (i.e., external molecular components) and internal learnt meaning associated to them. When it comes to olfaction, internal states can be defined as an activation pattern generated by the olfactory system due to contextual factors, internal predispositions, and learnt associations (e.g., food odour can generate hunger or nausea depending on whether people are satiated or whether people have associated this food smell with a bad event). Thus, the chemical molecules are only partially part of the stimulus. The olfactory system tends to complete the "sniffing process" by generating the appropriate associated internal components (Yeshurun & Sobel, 2010). In fact, even information evoked by the olfactory stimuli is more complex to elaborate in comparison with other information evoked by other sense. Recently, a study (Larsson, Willander, Karlsson, & Arshamian, 2014) has shown that personal information evoked by olfactory stimuli is different from information evoked by the primary senses (i.e., sight and hearing).

Interestingly, in many animals, besides the common olfactory system dedicated to discriminate odours, a second olfactory system has developed which is dedicated to find receptive mates, the so-called vomeronasal organ (VON). The VNO is an accessory olfactory system that is separated from the main olfactory epithelium (Firestein, 2001; Keller & Vosshall, 2008). This system is fundamental for recognising species-specific olfactory signals in order to regulate sexual behaviour (e.g., information about hormonal level, productivity state, and availability) and other social behaviours (e.g., territoriality and aggression). In parallel, in humans the VNO is vestigial in the embryonic phase and seems to disappear before birth. For this reason, although humans are lacking this accessory olfactory system, the sense of olfaction plays a main role in many humans' behaviours (see Meredith, 2001 for an extensive review). One of the evidences of this paradox is the influence of pheromones on human behaviour (Rodriguez, Greer, Mok, & Mombaerts, 2000). In fact, the encoding of pheromones is mainly correlated to the VNO (Knecht, et al*.,* 2003).

In general, discriminating between pleasant and unpleasant smells is of primary importance for humans and other mammals (Khan et al., 2007). Emotional responses are commonly associated with odour perception (Savic, 2005); indeed, olfaction has always been considered to be an important sensory system for emotions (Yeshurun & Sobel, 2010). The response to odorants seems to be primarily emotional (Chu & Downes 2002, Epple & Herz 1999, Herz, Eliassen, Beland, & Souza, 2004; Herz 2004, Herz & Cupchik, 1995, Herz & Schooler, 2002; Kirk-Smith et al., 1983). In fact, notice that odorants can both attract and repel. Pleasantness is the principal dimension in both emotion (Fontaine, Scherer, Roesch, & Ellsworth, 2007) and olfaction (Khan et al., 2007). Indeed, unpleasant odours often signal danger, thus requiring a rapid decision, while pleasant odours may differently attract our attention, therefore promoting an approach to the source of odours. In evolutionary terms, the capacity to move away from unpleasant odours and to move toward pleasant odours might also be crucial. This basic emotional response to odour can be easily compared to the two motivational systems of emotions (i.e., appetitive and defensive or "flight or fight", see chapter 1) (Bradley et al., 2001; Frijda, 1986; Lang et al., 1997). Emotional valence is crucial in the processing of smell; humans even involuntarily categorize odours according to pleasantness (Bensafi et al., 2002b, 2003).

Interestingly, odour is part of the sensory channels involved in human communication, with an importance similar to vision and audition (Haviland-Jones & Wilson, 2010; Yeshurun & Sobel, 2010). Odours are a communication tool and, at the same time, a device to elicit emotions. Even if humans are not aware of their own abilities in olfaction (Sela & Sobel, 2010; Lundström, Boyle, Zatorre, & Jones-Gotman, 2008), they indeed have an extraordinary sense of smell (Shepherd 2004; Zelano & Sobel, 2005). For instance, as body odours carry unique information about an individual, they represent the chemical basis of human communication (Lundström & Olsson, 2010; Pause, 2012) at the same level and importance of auditory or visual modalities (Semin, 2007). Chemical signals serve a variety of communicative functions (Semin & de Groot, 2013). Semiochemicals can influence emotional pre-attentive processes and affect emotions and high-level cognitive processes (Haviland-Jones & Wilson, 2010). Interestingly, people seem largely unaware that they themselves produce chemo-signals and that, at the same time, they are influenced by the chemo-signals produced by others. For instance, humans can detect the smell of fear in human sweat (Ackerl, Atzmueller, & Gramme, 2002; Chen & Haviland-Jones, 2000; de Groot, Semin, & Smeets, 2014), they select mates in function of body-odour compatibility (Wedekind & Füri, 1997), women have been observed to synchronize their menstrual cycle based on olfactory cues (Stern & McClintock, 1998), babies as young as six days can distinguish the smell of breast-feeding mothers from other mothers (Macfarlane, 1975; Schaal, 1986), and older kids can discriminate between the unique smells of their close friends (e.g., 9 years old) (Mallet & Schaal, 1998).

The dual function of olfactory stimuli (i.e., as a tool to communicate and as influence of emotions) will be studied and presented more extensively in Chapter 3.

2.4.1 The olfactory system

Compared to the olfactory system of most mammals, the human olfactory system is less developed (Stevenson, 2009). The term "olfactory system" does not only refer to one system but can refer to three distinct systems: (1) the actual olfactory system, (2) the trigeminal system (i.e., somatic arousal detection as temperature or pain; see Brand, 2006 for a review), and (3) the vomeronasal organ (see section 2.4) (Haviland-Jones & Wilson, 2010). In the present paragraph, only the actual olfactory system is presented, which is traditionally called and recognise as the olfactory sensory system.

The olfactory system is composed of about 1.000 odorant receptors on the epithelium lining ($3cm^2$) inside the nasal cavity; most of the odour molecules are detected by more than one receptor (Nef et al., 1992; Vassar et al., 1994). In fact, most receptors recognize several odours by detecting their corresponding chemical properties. The axons of the afferent sensory neurons merge to form the olfactory nerve, which, passing through the cibriform plate, distributes over the olfactory bulb (Mori & Sakano, 2011). For a detailed overview of olfaction and olfactory circuits see Mobley, Rodriguez-Gil, Imamura, and Greer (2014), Sela and Sobel (2010), and Yeshurun and Sobel (2010). In the olfactory bulb, different areas are sensitive to distinctive features of odours' molecules; this multiple activation process leads to a vast combinatorial strategy in the encoding of the stimulus to the sensing of smells. The olfactory epithelium in the nasal cavity is relayed to the olfactory bulb, which projects directly to the primary olfactory cortex, in an ipsilateral modality (Brand, 2006). Interestingly, studies have shown how odour concentration enhances odour processing at the level of the epithelium; in particular, unpleasant odours generated larger amplitudes in comparison to pleasant odours (Lapid et al., 2009). In the present work, how the olfactory information is mapped in the brain is not discussed, a detailed discussion of the topic can be found in other reviews (Buck, 2000; Mombaerts, 1999). Nowadays, thanks to the techniques of modern molecular genetics, the organization of the stimulus inputs coming from the olfactory bulb is known. Ressler, Sullivan and Buck (1994) provided evidence that information from widely distributed sensory receptors in the nose is transformed, thanks to the olfactory bulb, into a highly-organized spatial map in the olfactory cortex. However, the meaning of that variegated stimulus and the subsequently activation of physiological processing, in the bulb and in higher cortical levels then, still remain unknown. As suggested by Firestein (2001), the issues about 'how the human smell', and how the unconscious process of olfactory perception is working are still not completely understood. Indeed, conscious awareness is not a prerequisite for eliciting physiological and emotional responses via olfaction (Bensafi et al., 2002a).

2.4.2 Common brain networks between emotions and odours

The olfactory sense is defined as an emotional system (Lundström et al., 2008). A number of neuroscience studies have shown that certain brain areas are activated both in odour processing and in emotional processing (Ehrlichman & Bastone, 1992), mainly in the common neural substrate of the limbic system (LeDoux, 2012). These common areas are: amygdala, hippocampus, insula, anterior cingulate cortex and orbitofrontal cortex (Price, 1999; Rolls, 2004; see Soudry et al., 2011 for a review). In particular, the projections between the amygdala and the orbitofrontal cortex, which are implicated in emotion processing (Bass, Aleman, & Kahn, 2004; Britton et al., 2006), are bidirectional. The amygdala is involved in odour intensity perception, odour hedonic judgment, and odour memorization tasks (Pouliot & Jones-Gotman, 2008).

Emotional responses are commonly associated with odour perception (Savic, 2005). Indeed, odour may have emotional responses even when presented under the absolute detection threshold. In fact, the amygdala is activated at the most primarily level of smell processing. Another indication of the close relation between olfaction and emotion comes from clinical psychology: Olfactory disorders are regularly observed in case of depression or schizophrenia (Schneider et al., 2007). This finding suggests that the brain regions impaired by those types of disorders play a role in processing both emotion and odour.

Additionally, odours and emotions seem to share the difficulty to be accurately recalled (Yeshurun & Sobel, 2010). The topic on what can be exactly recalled by the olfactory imagery has been debated (Stevenson & Case, 2005), but what seems to be prevalent recalled is the mainly pleasantness/unpleasantness valence associated with the odour (Bensafi et al., 2003b; 2007).

2.4.3 The complexity of olfactory stimuli and the diffusion issue

The main issue in olfaction research is the so-called "stimulus problem" (Auffarth, 2013). This problem is related to the fact that olfaction completely depends on sensing chemical molecules in the environment. Thus, the complexity of the olfactory stimulus is due to the mixture of the chemical molecules that compose each odorant. The term "odorant" is used as a synonym of olfactory stimulus; therefore odorant refers to any substance that has a distinctive smell and it is constituted by distinctive chemical components.

The olfactory threshold is another crucial issue regarding olfactory stimulation. Other concepts frequently used as synonymous for olfactory threshold are flux or concentration of odorants over time (Firestein, 2001). Interesting, the olfactory thresholds measured in humans by means of psychophysical instruments are frequently lower than the thresholds detected in single-cell recordings (Firestein, 2001). This can be explained with the complexity of the olfactory decoding process. In fact, a study by Sobel et al. (2000), considering the assumption of a nostril differentiation in the air flow-rate, suggested that the intensity and the duration of the sniff are fundamental to investigate the olfactory threshold. Moreover, in order to transform and encode the chemical components of odorants into the real perception of smells, more than one olfactory receptor and the epithelium nostril area need to be activated. The activation of combined areas needs relatively high in temporal resolution and integration time. This can suggest that the olfactory system is less quick than vision or audition. In humans, this consideration can be true only in the case of complex odours. Indeed, in this case, the olfactory perception starts with a slow timescale due to the numbers of chemical components that need to be encoded (Bowman, Kording, & Gottfried, 2012; Laing & Francis, 1989).

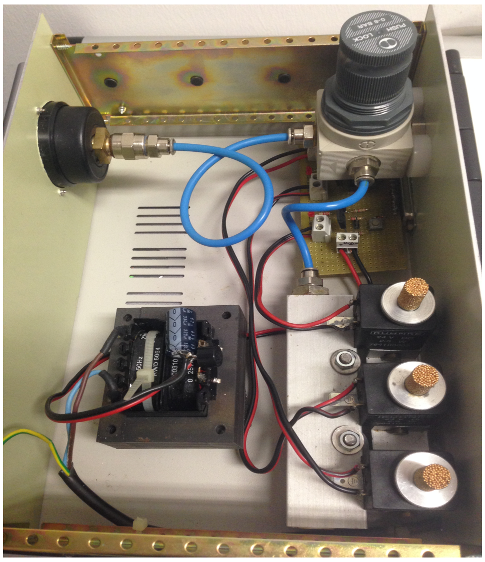
However, literature on the olfactory threshold is very controversial, as variations in experimental protocols (i.e., method of stimulation, method of stimulus dilution, volume of inhalation and number of trials presented) often yield different detection thresholds for odours. Similarly, detection thresholds depend on variations in the effectiveness/potency of a specific chemical component to stimulate an effect on the nasal tissues (Abraham, Sánchez-Moreno, Cometto-Muñiz, & Cain, 2011; Cometto-Muñiz & Abraham, 2008; Pierce, Doty, & Amoore, 1996). Recently, two protocols tested a large number of chemicals (> 60) using a standardized method. These two methods are the Japanese triangle odour bag (Nagata, 2003) and the odour squeeze bottle (Cometto-Muñiz & Cain, 1990; Cometto-Muñiz, 2001). The Nagata method covered 223 chemicals, whereas the odour squeeze bottle covered 59 chemicals. The Nagata method works on a concentration descending method (see http://www.env.go.jp/en/air/odor/olfactory_mm/01method_2-2-2.pdf for a detailed description of the method) as well as the second method (see Cometto-Muñiz & Cain, 1990 for a detailed description of the method). The descending methods are based on the constant reduction of the odour' concentration to test which are the participants' threshold. This descending method is particularly useful to avoid adaptation in the participants (Cain, 1989). Starting from the findings of those two methods, Abraham et al. (2011) tried to create an algorithm to predict the values of the odour thresholds. This algorithm is able to detect 353 odour thresholds in humans, which makes it a useful tool to use as a starting point for investigating complex odorants and their thresholds. In the present thesis, the issue of threshold level is not taken in account and only odorants above the detection threshold are used in the experimental studies (see chapters 3, 4, and 5).

In addition, the feature that is really relevant to control using olfactory stimuli in a laboratory setting is not the quantity of smells that humans can detect (e.g., same relevance of determining how many colours we can see) but the chemical components that act upon the nasal tissue (e.g., certain volatility, solubility and stability). Taking into account the chemical components of the olfactory stimuli leads immediately to another issue: the intensity of those olfactory stimuli. The perception of the quality of an odour can change as a function of the stimulus intensity. Certainly, the perceived intensity of the odour depends on its concentration and the pressure with which it is diffused. Some studies have shown that, when the concentration of an odorant increases, additional glomeruli are recruited into the detection of the stimulus; in other words new receptors are activated following an increase in concentration (Rubin & Katz, 1999). That is, the exposition to highly concentrated smell can reduce the threshold of the olfactory detection (Fasunla et al., 2014). Amongst all odour attributes, odour concentration is a paramount attribute driving the olfactory detection process (Laing, 1983; Frank, Dulay, & Gesteland, 2003; Johnson, Mainland, & Sobel, 2003) and inducing by itself activation in the human primary olfactory cortex (Sobel et al., 1998).

To limit the impact of the issues discussed in the present paragraph (i.e., intensity issue, concentration issue), a computer-controlled olfactometer was built (see Figure 2.2) to carry out the studies discussed in the present thesis. By using this instrument in order to diffuse smells, the quantity, intensity, saturation, and duration of the olfactory stimulus presentation can be regulated and strictly controlled.

In addition, the olfactometer permitted the delivery of odourised and odourless air. Specifically, the olfactometer is composed of three electro-valves activated via a parallel-port computer-controlled system, connected with a tank of compressed medical air (capacity 5 l at 300 Bar, N. ONU 1002, class 2, GASTEC-VESTA® S.r.l.). The inflow of compressed air was controlled by directing the airflow into one of the three valves (each valve can be on-off activated, 0-8 Bar). The airflow was usually set at a constant pressure of 0.2 Bar-l/min (see chapters 3, 4, and 5 for additional details), through a manometer (0-10 Bar, Tecnocryo Harris Aria, En. 562). Each of the valves is connected to a small glass bottle that contains one odorant. All airflow pathways are carried through odourless plastic tubes with a diameter of 4 mm. The odour can reach the participants' nose through a medical mask or be diffused directly in the ambient.

A B



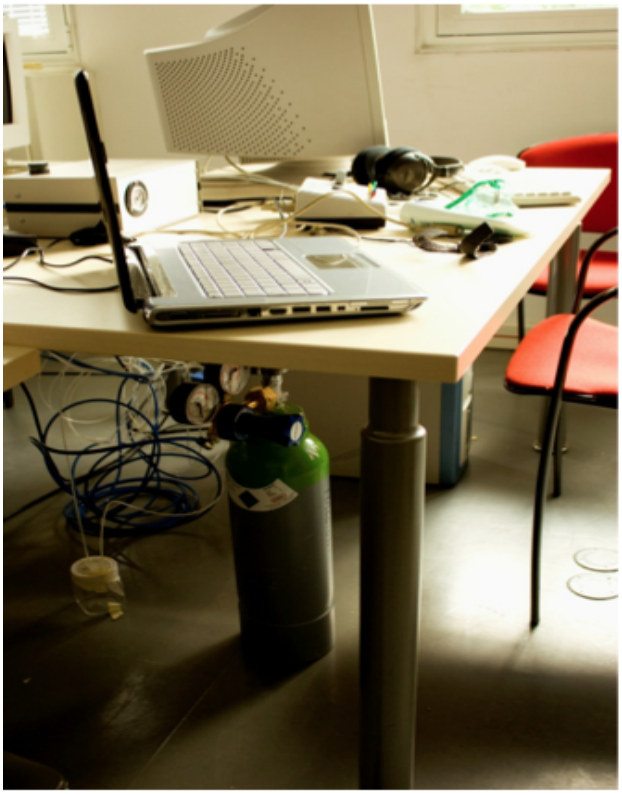


Figure 2.2 Custom-built olfactomter. (A) Internal view of the olfactometer. Three electro valves and the way-in air pressured stabilizer. (B) The experimental setting. The olfactomer is connected with the air-compressed tank and the small glass bottle placed under the desk.

Participant adaptation is another important issue that must be considered when using olfactory stimuli. The magnitude of such a habituation effect is highly correlated with the intensity and valence of an odorant. On the one hand, olfactory adaptation can lead to a decrease in the perceived intensity of odorants (Cain, 1969; Frank, Dulay, & Gesteland, 2003). On the other hand, the persistent and repeated exposure to odorants induces affective habituation of perception (Ferdenzi, Poncelet, Rouby, & Bensafi, 2014). That is, odours are perceived differently in relation to their valence. Indeed, unpleasant olfactory stimuli lead to increase attention, due to the connection with potential dangers. However, repeated presentations seem to reduce emotional saliency. This has been shown, for example, by the decrease of neural activation during persistent and repeated smelling of unpleasant odours (Croy, Maboshe, & Hummel, 2013). In addition, a recent study has demonstrated that the neural activity decrease is not only related to repeated smelling of negative odorant stimuli but also to repeated smelling of positive odorant stimuli (Ferdenzi, Poncelet, Rouby, & Bensafi, 2014). These findings are in line with a pioneer work by Cain and Johnson (1978) that suggested how repeated exposure can shift the pleasantness ratings of odours toward neutrality (i.e, a phenomenon called "affective habituation"). In particular, frequent repetitions of a pleasant odour typically lead to a decrease in perceived pleasantness; conversely, repetitions of unpleasant odours lead to an increase in perceived pleasantness. Consequently, in all the three experimental studies that will be presented in the next chapters, the odorants were always presented at regular intervals instead of providing continuous stimulation lasting throughout the experimental session to avoid any problems of perceptual habituation.

2.5 The influence of cross-modal interactions on consumers' emotions and behaviour

Cross-modal integration and correspondences between different sensory modalities have been extensively studied (see Spence, 2011 for a review). However, the effect of crossmodal integration and correspondences on emotions has received only scant scholarly attention. This is surprising, given that the integration of emotional cues across different modalities plays an important role for human survival. In fact, emotional responses and expressions are the result of the diverse information sources present in the surrounding environment (Griffiths & Scarantino, 2009; Smith & Semin 2004; Semin & Smith 2013). Many studies in the field of affective science have primarily investigated the interaction between audition and vision (Magnée, Gelder, Van Engeland, & Kemner, 2007). Over the last few years, research on the effects of the olfactory modality in interaction with other senses on emotions or on cognitive performance has focused exclusively on the emotion of fear (cf. Chen, Katdare, & Lucas, 2006; Partan & Marler, 2005). For instance, a study by Zhou and Chen (2009) showed how an emotion signalled by one sense can modulate the same kind of emotion perceived in another sensory modality. Using a purely female sample, the authors investigated the interaction between olfactory cues (i.e., fearful sweat) and the perception of expression in faces (i.e., faces featuring an ambiguous vs. easily discernable expression). Those findings provided evidence that fear-related chemosignals modulate the perception of visual affective stimuli, a finding that is supported also by a recent study examining the interaction between olfactory and audiovisual (in-)congruent information on fear response (de Groot et al., 2014). In their study, de Groot and colleagues (2014) argued that emotions can be communicated not only via visual and verbal/linguistic cues, but also through the olfactory modality; specifically, olfactory fear signals may induce fear in an unconscious way. More generally, the response to threat signals is enhanced when communicated by a combination of more than one sensory modality (Partan & Marler, 2005).

Humans rely on the successful integration of multiple sensory signals to function adequately (Schaal & Durand, 2012). In the consumer field, the multimodal elicitation of emotions and the coordinated presentation of multisensory cues are especially important to reach the consumers' emotion and thus influence their evaluations and decision processes.

Indeed, a number of studies has investigated direct effects of ambient conditioning and multi-sensory stimulation on consumer behaviour (Kotler, 1973; Belk; 1975; Markin, Lillis, Narayana, 1976; Gordon, 1989; Donovan & Rossiter, 1982; Babin, Darden & Griffin, 1994; Boedeker, 1995; Tai & Fung, 1997; Van Kenhove & Desrumaux, 1997; Hui, Dube & Chebat, 1997; Wakefield & Baker, 1998; Castaldo & Botti, 1999; Daucé & Rieunier, 2002). However, only few studies have highlighted the importance of the ambient variables on emotional reactions of consumers (Sherman & Smith, 1987; Donovan, Rossiter, Marcoolyn, & Nesdale, 1994). From those referred studies can be argued that store "atmospherics" (Kotler, 1973) may affect consumers via two parallel routes: 1) a direct route (store atmospherics directly influence behaviour) and 2) an indirect route (store atmospherics influence behaviour through their effect on emotions (see Spence, Puccinelli, Grewal, & Roggeveen, 2014 for an extensive review). However, studies that investigated the effect of olfactory influences on consumer behaviour are limited (Bone & Scholder, 1994; Gulas & Bloch, 1995; Mitchell, Kahn & Kanoska, 1995; Morrin & Ratneshwar 2000; Spangenberg, Crowley, & Henderson, 1996; Spangenberg, Grohmann, & Sprott, 2005; Spangenberg, Sprott, Grohmann, & Tracy, 2006).

Cross-modal interactions between audition, olfaction, and vision in the case of arousing emotions will be discussed in more detail in the experimental study presented in Chapter 4.

2.6 Do emotions work as a heuristic in consumer behaviour?

Emotions are an important source of information for humans in general and especially for consumers (Bagozzi, Gopinath, & Nyer, 1999; King & Slovic, 2014). The consumer's evaluation process is driven by, and refers to, an emotional reaction toward the stimulus (e.g., a product, a brand, or a shopping ambience; Schwarz & Clore, 1988). This evaluation process is primarily guided by the valence associated to the stimulus (e.g., pleasure and good vs. unpleasant and bad; Finucane, Alhakami, Slovic, & Johnson, 2000). In the present work, the term "emotions" do not refer to the affective evaluation toward the target (e.g., a stimulus object such as a product), but mainly to the consumer's emotion not related to a specific object. This affective evaluation is a crucial construct in decision-making (Zajonc, 1980;

Kahneman, 2003; Peters, Västfjäll, Gärling, & Slovic, 2006; Clore & Huntsinger, 2009) and consumer behavior in general (Andrade, 2005). In fact, frequently consumers are not able to process all available information when evaluating and making decisions (see paragraph 2.2), for this reason consumers try to compensate for that lack. Emotions can drive, stimulate, and can be used to justify choices. Rather than scrutinizing all available information, consumers often deduct information from their emotions that is used as a mental shortcut to simplify decisions. These mental cognitive shortcuts are known as heuristics (Gigerenzer, & Gaissmaier, 2011; Schwarz & Clore, 1983; Tversky & Kahneman, 1974).

It should be noted that the effects of emotions on consumer behaviour and intention to purchase are strongly dependant on the consumers' perception of product category involvement and product value (i.e., high vs. low involvement) (Traylor, 1981; Dittmar, 2000, 2001; Dittmar, Beattie, & Friese, 1996). In fact, the cognitive route of elaboration in the case of low involvement products has only a secondary role. In the classical attitude model (Solomon, 1997; Olivero & Russo, 2013), the low-involvement hierarchy together with the experiential hierarchy are the two main types of hierarchies forming attitudes in which emotions can play a crucial role. Particularly, this classical model suggests that (1) beliefs or cognition, (2) affect, (3) and behaviour are components of the attitude object (e.g., products or brand; Pachauri, 2002). The order of influence of such components defines the type of hierarchy or sequence for attitude formation (Solomon, 1997). In the low-involvement hierarchy (i.e., components order 1-3-2), consumers form attitudes by accumulating knowledge with regard to less information about product that lead immediately to create an emotional preference for that product. Contrary, in the experiential hierarchy (i.e., components order 2-3-1), consumers form attitudes developing an emotional preference toward a product thanks to intangible attributes of the product itself or of the point of purchase. This emotional preference leads consumers, only after behaviour-related response, to cognitively evaluate information about product (Solomon, Bermossy, & Askegaard, 2002).

In consumer behaviour, emotions influence high-level cognitive processes. Some studies have shown that positive emotions improve cognitive capacity (Mackie & Worth, 1989, 1991) and motivation (Isen & Reeve, 2005; Schwarz, 2002), suggesting that positive emotions lead to using more cognitive heuristics (Isen, 2000, 2001, 2008). Consumers can employ positive emotions differently. On one side, consumers frequently use information available about a target object to draw inferences about the target's attributes. Paradoxically, consumers are looking for a source of information even to a higher degree when information is unavailable (Huber & McCann, 1982; Kivetz, & Simonson, 2000; Levin, Johnson, & Faraone, 1984). This missing information may negatively bias consumers evaluation processing (e.g., Huber & McCann, 1982; Johnson, 1987; Johnson & Levin, 1985; Nagpal, 2011). However, at the same time, this lack of source information can be perfectly compensated by the emotional state of the consumers (Noda, Takai, & Yoshida, 2007); this emotional state can be modulated and influenced by ambient variable at the point of purchase or by intrinsic characteristics of the products (e.g., colour, shape, odours, materials etc.; Spence & Gallace, 2011). On the other side, consumers can select and process information to rationally justify emotional instinctive choice (Damasio, 1994; Lindstrom, 2008; Pham, 2007). In this perspective, consumers could buy products not only after having processed the main available information related to products' characteristics but also when stimulated by the emotional sources in the surrounding environment or by the product itself. Consequently, consumers could retrieve only *ad hoc* information to rationally justify the instinctive choice.

In sum, emotions are frequently used as a heuristic thanks to which humans can quickly interact with the surrounding environment. This function of emotions is particularly useful if activated in the context of the consumer behaviour decision process (Argyriou, & Melewar, 2011; Zurawicki, 2010).

2.7 Conclusion and discussion

The literature review on emotions and consumer behaviour clearly shows a lack of studies accounting for the importance of multi-sensorial integrations in the definition of consumers' behaviour. Human evaluation of object and events in the surrounding ambient completely depends on the information reaching our senses (Driver & Spence, 2000). Indeed, consumers generally perceive the world in a multisensory way, and the interaction between sensory information can differentially influence emotional response. Research has shown that environmental cues can influence consumers' emotions, decisions, and experiences (see, e.g., Schifferstein, Talke, & Oudshoorn, 2011). Most of these studies, though, have focused on a stimulus-response (S-R) approach, in which environmental variables exert an influence on attitudes (e.g., satisfaction) and behaviour (e.g., buying; Mehrabian & Russell, 1974). However, in this approach, emotions have received limited attention (Sherman, Mathur, & Smith, 1997; Hui, Dube, & Chebat, 1997; Spangenberg et al., 1996; Daucé & Rieunier, 2002).

Emotional states evoked by marketing stimuli have been found to exert a significant impact on consumer behaviour (e.g., Donovan & Rossiter, 1982; Dawson, Bloch, & Nancy, 1990; Laros & Steenkamp, 2005; Swinyard, 1993; Watson & Spence, 2007). Moreover, among the ambient cues, smell has gain less attention. While some previous studies have looked at the smell of a specific product (Schmitt & Shultz, 1995), research in the past ten years has focused on ambient scent (see Roxana & Ioan, 2013 for a review). Some studies argued, for example, that the presence of a pleasant smell increases the time spent in a store (Babin & Darden, 1995; Hui & Bateson, 1991; Knasko, 1989; Leenders, Smidts, & Langeveld, 1999; Mitchell et al., 1995), the number of items examined (Spangenberg et al., 1996), the amount of time taken to evaluate products (Knasko, 1995; Morrin & Ratneshwar, 2000), and the perceived quality of the environment (Mattila & Wirtz, 2001) and of the product (Demattè, Sanabria, Sugarman, & Spence, 2006; Baker, Grewal, & Parasuraman, 1994). The limited amount of studies with olfactory stimuli in laboratory and in the real word is mainly due to the complexity of the olfactory stimuli itself (see paragraph 2.4.3.).

From the literature review of instruments frequently employed in eliciting emotions, a critical point rises: Eliciting emotions in laboratory leads to a reduction of the ecological validity and, at the same time, of the emotional reactions and “naturalistic” value of emotions. This is certainly a common limitation occurring in laboratory experimental studies. In a laboratory condition, the control of all the features related to the stimulus (e.g., duration of the presentation, frequency definition or intensity, etc.) allows for perfectly linking the stimulus with the reaction and to reproduce the experimental paradigm. However, in the case of emotions’ elicitation through passive or perceptual-based methods, this limitation is even more salient. On the contrary, expression-based or active methods lead to a higher ecological validity and complete emotional reaction, that are obviously less intense compared to a real situation but more close to a “naturalistic” value of emotions.

Talking about olfaction, it cannot be forgotten to highlight its relation with memory (see Schab & Crowder, 2014 for a review); in the present theoretical chapter the connection between odours and memory was not discussed. However, in the filed of consumer behaviour this relation is an additional plus besides the hedonic valence of smell (see Cahill, Babinsky, Markowitsch, & McGaugh, 1995; Chu & Downes, 2002; Willander & Larsson, 2006, 2007, 2008). In fact, the “Proust phenomenon”, the sudden occurrence of a memory containing sensory and emotional components (Proust, 1922) was validated (Toffolo, Smeets, & Van den Hout, 2012): memories triggered by odours are older and more emotional than those triggered by verbal cues (Chu & Downes, 2002; Herz, 2004; Herz & Cupchik, 1995; Willander & Larsson, 2007). The memories related to odours are defined as state-dependent because are directly linked with the event in which the odour was smelled for the first time (Aggleton, & Waskett, 1999; Baddeley, 1990; Herz & Engen, 1996). For those reasons, using smell in consumer behaviour context, the recall of product (Krishna et al., 2010; Morrin & Ratneshwar, 2003) and even the performance of memory in the recall of unfamiliar brand (Morrin & Ratneshwar, 2000) can be enhanced. Moreover, this long-lasting effect of odours on memory can be easily applied to improve the retrieval of point of purchases (Emsenhuber, 2011).

In sum, taken together the findings of the studies presented in this chapter, suggest how the effect of smell presented in ambient can lead to several influences on consumers. On one side, smell acts directly on both behaviour and intention, when congruent with product as reminder of products' information (e.g., priming cue). On the other side, smell mostly works on emotions that, in turn, stimulate and facilitate behavioural responses and decision-making processes (cf., Hoffman & Turley, 2002). However, research have focused attention mainly on the effect of smell in ambient on emotions and consequently on intention and behaviour.

The literature critically reviewed in present Chapter on emotions and consumers emotions elicitation in laboratory, and on olfactory influences on emotions, represents the theoretical framework for the following experimental chapters (see Chapters 3, 4, and 5).

CHAPTER 3 − Tempting Smells: The Effect of Ambient Food Odours on Emotions, Product Recognition, and Willingness to Consume

3.1 Introduction

The role of ambient smells in consumer behavior, especially when they are congruent with a given target product, has received increasing attention from the fields of both marketing and psychology in recent years. Research on this topic draws on previous literature emphasizing the role played by smells in influencing affective states as well as product discrimination, evaluation, and purchase behavior (Milotic, 2001; for a review Roxana & Ioan, 2013; Teller & Dennis, 2012). Besides the positive impact that pleasant ambient smells may have in improving the general hedonic experience within retail spaces (as first put forward by Kotler, 1973, with in his seminal work on 'atmospherics'; Spence et al., 2014; see Turley & Milliman, 2000, for a review), both anecdotal and empirical evidence is also growing about the effect of product congruent smells on the potential purchase of related products. Although numerous business cases provide indications on the positive correlation between the in-store diffusion of product-congruent smells and related sales (Olivero & Russo, 2013) scientific research is still needed to further prove this effect and clarify the psychological factors underlying consumer decision making and behavior.

Previous research has shown that the effect of pleasant ambient smells on consumer decision making depends on whether the smells are congruent or incongruent with the target product class (Bosmans, 2006). So, for instance, Mitchell et al. (1995) conducted an experiment in computer-aided product selection in rooms that had been smelled. Product congruent odours influenced information processing and facilitated product selection while cognitive difficulties were experienced by consumers who had been exposed to non-congruent odours. When the ambient odour was congruent as opposed to incongruent with the product class, the participants spent more time processing the data. Interpretations of these results suggest that when the odour is congruent with the product class increased focus may be occurring. In contrast, when there is no match between the odour and the product class, cognitive interference may occur instead. When the information activated in memory is incongruent with the product class, the task becomes cognitively more demanding for the consumer (Mitchell et al., 1995). A few studies have previously pointed to the increase of attention and arousal associated with odours (Van Toller, 1998; Ehrlichman & Bastone, 1992), whereas indications on the effect of fragrances on attention toward certain products have been suggested by research that investigated the effect of pleasant fragrances on memory (Morrin & Ratneshar, 2003). Morrin and Ratneshar found that smell increased both memory and attention to brand. In their experiments, they manipulated whether the smell was present at encoding or retrieval and found that the enhancement of brand memory was due to the presence of an ambient smell at encoding rather than retrieval. The ambient smell increased attention in terms of longer viewing times of the experimental stimuli. These effects are likely to have important consequences in a retail setting and research that clarifies the underlying mechanisms of the impact of congruent ambient smells on attention and behaviour is needed.

Some understanding about the effect of odour-induced arousal on behaviour has been provided by experiments focusing on changes in task performance and reactions times. Millot, Brand, and Morand (2002) observed improved task performance with both pleasant and unpleasant fragrances and suggested that different explanations may apply. They suggest that pleasant odours would hinder the negative reactions associated with the experimental situation and reduce the effect of stress on task performance. Unpleasant odours would instead increase the level of arousal and, as a consequence, they would improve performance. According to the authors, although ambient fragrances constitute additional stimulations and could operate as a distracting stimuli they appear to operate in an opposite way by conversely reducing reaction times in simple task performances (Millot et al., 2002). It is therefore possible that in the case of product-congruent fragrances, reactions times in product recognition tasks could be improved by the arousal effect generally associated with fragrances and also positively complemented by the effect of cognitive facilitation due to the increase of product salience (see Mitchell et al., 1995).

Besides the increase of attention towards the product, the effect of fragrances on consumers' emotions is the other main factor that could explain the observed impact of product-congruent odours on buying behavior. Literature on the emotional impact of fragrances is vast (Vernet-Maury et al., 1999; Knasko, 1992; 1995; Lehrner et al., 2005, Schiffman, Miller, Suggs, & Graham, 1995) and fragrances have been often adopted as ideal 'emotion-inducing stimuli' in research on emotions (Ehrlichman & Bastone, 1992). Scholars agree that odours likely stimulate cortical and subcortical brain structures that are involved in the experience of emotions, mood, and affect (cf. Elsinger, Damasio, & Van Hoesen, 1982; Stellar & Stellar, 1985). Odour experience is naturally hedonic and studies of odour classification have clearly shown that their most salient attribute is pleasantness or unpleasantness (Engen, 1982).

Research that has focused on the impact of fragrance-induced emotions in a consumer setting and confirmed the relation between fragrances and emotions has also pointed to their significant impact on the perception of the retail environment and of product quality (Bradford & Desrochers, 2009; Gulas & Bloch, 1995; Michon, Chebat, & Turley, 2002; Spangenberg, et al., 1996). However the current understanding of the effect that fragrances have on emotions and choice is far from conclusive. For instance, de Wijk and Zijlstra (2012) assessed the influence of ambient smell on mood, arousal, and choice, and found that smells such as vanilla and citrus can have differentiated effects on the people's affective experiences.

In this study, the citrus smell had higher impact compared to the vanilla condition, on choice, arousal, and (less) negative emotions.

This research aims to replicate previous results on the effect of pleasant product congruent fragrances on emotions and to extend the current understanding on cognitive and behavioural effects, such as product recognition and buying behaviours. We conducted two experiments to test the effect of chocolate and coffee smells on the enhancement of positive emotions, on the discrimination time for smell-related products, and on willingness to buy. We expected that ambient olfactory cues would reduce recognition time, stimulate positive emotions, and willingness to buy.

3.2 Experiment 1

3.2.1 Materials and methods

Thirty undergraduate and graduate students enrolled at the University of Milan-Bicocca (12 males and 18 females, aged 19 to 35 years, *M* = 23 years, *SD* = 1.59) took part in the experiment. The students received course credit for taking part. The experimental procedure was explained to the participants and after that, they verbally agreed to take part. The experiment was performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki. None of the participants reported having olfactory dysfunctions or any knowledge or familiarity with the Chinese, Japanese, or Korean languages (this was a requirement for the hedonic evaluation test). We assessed the presence of any olfactory or sensorial dysfunctions and linguistic knowledge in the recruitment procedure, by means of a short questionnaire.

A chocolate smell (commercial name 24236) obtained from Agieffe International® (Milan, Italy) was used in the study[1]. This alcohol free and water-soluble smell (25% pure essential oil) was diluted at a concentration of 10% in water.

In addition, four pictures of chocolate desserts and four pictures of bread (12cm wide x 9cm high; RGB colour scale; 72 dpi), were used as target stimuli in the reaction time (RT) test. The pictures were taken from the free on-line database (Shutterstock®). Further, the target picture that was used in the intention-to-consume questionnaire was an image of a chocolate dessert (12cm wide x 9cm high; RGB colour scale; 72 dpi). This image was also taken from the same online database aforementioned (see Figure 3.1).

Figure 3.1 Pictures used for measuring willingness to consume.

The study included four different measures. The first one consisted of ratings of ideographs. The affective state of the participants after they had been exposed to the ambient smell was measured indirectly by assessing their liking ratings towards 8 black and white

[1] In order to select the olfactory stimulus for this study, which was created in accordance with the European Commission Directives (ECDIN; Penning, Roi, & Boni, 1990), a set of five alcohol-free and water-soluble scents were tested. The selection was based on three dimensions: liking ('How much do you like it?'), congruence-to-product ('How much this scent remind you of chocolate dessert?') and intensity ('How much do you like this scent intensity?'). The fragrances were rated on these dimensions by using 7-point Likert scales (0 = not at all, 7=very much). Thirty participants, with a mean age of 22 years, were involved in this preliminary study, and the scent that obtained the higher mean ratings (M = 5.25, SD = 1.5) in all dimensions, was selected for the Experiment 1.

Chinese ideographs, which have been selected as affectively neutral stimuli (Murphy & Zajonc, 1993). The order of presentation of the ideographs was randomized. This allowed the comparison of the hedonic evaluation both before and after ambient olfactory stimulation.

The second measurement consisted of reaction times. In order to investigate any effect of the chocolate smell in product recognition, a computerized reaction time test was used. In this test, the participants had to discriminate between images of chocolate (experimental condition) and bread (control) as rapidly as possible. The task consisted of two blocks (20 practice trials and 40 test trials), in which four target pictures (images of chocolate products) and four neutral pictures (images of bread) were used. Initially, the target images (chocolate products) were mapped to the 'e' key on the left side and the neutral images and negative words on the right ('i' key), for the first block. In the second block, the stimulus-response mapping was inverted. The participants were instructed about the mapping of the stimuli before starting the task. The names of the categories remained on the right and left side of the screen throughout the experiment as a reminder to the participants.

The third measure included in the study was the Profile of Mood States Questionnaire (POMS). The emotional experience was measured using a 30-items version of the profile of mood states questionnaire (POMS; McNair et al., 1992; Reddon, Marceau, & Holden, 1985). The items consisted of different adjectives used to describe the emotional experience of the participants. Each adjective was rated on a five-point Likert scale (0 = not at all, 5 = extremely). Only the scores of two dimensions were calculated, which were arousal/energy and valence. Predictions concerning the other subscales (Tension-Anxiety, Anger-Hostility, Fatigue-Inertia, and Confusion-Bewilderment) were not considered in the analysis. That said, the entire form was administrated in order to avoid tampering with its psychometric properties (McNair et al., 1992). This questionnaire was used to investigate the participants' emotional response post-stimulation.

Finally, an explicit intention measure was used. In order to measure the participants' willingness to consume smell-related product, a 4-item self-report questionnaire rated on a 7-point Likert scale (from 0= totally disagree to 7= completely agree) was used. The four items presented were: 'I can't wait to eat it', 'At this moment, I really would like to have it', 'I feel a need to have this product' and 'I would like to taste it'. These sentences were designed to evaluate the self-report intention of participants, to consume a smell-related product, a chocolate dessert (see Figure 3.1).

3.2.2 Procedure

The experimental procedure consisted of a between-participants experimental design with two conditions. Fifteen participants were randomly assigned to each condition: a chocolate smell condition and a control condition (no smell). The experiment was composed of four parts all programed in E-prime (version 2). The experiment was conducted on a laptop (1280 x 800 pixel screen resolution, 60 Hz refresh rate) positioned on the desk directly in front of the participants.

The olfactory stimulus was presented with a custom-built computer controlled olfactometer that allowed for the regulation of the saturation of the smell in the room and to replicate the same experimental condition for each participant.

After the participants arrived they were invited to sit comfortably on a chair approximately 70 cm from the laptop screen that was positioned on a desk. All of the participants were informed about the structure of the experiment. They were not, however, told anything about the ambient smell. The participants listened to white noise (55 dB), using an over ear headphone, for the duration of the experiment.

In the first part, the participants were asked to evaluate liking of the 8 black and white ideographs (Murphy & Zajonc, 1993). They had to rate their liking of each ideograph using the mouse and selecting the button that corresponded with their evaluation. Afterwards, in the RT test, the participants were instructed to respond as rapidly and accurately as possible to the images presented, using the keyboard of the laptop. Whenever the participant made an error, in the categorization task, a red X was presented on the screen for 300ms. During this task, the smell of chocolate was diffused in the room through the olfactometer (constant diffusion for 6000 ms with smell and 2000 ms of clean air, for 8 trials).

In the third part, the 8 black and white ideographs, already evaluated in the first part of the study, were rated again in random order. Next, the participants were instructed on how to answer the items in the POMS questionnaire (McNair et al., 1992; Reddon et al., 1985). The participants had to use the mouse in order to select how the adjective presented matched their emotions (from 1 to 5). Then, in the last part of the experiment, the participants had to rate, using the mouse to select the corresponding button as in the previous part but this time from 1 to 7, the self-report questionnaire on their willingness to consume chocolate products. The experiment lasted for approximately 40-50 minutes.

3.2.3 Results

A 2 (smell: no smell vs. chocolate smell) X 2 (ideographs liking: pre-stimulation vs. post-stimulation) mixed ANOVA was performed; the smell condition was considered as a between factor while the ideographs liking as a within-subjects factor. The implicit measurement of emotions through ideographs evaluation revealed a significant effect of chocolate smell on the liking rating for the eight tested ideographs; in the retest, participants exposed to the chocolate smell rated the ideographs as more likeable ($F(1, 28) = 10.48$, $p < .05$). The liking mean score post-stimulation ($M = 4.43$, $SD = .79$) with smell significantly increased in comparison to the control condition ($M = 3.77$, $SD = 1.01$). Moreover, there were no differences between the ratings of the control group (both pre and post stimulation), and the rating prior the stimulation of the group exposed to the chocolate smell ($F(1, 28) = 1.78$, $p > .05$).

Regarding the RTs, all of the participants responded correctly on more than 80% of the trials. A mixed factorial design was used to analyse the effect of smell on the participants' RT in the discrimination task of target stimuli (bread or chocolate pictures). The presence of the chocolate smell (smell vs. control group) was considered as a between factor, while the eight different pictures were grouped by target category (either bread or chocolate), and considered as a within-participants factor. The mixed ANOVA results showed a main effect of odour on the reaction times for both chocolate and bread pictures ($F(1,28) = 10.9$, $p < .001$); RTs of the control group were significantly slower in comparison to the experimental group (see Table 3.1). However, no effect of product category was found on RTs ($F(1,28) = 1.44$, $p = .22$).

	Condition			
Experiment 1:	**Smell**		**No smell**	
Chocolate smell				
	M	***SD***	***M***	***SD***
Bread Pictures	674 ms	358 ms	805 ms	454 ms
Chocolate Pictures	669 ms	321 ms	818 ms	499 ms
Experiment 2:				
Coffee smell				
	M	***SD***	***M***	***SD***
Water Pictures	663 ms	410 ms	719 ms	416 ms
Coffee pictures	644 ms	319 ms	683 ms	384 ms

Table 3.1 Reaction time mean scores in determination task, Experiment 1 and 2.

In the third part of the experiment, participants were asked to rate their emotional state on a POMS scale. In the smell condition, a trend that indicated the increase of positive emotional ratings and the decrease of negative emotional ratings was observed. Ratings were subjected to a factor analysis to further investigate this trend. Based on the screeplot, we estimated two factors as sufficient to explain the variability in the data. Chi-square statistics validate this hypothesis ($p < .01$). Plotting the data on a two dimensional space, as well as on a dendrogram, allowed us to interpret the two factors as “arousal” and “valence”(Bradley & Lang, 1994).

As previously suggested, the trend in the data would appear to be related with the arousal dimension, with the attribute interpreted as “positive valence” having a higher score in the condition where the chocolate smell had been presented and by contrast, the “negative valence” having a lower score. Next, we assessed the effect of the smell on all the scores of the positive emotions pooled together, and on all the scores of the negative emotions pooled together (see Figure 3.2). Results from a paired t test (95% confidence interval) revealed a significant improvement of the scores of positive emotions in the smell condition ($p < .05$).

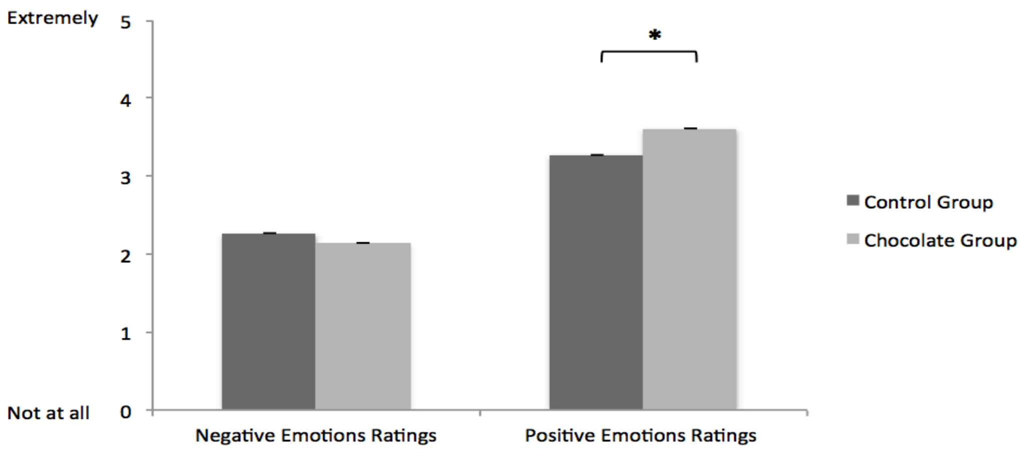


Figure 3.2 Positive and negative emotions ratings in the two conditions (control group, chocolate smell group). Asterisk represents significant differences at p < .05.

Finally, we analysed the intention to consume (α = .944). We examined the effect of the smell on the participants’ ratings concerning their willingness to consume the product. A t-test (95% confidence interval) revealed that the participants wanted to consume a chocolate product significantly more after being exposed to the chocolate smell (t (28)= 4.146, $p < .01$). In order to assess whether the participants’ emotional reactions to the smell increase the willingness to consume smell-related products the factors of arousal and valence were extracted, from the previous factorial representation (using the Bartlett method). The two emotional factor scores were regressed together with the grouping factor (no smell vs.

chocolate smell) on the intention to consume ratings. The regression model was significant ($R^2 = .44$; F (5,24) = 3.72, $p < .05$); in particular, the results revealed a significant main effect of the group on the intention to consume ($\beta = .656$, $p < .001$), confirming the results of the previous t-test. No effects of arousal and valence on intention to consume were found.

3.2.3 Discussion

The results of Experiment 1 showed that ambient smell had an effect on the self-reported willingness to consume smell-related products. Previous literature provides little evidence that smells increase the number of products sold or the amount of money spent (Knasko, 1993), our results show that product-congruent fragrances stimulate the intention to buy congruent products and thus indicating the potential role of cognitive priming of smell on consumers' decision making. Mitchell et al. (1995) showed that the presence of an ambient odour in the consumer marketplace promotes the retrieval of information about the related product and the product saliency. We hypothesized that ambient smell has an effect on the emotional state of participants. Data confirmed this effect and revealed a significant enhancement of positive emotions with the presence of chocolate smell. Moreover, this was confirmed by the increase in the liking ratings of ideographs after participants had been exposed to the smell. This result is consistent with previous findings where participants exposed to pleasant odours reported being in a better mood (Knasko, 1992; 1995; Lehrner et al., 2005, Mitchell et al., 1995; Schiffman et al., 1995; Vernet-Maury et al., 1999).

Further, we expected a reduction of the reaction times in the product discrimination test in case of smell-related products. This hypothesis was only partially confirmed because the decrease of reaction times was found but for all the products. Participants when exposed to chocolate smell were significantly faster in the products recognition test both for target products (chocolate pictures) and for control products (bread pictures).

3.3. Experiment 2

3.3.1 Materials and methods

Thirty undergraduate and graduate students (16 males and 14 females, from 20 to 40 years old, *M* = 23 years old, *SD* = 2.7 years) took part in Experiment 2. They were all psychology students at the University of Milan-Bicocca and received course credit for taking part in the study. Participants had the same selective restriction parameters as in in Experiment 1.

3.3.2 Procedure

Experiment 2 adopted the methodology and procedure of Experiment 1 to test the effect of coffee smell[2], provided by Agieffe International® (commercial name 24238). Images used in the reaction time test were four pictures of espresso cups and four pictures of water glasses (12cm wide x 9cm high; RGB colour scale; 72 dpi), which were found in an on line free database (Shutterstock®). A picture of espresso cup (see Figure 3.1) was used as target image in the explicit intention measure.

---

[2] In order to select the olfactory stimulus for this study, a set of five alcohol-free and water-soluble scents, which were created in accordance with the European Commission Directives (ECDIN; Penning, Roi, & Boni, 1990), were tested. As in the previous pretesting, the selection was based on three dimensions: liking ('How much do you like it?'), congruence-to-product ('How much this scent remind you of espresso coffee?') and intensity ('How much do you like this scent intensity?'). The fragrances were rated on these dimensions by using 7-point Likert scales (0 = not at all, 7 = very much). Thirty participants, with a mean age of 23 years, were involved in this preliminary study, and the scent that obtained the higher mean ratings (*M* = 5.4, *SD* = 1.2) in all dimensions, was selected for the Experiment 2.

3.3.3 Results

Similarly to Experiment 1, a 2 (smell: no smell vs. coffee smell) x 2 (ideographs liking: pre-stimulation vs. post-stimulation) mixed ANOVA was performed; the smell condition was considered as a between-subject factor, while the ideographs liking as a within-subject factor. Implicit emotion measurements through ideographs evaluation revealed an effect of coffee smell on the liking ratings of the ideographs ($F(1, 28) = 19.37$, $p < .001$); after the stimulation of the coffee smell, participants rated the ideographs as more likeable. Liking mean score of the experimental group post-stimulation was significantly higher ($M = 4.20$, $SD = .70$) than the one of the control group ($M = 3.55$, $SD = 1.23$). Participants' error rates were checked in order to control for possible unreliable participants. Again, none of the participants presented an error rate superior to the 20%, therefore no participants were discarded. As in the previous analysis, a mixed ANOVA was used to analyze the effect of the coffee smell on the participants' reaction time in the discrimination task (pictures of water glasses or coffee cups). The presence of the coffee smell in a group (smell vs. control group) was considered as a between factor, while the eight different pictures were grouped by product category (either water or coffee) and considered as a within factor. The mixed ANOVA results showed a main effect of the coffee smell on the reaction time both on coffee cup and water glass pictures ($F(1, 28) = 12.49$, $p < .001$). Participants were faster in responding in the coffee smell group, when both coffee cup pictures and water glass pictures were shown (see Table 3.1). However, no effect of product category was found on reaction times ($F(1, 28) = 1.46$, $p = .22$).

The results on the POMS scale were in line with the results of the experiment using the chocolate smell. Ratings seemed to follow the trend of the previous experiment. Ratings associated to the more positive attributes seemed to increase in the coffee smell condition, while the ratings concerning the negative attributes seemed to decrease. Once again, we performed a factor analysis on the participant ratings on the 30 items constituting the POMS. The two factors sufficient to explain the variability of the data were again interpreted as "arousal" and "valence" (Bradley & Lang, 1994).

We then repeated the procedure used before, assessing the effect of the smell on the positive emotions, and on the negative emotions mean scores (see Figure 3.3). The results from a paired t test (95% confidence interval) showed a significant enhancement of the scores of positive emotion in the smell condition ($t(28) = -3.48$, $p < .001$), and a significant decrease of the ratings relative to the negative emotions ($t(28) = 2.01$, $p < .05$). However, the positive trend of the arousal in the coffee smell group was not significant ($p > .05$).

Figure 3.3 Positive and negative emotions ratings in the two conditions (control group, coffee smell group). Asterisks represent significant differences at p < .05.

Finally, we assessed the intention to consume (α = .931). We examined the effect of the coffee smell on the product willingness to consume. A t-test (95% confidence interval) showed that participants' self-reported intention to consume increased significantly after being exposed to the coffee smell ($t(28)$= -3.48, $p < .01$). Once again in this case, we extracted the arousal and valence factors, from the previous factorial representation (using Bartlett method) in order to test whether enhancing positive and high arousal emotions may predict the intention to consume coffee products. The arousal and valence factor scores were regressed together with the group condition (no smell or coffee smell) on willingness to consume. The regression model performed was significant ($R^2 = .35$; $F(5,24) = 2.50$, $p < .05$). The results revealed a significant effect of the group on the willingness to have the smell-related product ($\beta = .44$, $p < .05$); smell stimulation predicts the intention to consume coffee products. Arousal and valence had no significant effect on willingness to consumer.

3.3.4 Discussion

Consistent with the results of Experiment 1, the ambient coffee smell increased significantly the participants' self-reported willingness to consume smell related-products. As in the previous experiment and in line previous literature, coffee smell increased participants' positive emotions and decreased negative ones (Knasko, 1992; 1995; Lehrner et al., 2005, Schiffman et al., 1995; Vernet-Maury et al., 1999).

The results of the product discrimination task, once again, showed a reaction time reduction in the smell condition for both target and control pictures (coffee and water pictures). Coffee smell, as chocolate smell, significantly reduces participants' reaction times in products discrimination task although without any difference for smell-related products.

3.4 General discussion and conclusion

The results of the present work suggest that the ambient smell related to products could impact impulse buying in the shopping context (for a review, see Muruganantham & Bhakat, 2013).

Odours operate as a cue that, either consciously or unconsciously, activates target objects information and affective information (Degel, Piper, & Köster, 2001). Conversely, an odour, which is not congruent with the target object will activate inappropriate information that may lead to cognitive interference (Mitchell et al., 1995). Our two studies provide further evidence to the argument for which both the pleasantness and the congruence of the smells with given target products can increase the intention to buy related products. In-store ambient stimuli drive the consumer to buy unplanned products because these operate as reminders of shopping needs (Abratt & Goodey, 1990). Previous research indicated that smells may influence the recalling of target products with the same accuracy as verbal, visual, tactile and musical cues; they also elicit more emotional memories than the other memory cues (Herz & Cupchik, 1995; Schifferstein & Blok, 2002). This critical olfaction-emotion relationship has been shown to be primarily due to the shared common brain pathways of emotions and odour processing (Ehrlichman & Bastone, 1992; Savic, 2001; see Soudry et al., 2011, for a review).

Impulsive buying has been theorized as an hedonic experience characterized by the common presence of high emotional activation and lack of cognitive control (Arnould, Price, & Zinkhan, 2002; Morrin & Chebat, 2005; Strack, Werth, & Deutsch, 2006; Weinberg & Gottwald, 1982; Rook, 1987). Our findings show that the hedonic valence of smells has general effects on consumers' emotions but significant evidence on the influence of positive emotions on the intention to buy was not found.

Previous research has indicated that olfactory detection is faster when there is a cross-modal semantic congruence between odours and related pictures (Gottfried & Dolan, 2003). Reaction times in the detection of odours are significantly faster when odours appear with semantically congruent pictures, thus suggesting a cross-visual facilitation of human olfactory perception (Gottfried, Deichmann, Winston, & Dolan, 2002; Zald & Pardo, 1997; Zatorre, Jones-Gotman, Evans, & Meyer, 1992). We argue that the olfactory visual integration could be verified in the reverse case. Previous eye-tracking studies suggested that odours can enhance attention towards visual objects. The priming effect of odours was shown to increase selective attention for congruent visual objects as compared to a control condition without any odour (Seo et al., 2010). We have attempted to verify the priming effect of odours on odour-congruent products, however our results showed an overall decrease in the reaction times of the recognition task for all the products, including the control ones that had no congruency with the odour. The sole presence of the odours reduces the reaction times for all the target products. This result is in line with previous findings that explained the decrease of reaction times in the presence of both pleasant or unpleasant odours as the consequence of the arousing effect of olfactory stimulations (Millot et al., 2002). In fact, relaxing effect of certain odours does not lead into an increase of alertness (Schifferstein et al., 2011). Paradoxically, participants can perceive and experience a sense of relaxation but at the same time an increase of arousing level (Chrea et al., 2009). In accordance with these findings our results suggest that is plausible that the observed overall reduction of the reaction times be caused by the alertness effect of odorants' stimulations. It is interesting to note that these effects are not usually shown in self-report questionnaires. Literature has shown an inability in participants' self-evaluation of smell effects on autonomous nervous system activity (Alaoui-Ismaili et Al., 1997). A change in the arousal state is normally uncountable only beyond conscious awareness; participants' self-reports of arousal do not highly correlate with the awareness of physiological activation (Li, 2008; Zillmann, 1978). Nevertheless, our results seem to be in contrast with other findings showing how pleasant odours positively affect mood and decrease arousal, suggesting that only strong negative odours may induce higher arousal (Bensafi et al., 2002c; Royet et al., 2003; Heuberger, Hongratanaworakit, & Buchbauer, 2006). Future studies should clarify further the arousing effect associated with odours and, in particular, it seems important to investigate whether there might exist consistent differences between types of odors and how these odour-specific effects may further vary according to specific features of the odour (e.g., pleasantness vs. unpleasantness) and given target-object categories in the reaction time tasks.

In conclusion, our results have significant implications for sensorial marketing in the retail settings (Spence et al., 2014). Although we could not find a significant impact of positive emotions on intention to buy, an important result is the impact of product-congruent (pleasant) fragrances on the intention to buy. Again, future research should investigate further this relation and clarify what is the potential role of emotions when they are stimulated by fragrances which appear to have an impact on willingness to consume. The evidence we have found on the effect of products-congruent ambient smells on intention to buy, on positive emotions and on the product recognition task unequivocally emphasizes the potential of adopting a multisensory congruence strategy in the retail setting (Spence et al., 2014). However, if our studies provide further support about the enhancing role of multisensory congruent stimuli in food consumption (see Spence, Shankar, & Blumenthal, 2011; Spence, 2012) more empirical research is needed to clarify the relative contribution of the diverse stimuli on both the general hedonic experience of the consumer and the specific neurocognitive correlates beyond decision making and buying behaviours.

CHAPTER 4 − The Effect of Crossmodal Correspondences between Smell and Sound on Emotions

4.1 Introduction

Emotions are considered as action disposition-motivational tendencies that serve immediate survival functions (see chapter 1 for a detailed discussion). Basically, emotions are organized around two motivational systems (i.e., appetitive and defensive), due to the primary role of the valence dimension of the emotional triggers (Bradley et al., 2001; Lang et al., 1997). In addition to hedonic valence, arousal also represents a basic parameter in these two motivational systems. In fact, arousal cannot be viewed as having a separate substrate but rather as reflecting variations in the activation (i.e., metabolic and neural) of one or both systems (see Cacioppo & Berntson, 1994).

Generally, valence determinates which system must be activated (i.e., "flight or fight"), while arousal determinates which trigger stimulus could promote an emotional reaction (i.e., emotional threshold). In particular, pleasant emotions are associated with the activation of the appetitive system, the innate tendency to approach; whereas unpleasant emotions are more frequently associated with the activation of the defensive system, the innate tendency to escape. Moreover, the emotional arousal level modulates humans' attention resources (Bradley, 2000; Lang et al., 1997) and then the subsequent intensity of the emotional response (Sloboda & Juslin, 2001). Particularly, arousal typically refers to the physiological activation that in turn triggers automatic nervous system responses (Khalfa, Isabelle, Jean-Pierre, & Manon, 2002). Common tools to investigate these automatic nervous system reactions are the skin conductance (SCR) and the heart rate measurements (HR) (Lang, 2014; Kreibig, 2010).

In humans, the integration of information from different sensory modalities is fundamental for interacting with the surrounding environment and respond to external triggers (Darwin, 1872). Emotional responses can be elicited by stimuli in different sensory modalities (Gomez & Danuser, 2004). Imagine, for example, to watch a highly arousing video without sound. Then, add a congruent, highly arousing sound. Would the emotional response be any different? Marin, Gingras, and Bhattacharya (2012) have demonstrated that there is a crossmodal transfer of arousal from the auditory to the visual domain. These authors suggested that emotional information in one sensory modality could influence the processing of emotional information in other sensory modalities. In fact, other studies supported the idea of an integration of the affective multimodal information (see Spreckelmeyer et al., 2006): Humans integrate information from both verbal and nonverbal emotional cues during emotion processing (de Gelder, Böcker, Tuomainen, Hensen & Vroomen, 1999; de Gelder & Vroomen, 2000; Van den Stock, Rightart, & de Gelder, 2007). Over the last few years, olfaction has also been considered within this crossmodal approach. However, research on the effects of the olfactory stimuli in interaction with other senses on emotions or on cognitive performance has focused exclusively on the specific emotion of fear (cf. Chen et al., 2006; Partan & Marler, 2005).

To the best of our knowledge, research on the influence of sensory information on emotions has hardly focused on how crossmodal interactions may influence emotional arousal. While several studies have shown the effects of emotion elicitation through visual scenes and pictures (e.g., Lang & Bradley, 2007; Rottenberg et al., 2007), empirical studies on the combined effect of music (Baumgartner, Esslen, & Jäncke, 2006; see Gerdes, Wieser, & Alpers, 2014 for a review; Khalfa et al., 2002) and smell (Banks, Hg, & Jones-Gotman, 2012; Pollatos et al., 2007) on the processing of affective pictures are, as of yet, missing. Indeed, music is frequently described as an emotional language (Peretz, 2006); tempo is well known as a structural property of music that conveys information regarding valence (Hevner, 1935, 1937) and arousal of the musical piece (Balch & Lewis, 1999; Gabrielsson & Lindström, 2001; Thompson & Robitaille, 1992). It has been shown that listening to sonatas by Mozart can induce arousal that subsequently enhances cognitive performance, for instance increasing spatial-temporal abilities (Rauscher, 1999). Indeed, the "Mozart effect" modulates not only a listener's general arousal state but rather and specifically the "enjoyment arousal" (Husain, Thompson, & Schellenberg, 2002; see Chabris, 1999 for a meta-analysis). Furthermore, the ability of music to induce arousal is reflected in patterns of frontal electroencephalographic (EEG) activity; the increase of the overall frontal EEG activity is greater for intense music than for calm music (Schmidt & Trainor, 2001). Thus, music is a powerful elicitor of emotion (Altenmuller, Schürmann, Lim, & Parlitz, 2002; Krumhansl, 1997) that can trigger a clear physiological response, due to both the arousal and the valence dimensions (Baumgartner et al., 2006; Husain et al., 2002).

Just like pictures and music, also smell can directly elicit emotional responses due to the shared common brain pathways of emotions and olfactory processing (Ehrlichman & Bastone, 1992; Savic, 2001; see also paragraph 2.4.2 and Soudry et al., 2011, for a review). Valence and intensity are the main attributes commonly associated with smells, and both those attributes have a direct effect on the amygdala activation (Anderson et al., 2003; Herz et al., 2004). However, the capacity to induce arousal is also an important attribute associated with smells (Lorig & Roberts, 1990; Millot et al., 2002; Torii et al., 1988). The arousal-inducing capacity of a smell is directly linked to its intensity (Bensafi et al., 2002c, 2002a, 2002b). Indeed, previous research has shown that odours can induce activation or relaxation states by provoking changes in physiological responses (i.e., HR or SCR) (Alaoui-Ismaili et al., 1997; Bensafi et al., 2002; Ilmberger et al., 2001).

Taking into account also the classical literature on crossmodal correspondences (Crisinel, Jacquier, Deroy, & Spence; 2013; Gilbert, Martin, & Kemp, 1996; see Spence, 2011 for a review), we decided to investigate to investigate the combined effect of auditory and olfactory stimuli on processing of emotional pictures. Specifically, olfactory and auditory stimuli that are congruent/incongruent in terms of their arousal level were selected: two kinds of smell (i.e., orange and lavender) and the same piece of classical music with two different tempi (i.e., 165 and 60 bpm) were used as ambient stimuli. The goal of this study is to assess the arousing effect of congruent versus incongruent olfactory and auditory cues, in the context of ambient stimulation, on the processing of affective pictures (i.e., International Affective Picture System, Lang, Bradley, & Cuthbert, 1999). To this purpose, implicit and explicit self-report emotional assessment and physiological measurements (i.e., SCR and HR) were used in the experiment. The emotional responses were measured while participants viewed pictures with varied affective (i.e., pleasant and unpleasant) and neutral contents.

4.2 Materials and Methods

4.2.1 Participants

Sixty-six participants, split into four groups according to 2 (high and low arousal smell) × 2 (fast and slow tempo music) between-participants experimental design were recruited at the University of Oxford and took part in the study (27 males, M = 24.4 years, SD = 4.92 years, range 18-34 years).

The Central University Research Ethics Committee of the University of Oxford approved the experiment. The experiment lasted for approximately 40-50 minutes. Before taking part in the experiment, all participants read the information sheet and gave written consent. People who claimed to be affected by any olfactory or auditory dysfunction, as well as people who were affected by temporary conditions known to alter olfactory or auditory functions were excluded from the experiment.

4.2.2 Stimuli

Two smells were used to modulate the arousal level of the participants. Specifically, orange smell (100% Citrus, pure essential oil) was selected as a stimulating odour, while lavender smell (100% pure essential oil) was selected as a relaxing odour (Diego et al., 1998; see Herz, 2009 for a review; Hongratanaworakit, 2004). In order to obtain a smell-saturated environment, the smell was diffused in the experimental booth, rather than being directly administered to the nose of the participant by means of an olfactometer: A burst of smell was diffused every 6000 ms throughout the duration of the experimental session. In this way, a consistent exposure to the smell was ensured. A computer-controlled olfactometer was used in order to perfectly control the quantity, intensity, pressure, and duration of the olfactory stimulation, with the aim to replicate the same stimulation for each participant.

The same piece of music presented in two different tempi was used to modulate the arousal state of the participants. The two types of music tempo (fast and slow tempo) were obtained by computer-editing the MIDI file of the first movement of Mozart's sonata K. 448 (MIDI file created and used by Husain et al., 2002) using the open-source software Audacity®. The movement was performed by a single piano; its key was D major. The tempi of the sonata for the fast and slow versions were 165 and 60 bpm (Balch & Lewis, 1999; Holbrook & Anand 1990). The music was played back using stereo computer speakers at a level of 55 dB.

Moreover, to assess the interactive effect of environmental stimuli on emotional responses, a series of pictures from the International Affective Picture System (IAPS, Lang et al., 1999) were selected: twenty pictures with neutral valence, seven pictures with pleasant valence, and seven pictures with unpleasant valence (see Figure 4.1, B, C, and D). The pictures were selected to be similar in term of rated affective arousal but necessarily varied in rated hedonic content.

Figure 4.1 The set of experimental visual stimuli selected for the experiment. (A) The 21 Chinese ideographs selected for the implicit measurement of emotions, presented after pictures exposition. (B) The 20 neutral IAPS

pictures selected to be used for the baseline biofeedback measurement and the experimental phase. (C) The 7 unpleasant IAPS pictures selected to be used in the experimental phase. (D) The 7 pleasant IAPS pictures selected to be used in the experimental phase.

In addition, a selection of 21 black Chinese ideographs (see Figure 4.1, A) presented on a white background screen was used as target, allowing the participants to report the emotion that they were experiencing immediately after the priming with the emotional pictures. The implicit emotional assessment is made through the liking of these ideographs, on a seven-point Likert scale, where 1 = *not at all* and 7 = *very much*. Chinese ideographs have commonly been considered as affective neutral stimuli (Cacioppo, Priester, & Bernston, 1993; Murphy & Zajonc, 1993). Simultaneously, the participants' physiological response was registered in order to investigate the anatomic nervous system reactions to the emotion elicitation. The biofeedback was collected from sensors by an 8-channel encoder at a sampling rate of 100 Hz (sensors and encoder by Thought Technology Ltd., Montreal, CA.)

The overall emotional experience was measured using a 30-item version of the profile of mood states questionnaire (POMS; McNair et al., 1992; Reddon et al., 1985). The items consist of different adjectives used to describe the emotional experience of the participants (i.e., explicit emotional assessment). Each adjective is rated on a seven-point Likert scale (1 = *not at all*, 7 = *very much*). Scores were calculated only for two sub-dimensions of the scale—arousal/energy and valence. Ratings for the other subscales (Tension–Anxiety, Anger–Hostility, Fatigue–Inertia and Confusion–Bewilderment) were not considered in the analysis, but the entire form was administrated in order to avoid tampering with its psychometric properties (McNair et al., 1992). This questionnaire was used to investigate the participants' overall emotional response to the experimental procedure.

4.2.3 Procedure

The procedure followed a 2 (smells: orange and lavender) x 2 (music tempi: fast and slow) between-subject experimental design. The volunteer was comfortably seated on a chair in a darkened experimental booth, approximately 70 cm away from a desktop computer (resolution 1280 x 960 pixels, refresh rate 70 Hz). Immediately after, participant was informed about the division of the experiment in two separate parts.

In the first part of the experiment, a baseline of participant's physiological indices was recorded, for approximately 8 min. All the sensors were placed on the participant's left hand, and the participant had to remove any wristwatches and rings prior to the physiological measurement. Particularly, skin conductance response (SCR) was measured from electrodes placed on the second and fourth fingertips, blood volume pulse (BVP) was measured from a photoplethysmograph placed on the third finger, and skin temperature was measured from the fifth finger. After the application of all the sensors, the participant was instructed to avoid any movements during all physiological measurement while watching a series of pictures that would appear on the monitor, and to keep attention for the entire time of permanence of that picture on the screen. Thirteen IAPS pictures with neutral content valence were shown in random order. Each picture remained on the screen for 15 s and was preceded by a fixation point; the duration of each fixation point varied randomly between 5 to 8 s.

In the second part of the experiment, the participant was informed, both with oral and written instructions, about the ambient stimulation that would be presented and about the ideograph rating procedure. The liking rate of ideographs was made on a seven-point Likert scale, using the mouse. In particular, two screens containing all instructions were presented. In addition, they were informed to limit the movements to only the use of the mouse with the right hand (i.e., to select the ideograph's liking) and to keep the attention on the centre of the screen for all the duration of the pictures' vision. In the booth, the presentation of the Mozart sonata and smell began simultaneously, with the appearance of the second screen of the instructions. In contrast with the first part of the experiment, all twenty-one IAPS pictures, with the three content valences, were randomly presented for 15 s each. A frame containing the ideograph and the liking rate of that ideograph followed each picture. All visual stimuli, pictures and ideograph liking, were separated by a screen with a fixation point with randomly chosen duration between 5 to 8 s (in steps of 1 s). The outline of the experimental procedure is presented in Figure 4.2.

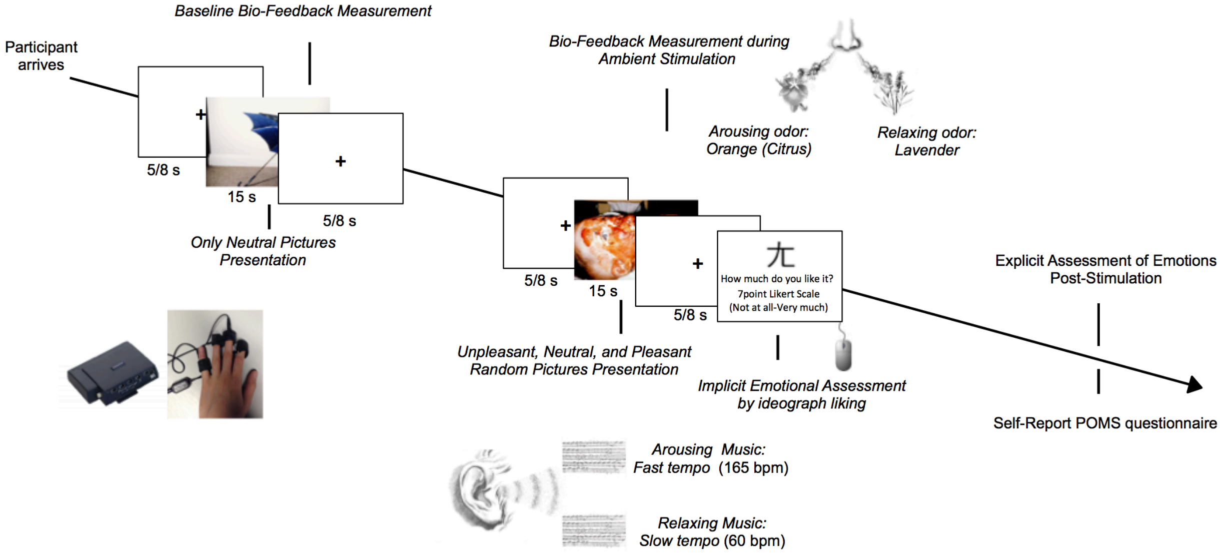


Figure 4.2 Timeline of the study, schematically represented.

Finally, in the post-stimulation phase the participant was asked to assess their explicit emotional experience. Every single adjective of the POMS questionnaire was rated on a seven-point Likert scale, where 1 = *not at all* and 7 = *very much*. We subsequently debriefed the volunteer.

4.3 Results

In the present experiment we collected two types of self-assessment measures of emotion: an implicit measure, through an ideograph rating procedure (Cacioppo et al., 1993; Murphy & Zajonc, 1993), and a direct measure, using a self-report questionnaire (POMS). Furthermore, participants' measures of the physiological indices (HR and SCR) were collected throughout the emotion elicitation phase. These measures were used to assess the combined effects of congruent versus incongruent arousing music and smell on the processing of emotional pictures. The analyses performed on these measures (i.e., dependent variables) are presented and discussed separately. We have not analysed data regarding participants' temperature, due to technical problems of the specific sensor.

Ideograph liking. We used a linear mixed model to test the interactive effects of visual (IAPS pictures), music (fast and slow tempo music), and olfactory (orange and lavender smells) stimuli on participants' emotional state.

First of all, the assumption of the emotion neutrality of each ideograph used was tested. However, this assumption was not confirmed ($p < .01$). To ensure that, we removed data of ideographs with a distance of one or more standard deviations from the overall mean scores. The data of the remaining 18 ideographs satisfied the assumption of neutrality ($p > .05$).

To estimate the model we used the software *R* (R Core Team®, 2013) with the lme4 package (Bates, Meachler & Bolker, 2013). We analysed the ideographs liking ratings as a function of the music, the smell, and the expected pictures valence, adding all their respective errors. We used a mixed model to account for the variability due to a repeated measures design, in which the subjects represented the grouping factor. The intercepts and the expected valence slopes were specified as random effects. Since the linear mixed-effect model estimates these intercepts, it constitutes a better tool to investigate variability in participants and in expected valences than other traditional analysis methods, such as mixed multi-factor ANOVA (Baayen, Davidson, & Bates, 2008). The two within-subjects (i.e., smell and music) and the one between-subjects (i.e., three expected pictures valence: negative, neutral, and positive valence) factors, were specified as fixed effects, thus resulting in a mixed 2 x 2 x 3 design model. Formally, the fitted model can be expressed as:

$$Y_{ij} = S + M + Ex + s_i + i_j + \varepsilon_{ij}$$

where "Y_{ij}" is the liking rating of ideographs for participant ("i") and picture ("j"), "S", "M", and "Ex" are the fixed effects of the independent variables (i.e., "S"= smell, "M"= music, and "Ex"= expected pictures valence), "s_i" and "i_j" are the random effects accounting for between-subjects' and expected picture valences' variability and "ε_{ij}" is the overall error of the model.

As expected, the analysis revealed a statistically significant priming effect of the picture valence on the ideograph judgment ratings ($F(2, 79.05) = 7.03$, $p < .01$). The exposure to neutral and positive valence of the IAPS pictures increased the liking ratings of the ideographs, compared to the exposure to negative valence pictures. The main effects of the music and smell were not significant, as well as the two-way interaction effects between each of the three independent variables (i.e., expected valence and music, expected valence and smell, smell and music). Finally, the three-way interaction effect was statistically significant ($F(2, 79.05) = 3.31$, $p < .05$). More specifically, the mean of the ideographs judgments significantly varied in function of the experimental condition and of the expected valence of the pictures to which the participant was exposed immediately before judging the ideographs. This indicates that the type of visual, olfactory, and auditory stimulation influences this judgement. In fact, when participants were exposed to neutral pictures with the auditory and olfactory congruent combination (i.e., high-arousal smell and fast-tempo) the mean score of the ideograph liking ratings was higher and significantly different from the congruent low-arousal condition (i.e., low-arousal smell and slow music tempo) ($t(56.94) = 2.57$, $p < .05$) (see Figure 4.3).

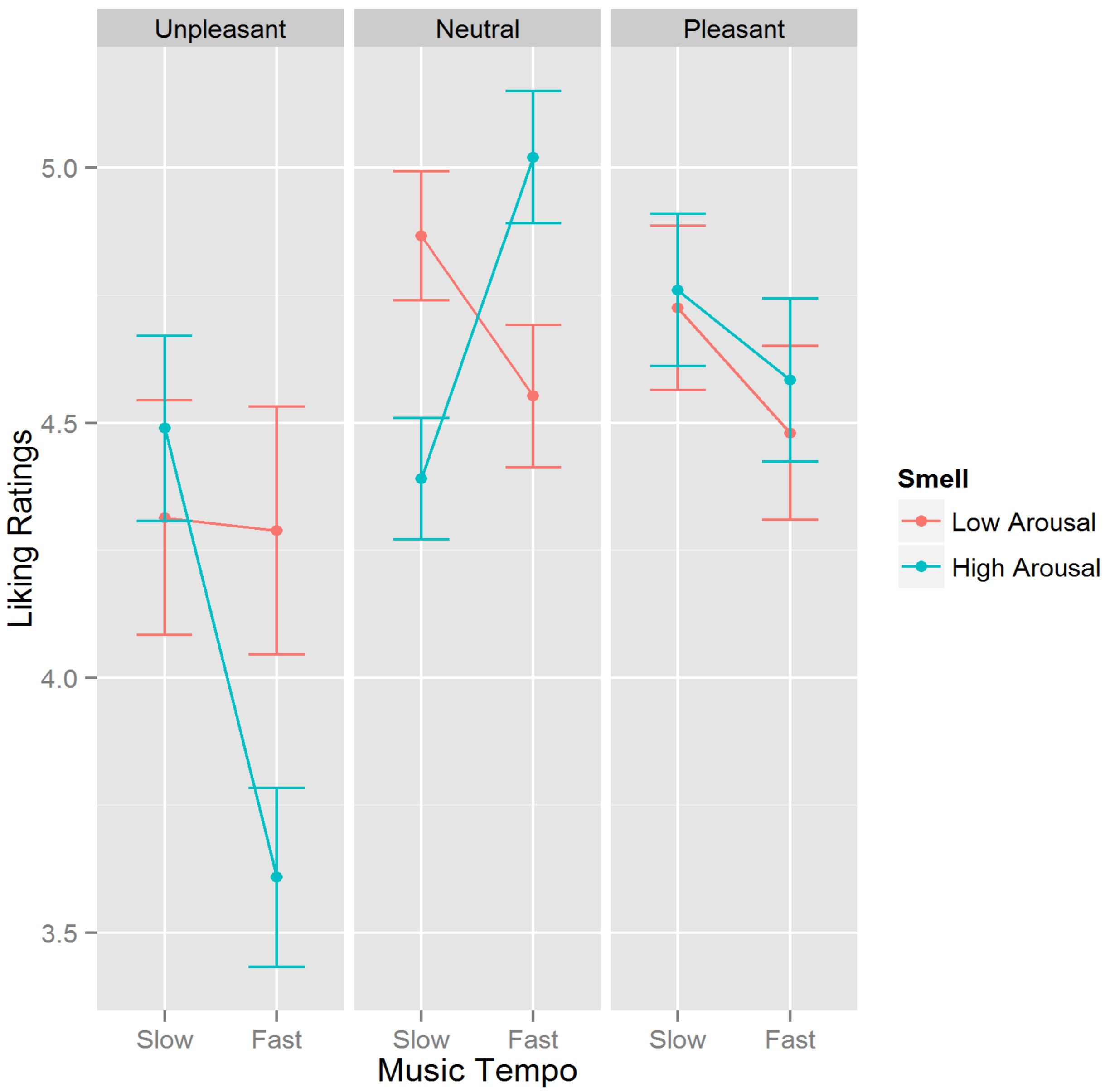


Figure 4.3 The predicted mean values of the ideographs' liking rate for the 3 factors of interactions: 3 expected pictures' valence (negative pictures valence, neutral pictures valence, and positive pictures valence), 2 levels of smell (i.e., low-arousal: lavender, high-arousal: orange) and 2 levels of music (i.e., low-arousal: slow-tempo, high-arousal: fast-tempo).

Profile of mood state questionnaire (POMS). In the last part of the experiment, participants were asked to rate their emotional state post-stimulation through POMS. To further investigate this hypothesis and in order to group the emotional adjectives of the POMS, we performed an explorative factor analysis (EFA) on the participants' ratings for the 30 items constituting the POMS (see Table 4.1). The EFA produced six groups of emotions distributed across two dimensions (factor 1 = valence, factor 2 = arousal) (Bradley & Lang, 1994): positive (α = .892), positive high-arousal (α = .779), positive low-arousal (α = .886), negative (α = .901), negative high-arousal (α = .745) and negative low-arousal (α = .778) valence.

Table 4.1 Two-factor solutions, resulting from the EFA performed on participants' ratings of 30 POMS items. Factor 1 represents the valence dimension, whereas Factor 2 represents the arousal dimension.

Next, we performed a series of 2 × 2 (i.e., two levels of smell and two levels of music) ANOVAs to evaluate the effects of music and smell on the six groups of emotion valence obtained with the EFA.

The results showed an interaction (see Figure 4.4) effect between music and smell on positive high-arousal emotional state ($F(1,57) = 7.652$, $p < .05$). In both the conditions of congruent arousal stimulation (i.e., high-low arousal smell and fast-slow tempo), positive high-arousal state was rated higher than in the incongruent conditions.

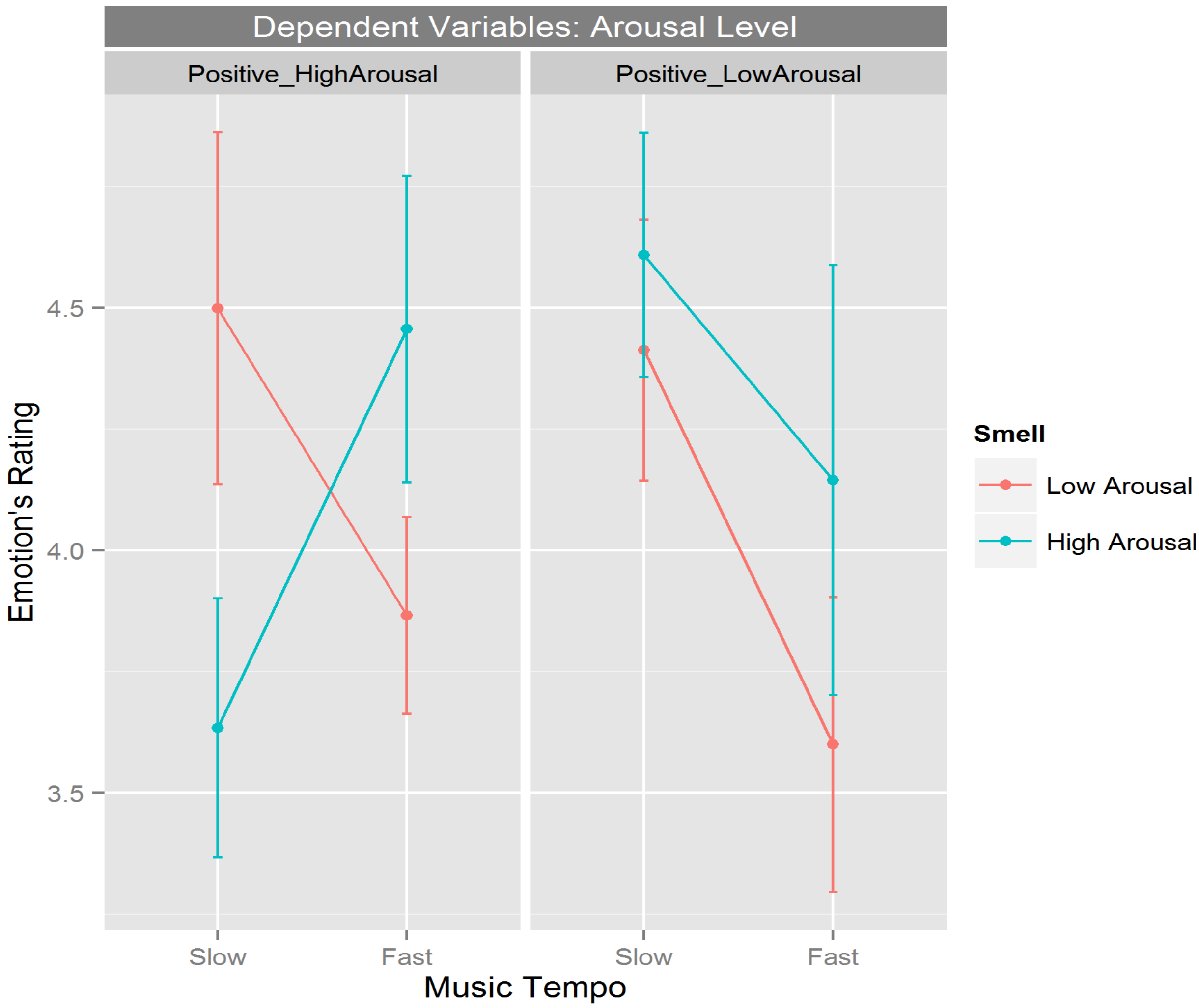


Figure 4.4 Mean scores of the positive high arousal and positive low-arousal emotional states scored in self-report questionnaire POMS: 2 levels of smell and 2 levels of music.

However, the Tukey post-hoc comparisons showed a marginal trend toward significance (p = .07) in the mean score of the positive high-arousal state between the congruent and the incongruent condition of high-arousal ambient stimulation, and the mean score in the incongruent condition.

Heart rate (HR). Recordings of the blood volume pulse (i.e., BVP) sensor were analysed in terms of heart rate (i.e., HR). Primarily, high and low pass Butterworth filters were applied to the raw signal of the heart rate waveforms, in order to account for eventual drift and to clean signal noise (see Haag, Goronzy, Schain, & Williams, 2004). The HR was measured as the number of beats within one minute. The HR delta scores were calculated for each participant and each trial (i.e., each picture presented with different content of valence) as the difference between the HR mean scores post-stimulation and the HR mean scores pre-stimulation (2 s before pictures' viewing). The HR change, occurring between 0 and 6 s of picture viewing, was considered the HR post-stimulation. Participants with more than 70% of missing data were excluded from the analyses and data of twelve participants were omitted, due to technical errors during the recording process. Thus, scores of fifty-four participants were analysed.

As for the previous analyses, we used a mixed model to assess the trend of the HR changes during the stimulus presentation. Nevertheless, in contrast to the previous model used to analyze ideographs ratings, we modelled the HR time changes by using a mixed-effect polynomial model and testing for cubic, quadratic, and linear time effects (Bradley et al., 2001). All higher-order parameters were included to test a nonlinear trend changing over time; thus, linear, quadratic, and cubic effects were added to the model, both for fixed and random effects.

A cubic model provided appropriate fit for the HR changes: in fact the HR changes had not a linear distribution ($p > .05$). The three-way interaction effect between music tempo (i.e., fast and slow tempo), smells with different arousal level (i.e., orange and lavender), and expected pictures' valence was significant ($F(2, 10190) = 5.42$, $p < .01$) (see Figure 4.5). In particular, in the high-arousal condition and in the case of the priming with neutral pictures, the maximum interaction effect between ambient variables on the HR changes were scored. Significantly different to HR changes in the low-arousal condition and in the case of the priming with pleasant pictures ($t(10190) = 2.70$; $p < .01$).

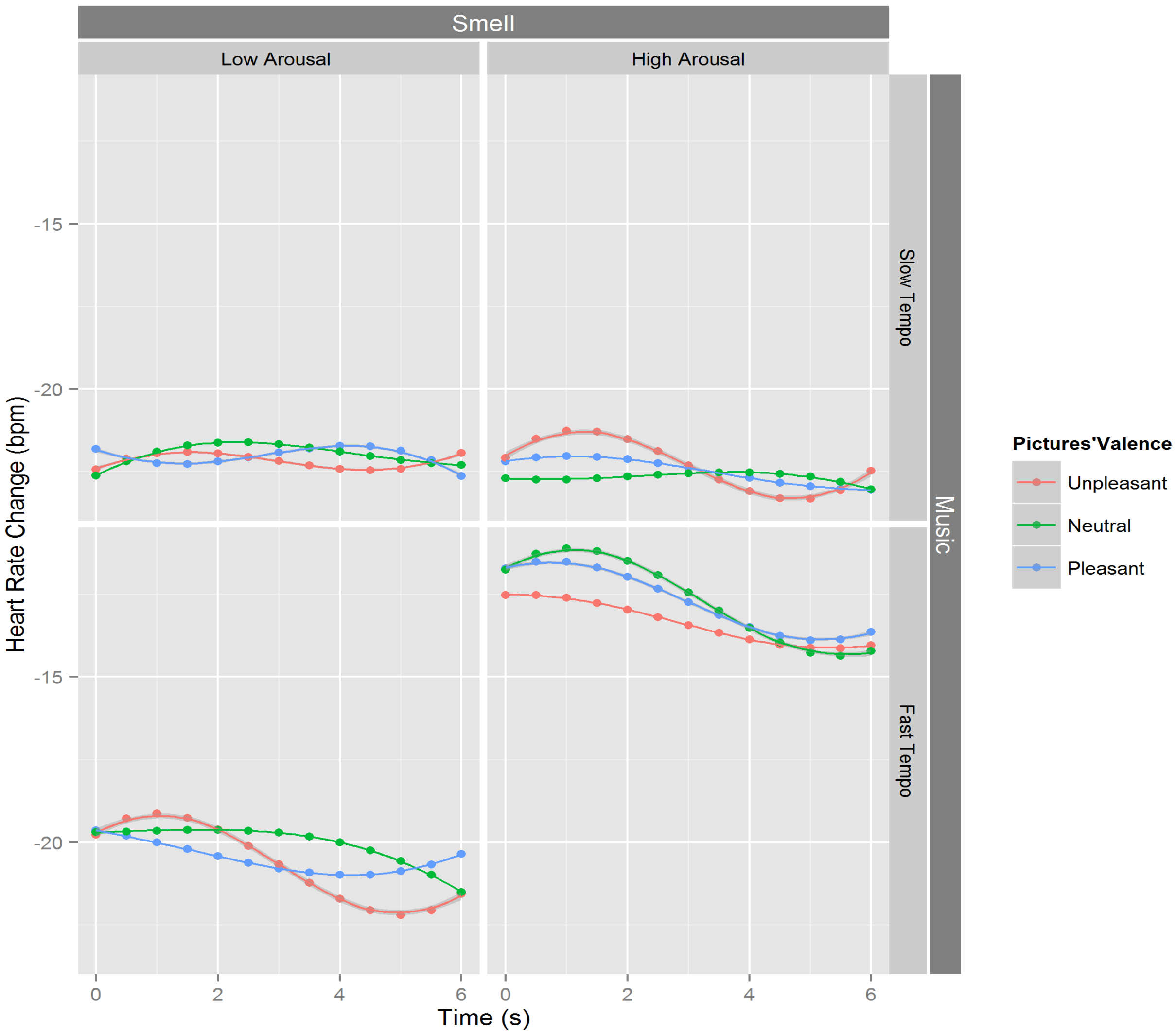


Figure 4.5 Graph of the mean scores of the HR predicted changes of the cubic mixed-model tested, in function of the different valence contents of pictures

However, neither the main effects of music and smell nor the main effects of expected valences were significant ($p > .05$). Interestingly, in the condition of congruent arousal activation, the HR was higher than in the other condition, even though with the priming of neutral pictures a deceleration of HR was observed ($p < .01$).

In sum, the analyses of the HR changes have shown that expected valance of pictures affected the cardiac response. Additionally, the cardiac response was reduced when one of the two ambient stimuli were presented at low-arousal level. This suggests that the HR is only increased in congruent high-arousal setting, that is, when fast tempo music and a high-arousal scent are perceived.

Skin conductance response (SCR). For the analysis of the skin conductance response, the maximum change occurring after the picture onset, from 0 to 6 s, was scored. A log transformation (log [SCR +1]) was performed to normalize the data. The SCR delta scores were calculated for each participant and each trial (i.e., each presented picture valence) as the difference between the SCR mean scores pre-stimulation (2 s before pictures presentation) and the SCR post-stimulation scores. Participants with missing data were excluded from the analyses; the scores of fifty-four participants were analysed. Similar to the analysis of the HR change, a polynomial mixed model was used to analyse SCR changes, testing for cubic, quadratic, and linear time effects (Bradley et al., 2001). Thus, as in the HR model, linear, quadratic, and cubic effects were added to the model, both for fixed and random effects. A cubic model perfectly fitted the data ($p < .05$). The three-way interaction between music, smell and the expected content valence of the pictures was significant (F (2, 12608.48) = 4.22, $p = .01$). Moreover, the expected content valence of pictures (F (2, 49.19) = 6.75, $p < .01$) and the interaction effect between expected valence and music tempo (F (2, 12610.76) =

4.83, $p < .01$) significantly influenced the SCR change (see figure 4.6). The results showed that the effect of the congruent arousal stimulation on the SCR change post-pictures viewing was more marked, in comparison with the HR change after pictures viewing.

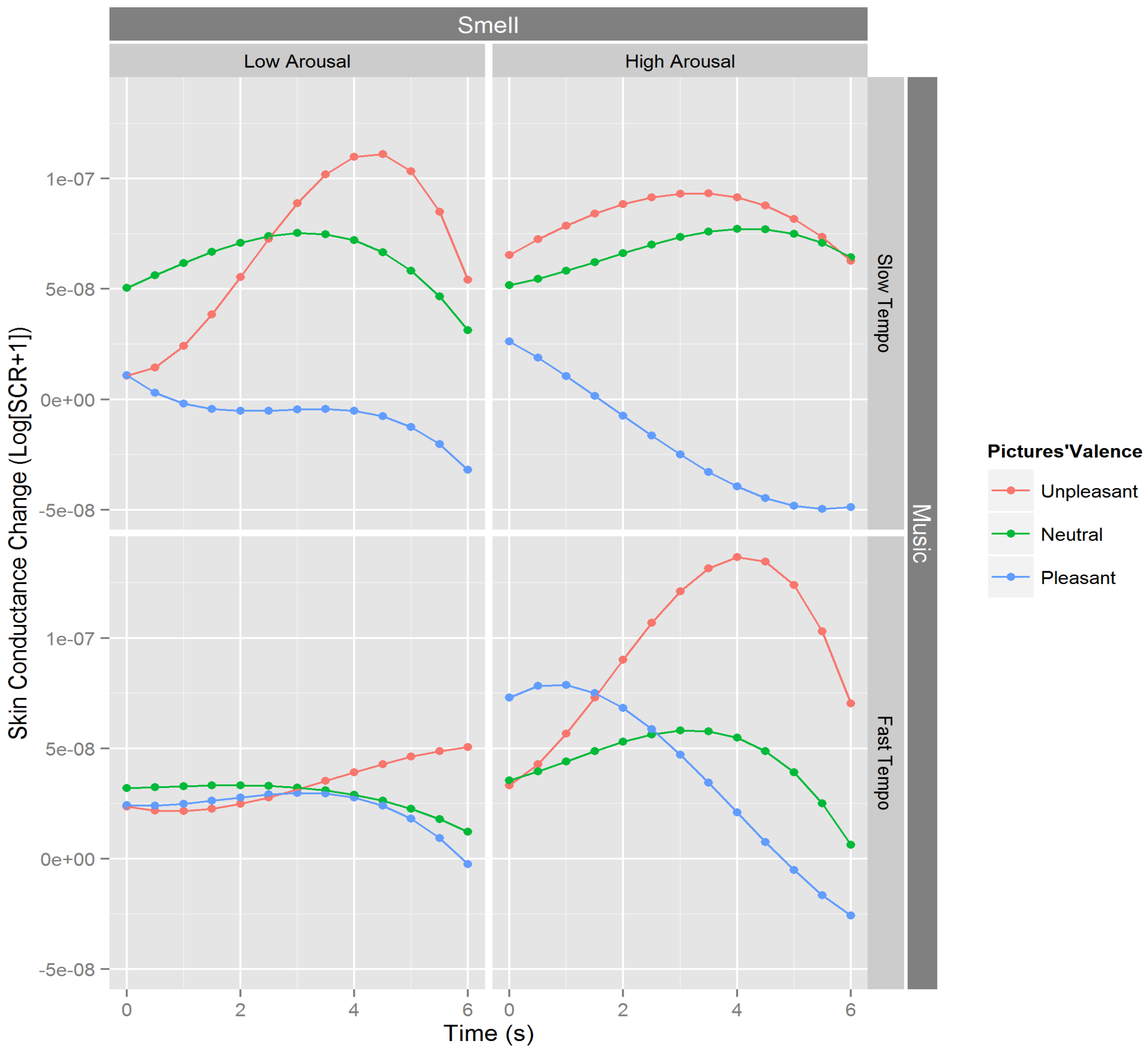


Figure 4.6 Graph showing the mean scores of the SCR (μSiemens) predicted changes of the cubic mixed-model tested, in function of the different valence contents of pictures.

Particularly, in the condition of maximum arousal activation (i.e., fast-tempo and orange smell) the SCR change score was higher and the effect was observable longer than in the other experimental conditions, however only with the negative pictures priming. In addition, no evident effects on SCR change in the incongruent arousal condition were detected. Pictures with pleasant content were perceived as less attractive and less activating by participants, indeed they seem to get rapidly used to those pictures with a pleasant valence. That is, the SCR change during the viewing of the pictures with pleasant content was less intense and less persistent than that related to pictures with unpleasant content.

4.4 General discussion

4.4.1 Summary of results

The present findings are of theoretical and practical importance. We showed that arousal congruence versus incongruence of auditory and olfactory environmental cues can influence the emotional response to visual affective stimuli (i.e., IAPS pictures). We used the implicit and the explicit assessment of the perceived emotions and the physiological responses (i.e., HR and SCR) to the visual, auditory and olfactory cues.

In particular, the four main results of the present work overall showed how varying the valence contents of pictures presented with a different arousal ambient stimulation (i.e., congruent vs. incongruent) determinates a different implicit emotional assessment, besides a different physiological pattern of activation. First, an interaction effect of music and smell on the implicit assessment of emotion was showed only after the priming with neutral valence pictures; consequently, in both the congruence combination of the ambient cues (i.e., high-arousal and low-arousal stimulation) the rate of ideograph liking was higher in comparison to the incongruent conditions of stimulation (i.e., fast-tempo music and lavender, slow-tempo music and orange). Second, the self-report questionnaire to assess the emotional state of participants after the experimental manipulation revealed once again an interaction effect of the two ambient variables (i.e., music and smell) on the positive high-arousal state. Indeed, in the congruent condition of stimulation, the perceived high-arousal emotional state was rated higher in comparison with the incongruent condition (i.e., fast-music and lavender smell, slow-music and orange smell). On the contrary, the positive low-arousal state of emotions was influenced only by the music tempo; with the presence of slow-tempo sonata participants rated this perceived state higher compared to the conditions with fast-tempo music. Third, the measure of the HR changes showed a priming activating effect of the expected valence of the pictures in addition to an interaction of this priming effect with the two ambient variables we manipulated (i.e., music and smell). Particularly, in the condition with fast-tempo, high-arousal smell and priming with neutral pictures, the maximum interaction effect of ambient variables were observed on the HR changes, in comparison with the condition of slow-tempo music, low-arousal smell and the priming with pleasant pictures. Fourth, a priming effect of the expected pictures valences, in addiction to an interaction between this priming effect, the music tempo and the smell on the SCR changes, were observed. In particular, in the condition of fast music and high-arousal smell with the priming of both neutral and pleasant pictures, the maximum effect of the ambient was registered, in comparison with the priming effect of unpleasant pictures in the condition of low-arousal stimulation (i.e., slow-tempo and lavender smell). In general, one more time, the interaction between smell and music on the SCR changes was clearly different in function of the arousal congruence of those two sensory modalities stimulation.

4.4.2 Discussion

Classical music with different tempo and smell with different affective state, taken together, can markedly enhance the emotional responses to affective pictures. These findings are in line with previous literature on the synergic effect of affective music and pictures on emotions (Baumgartner et al., 2006; Koelsch et al., 2004). However, to our knowledge, the present study is the first one that tried to assess the combined effect (congruent vs. incongruent) of multisensory arousing stimuli on the emotional experience evoked by affective pictures.

In particular, the emotions perceived by the participants were investigated using implicit tests and self-report questionnaires. On one side, the task to rate the liking of neutral Chinese ideographs allowed the participants to implicitly report the valence of the emotion that they were experiencing immediately after the exposition to pictures with neutral contents and with different valence contents of emotions (i.e., pleasant and unpleasant). The results of this implicit assessment of emotions clearly showed that listening to classical music and smelling affective scents could significantly influence the subsequent evaluation of those ideographs. This ambient effect was larger and significant for the priming with neutral pictures; particularly, the congruent combination of both auditory and olfactory cues increased the liking rates, despite of the arousal level of those ambient cues. Instead, the visual affective information seemed to be more salient and predominant on the other two sensory channels (Campbell, 2008; Recanzone, 2009; Smith, 2007). In fact, a clear interaction effect between music and smell did not emerge in the implicit evaluation of emotion after the exposition to unpleasant and pleasant pictures. Therefore, the emotional content elicited by pictures (i.e., unpleasant and pleasant) cannot be completely modulated by ambient stimuli. On the other side, the measurements of how the participants perceived their emotional state post-stimulation, through POMS questionnaires, permitted to evaluate the overall arousal level after the experimental manipulation. The results of this explicit assessment of emotion interestingly showed a higher rate of positive high-arousal emotion, in conditions of a congruent combination of arousal stimulation. As we expected, there was not a marked effect of the arousal level of the stimulus types (i.e., lavender and slow-tempo, orange and fast-tempo) on the self-assessment of emotion, despite of a marked effect of the combined congruent ambient cues. In the self-assessment of emotions, the higher level of the high-arousal state estimated by participants in the congruent ambient condition (high-arousal vs. low-arousal stimulation) can be maybe due again to the combined additive congruency effect of ambient stimulation rather than to the expected arousing levels. In contrast, with the effect of congruent combination of arousal ambient cues (i.e. fast-tempo and orange smell, slow-tempo and lavender) on the participants' perception of the high-arousal emotional state, the positive low-arousal emotional states had a strong correlation with only congruent low-arousal stimulation. In particular, in the condition of lavender smell and slow-tempo, this emotional state was scored higher in comparison with the rates of the other conditions. However, this result seemed to be mostly due to the predominance of the music tempo, in line with previous studies that showed that music can transfer emotion to visual stimuli (Logeswaran & Bhattacharya, 2009). Prior research has also shown that participants can self-evaluate their autonomic nervous system activity with difficulty (Alaoui-Ismaili et al., 1997): Participants' self-reported arousal does not correlate highly with their awareness of their physiological activation (Li, 2008).

In summary, the results of the emotions' self-assessments interestingly highlighted how affective stimuli presented in distinct modalities (i.e., auditory and olfactory) were mainly considered as more incisive and so with high influence on the emotional response of the participants, when presented in a congruent affective condition. In the present study, the cross-modal affective stimulation was modulated in the case of congruent ambient cues in terms of emotional arousal (i.e., music with different tempo and smells with different arousing level). Indeed, this multimodal integration of affective information stimuli supported the assumption that humans automatically evaluate afferent affective stimuli information thanks to an evaluative decision mechanism (Hermans, Baeyens, & Eelen, 1998; Zajonc, 1980). The main effect of the affective congruence stimuli on the perceived emotions was confirmed as a strategic cognitive process for simplifying the arousing information coming from the same temporal and spatial window form the surrounding environment. Indeed, when the arousing ambient cues were incongruent, they had a reduced impact on the evaluation of the emotions, even in presence of modality predominance (i.e., visual affective pictures).

The physiological indices (i.e., HR and SCR) of the participants were collected throughout the emotion elicitation phase (i.e., IAPS pictures exposition) with the aim to evaluate different automatic reactions due to the combined ambient cues (i.e., music and smell) stimulation with congruent and incongruent arousal dimension intensity. Our findings show a differentiation of physiological responses in function of the valence of the priming pictures and of the music tempo and arousing smell congruence stimulation.

In general, the physiological responses to affective cues are determined by a co-activation of both sympathetic and parasympathetic systems (Cacioppo et al., 1999). These physiological indices are typically characterized by cardiac deceleration, followed by a shift toward acceleration (Graham, 1979) and moderate electro-dermal increase (Vasey & Thayer, 1987). Normally, the affective visual stimuli in a passive viewing mode provoke a transitory physiological response that varies in function of the presented pictures valence (Baumgartner et al., 2006). The current results of the HR changes clearly highlighted an initial cardiac deceleration as response to the affective priming with pictures. However, this deceleration is marked in the condition of congruent high-arousal stimulation, with all type of pictures, and the HR per minutes before the pictures exposition seemed to be higher than the other condition. In general, participants were extremely activated by the combined stimulation with fast-tempo music and orange smell; this activation amplified the cardiac deceleration in response to all the affective pictures. Though, the pattern of that cardiac response was different in function of the pictures valence the participants were exposed to. On one side, in the case of the priming with pleasure pictures, there was no correlation with metabolic demands and thus evoked moderate automatic activation; this result is in line with previous literature (Bradley et al., 2001). Indeed, our results of the HR change showed an initial cardiac deceleration that remains stable for all picture exposition, paralleling results that were obtained with neutral pictures. Thus, positive emotions may recover faster from the cardiovascular activation than negative emotions (Levenson, 1994). On the other side, in case of priming with unpleasant stimuli, some scholars proposed a similarity with animal reactions on the basis of the physiological reactions to aversive stimuli (Bradley et al., 2001; Lang et al., 1997): Just like other mammals, human participants in the laboratory may react to the negative valence of pictures with a freezing state, consistent with the defence cascade model (Bradley & Lang, 2000; Lang et al., 1997). Our findings showed a marked cardiac deceleration after the exposition to negative pictures, which involved an arousal reaction greater than that elicited by the exposition to neutral and pleasant pictures.

Besides the results of HR changes, our findings of the SCR changes showed an electrodermal response to the affective priming with pictures, in line with previous research (Bradley et al., 2001). However, once again, as with the HR responses, the pattern of the electrodermal increase was different in function of the picture valence to which participants were exposed.

In the case of priming with pleasant pictures, as in the HR changes, there was a moderate automatic activation; this result is consistent with previous literature (Bradley et al., 2001). In fact, the SCR changes after the priming with positive pictures showed a rapid habituation effect with a subsequent immediate decrease, which was the consequence of the pleasure of relaxation coming from the exposition to positive pictures. Instead, the SCR responses after neutral pictures had an initially slow increment that was rapidly backed to the normal electrodermal activity in few seconds after picture exposition.

On the other side, the priming with negative pictures, as explained in the paragraph about the HR results, showed a rapid marked SCR increase. These affective responses serve a survival function consistent with the defence cascade model and reflect the motivational system (Bradley & Lang, 2000; Lang et al., 1997). This marked increase was higher in the condition of congruent high-arousal stimulation (i.e., fast music and orange smell) than in the condition of low-arousal congruent stimulation and in both incongruent conditions.

In summary, in our study, the physiological indices rapidly changed (i.e., HR decreased and SCR increased), mainly in the condition in which music and smell were in the congruent high-arousal condition (i.e., orange smell and fast-tempo). In a situation with high-arousal level, participants were prepared to promptly react to aversive stimuli. Moreover, the current findings were perfectly in line with the assumption that SCR is more reactive to the arousal dimension (Bradley & Lang, 2000; Khalfa et al., 2002; Sokhadze, 2007), while HR seems to be more related to the affective valence of visual stimulation (Lang et al., 1997; Sokhadze, 2007).

From a neuroanatomical prospective, the impact of the combined stimulation with congruent and incongruent auditory and olfactory ambient cues on the processing of emotional visual stimuli supports the integration theory of emotional neural network substrates. Indeed, the amygdala is a fundamental structure in emotion detection, both in animals and humans (see Armony, 2013 for a review): Empirical evidence from imaging studies have shown that the amygdala plays an important role in the processing of emotional visual (Phan et al., 2002), auditory (Klinge, Eippert, Röder, & Büchel, 2010) and olfactory cues (Gottfried et al., 2002). Our findings strongly support this evidence; the interaction between olfactory and auditory cues directly influences the processing of emotional visual cues. Future studies using neuroimaging techniques are needed to identify the brain areas involved in this multisensory integration, in the case of arousal.

In conclusion, in the present study, the cross-modal interaction between emotional stimuli presented in different modalities (i.e., visual, auditory, and olfactory) was tested using both behavioural and physiological measures. The presentation of visual affective cues in the same temporal window of congruent and incongruent (in terms of arousal intensity) auditory and olfactory cues showed a main effect of congruence of the ambient stimuli on the implicit and explicit perception of the emotional state. Our findings, relative both to physiological and self-report measurements, are in line with previous studies that investigated emotional reactions associated with the processing of affective pictures (Lang et al., 2001). Even the different effect, as experienced by participants, of the affective stimuli in three sensory modalities on the perceived emotional state (i.e., implicit and self-reported) and the profile of the physiological reactions support previous findings on the effect of scents on emotions (Chrea et al., 2009; Schifferstein et al., 2011). More importantly, this study specifically showed that it is the congruency between the affective information arriving from different sensory modalities (i.e., olfactory and auditory) that operates like a sort of “emotional synaesthesia”, amplifying the emotional reactions to affective pictures, in this case based on congruency and not on coherence of the ambient sensory information (e.g., consistent synesthetic perception) (Banks et al., 2012; Hochel et al., 2009). To the best of our knowledge, this study is one of the first studies that showed how the crossmodal congruency could improve the emotional experience.

4.4.3 Practical implications

The investigation of multisensory integration in the cause of emotions has enormous implications in the consumer behaviour research. From a practical perspective, emotional states evoked by marketing stimuli have indeed been found to exert a significant impact on consumer behaviour (e.g., Donovan & Rossiter, 1982; Donovan et al., 1994; Dawson et al., 1990; Laros & Steenkamp, 2005; Swinyard, 1993; Watson & Spence, 2007). For instance, Sherman, Mathur and Smith (1997), basing their work on the stimulus-organism-response framework, suggested that the environment of the store and consumers' emotional states could influence purchase behaviour. Walsh, Shiu, Hassan, Michaelidou and Beatty (2001), found that store-related cognitions influence emotions and particular emotions could mediate the relationship between cognition, satisfaction, and loyalty. Moreover, Cheng, Wu, and Yen (2009) found that store atmospherics (e.g., music and colour) can play an important role in consumers' emotions in online settings, which in turn can influence consumer behaviour. Furthermore, sensory information can directly influence consumers' emotions and subsequent behaviours (e.g., Krishna, 2012). Mattila and Wirtz (2001) showed that, when the arousal levels of ambient smell and background music matched consumers' evaluations of the shopping experience, the shopping experience definitely can be enhanced. Moreover, Schifferstein, Talke and Oudshoorn (2011) demonstrated that ambient smells could influence consumer's mood in a nightlife setting.

It is important to note that consumers generally perceive the world in a multisensory way, and the interaction between sensory information can influence emotional responses differentially. For example, Morrison, Gan, Dubelaar, and Oppewal (2011) showed that both the volume of music and the presence of a vanilla aroma can have a significant impact on shoppers' emotions and satisfaction levels. Spangenberg et al. (2005) demonstrated that the effects of an ambient Christmas smell are moderated by the nature of the background music and, in particular, that non-congruent combinations are unlikely to elicit favourable outcomes. Michon et al. (2005) observed that the interaction between (arousing) fast tempo music and citrus ambient odour triggers some cognitive processing through shoppers' perception of the mall environment. Taken together, these results provide evidence for the idea that there is a relationship between sensory information, emotional processes and consumer behaviour. Consequently, it is fundamental to thoroughly investigate the multisensory integration in the case of emotion elicitation. The present study is the first laboratory research that attempted to test the influence of music and smell on visual affective stimulation. The literature, previously discussed, showed how the manipulation of the sensory information influences the emotional processes and so the consumer behaviour. Indeed, the present findings have important practical implications in the sensory marketing field. For instance, from those results future research can be developed to investigate this combined multisensory interaction on the evaluation of products' quality or on the general experience of consumers.

4.4.4 Limitations and further research

There are some limitations that need to be mentioned. First, there is no possibility to have a control condition in which both smell and music would be neutral, as a neutral stimulus could not be used as a music piece because every type of music transmits emotional information (Baumgartner et al., 2006; Krumhansl, 1997). Second, the timing of emotional processing represents an issue that needs to be controlled (Sabatinelli et al., 2009); for example the time of exposure to pictures and the number of pictures presented could modify the emotional processing, reactions, and even influence the habituation effects (Carretié, Hinojosa, & Mercado, 2003). In our study, the experimental paradigm of picture presentation closely resembled the one already used by Bradley et al. (2001) in their research to avoid any timing bias.

Third, it is possible that the self-report questionnaire for the explicit assessment of the emotional experience may have induced linguistic and/or cultural bias in participants (i.e., different interpretation of the same emotional label due to language differences). In order to avoid those kinds of biases, future research designs should not use such item-based self-report questionnaires. Instead, more consistent explicit measures of emotion, such as the Self-Assessment Manikin (Bradley & Lang, 1994) could be used to avoid any problem regarding linguistic and cultural bias (Levenson et al., 1992; Stearns & Parrott, 2012). The self-report questionnaire used (i.e., POMS) in the present work aimed to investigate the participants' introspective assessment of emotions. The measure of the perceived emotions through questionnaires based on adjectives that describe emotional state give extensive knowledge of the emotional state of people but at the same time, it requires a homogenous sample of participants, in terms of cultural background.

In addition, an issue that could be of great theoretical and practical importance is to consider a cross-cultural sample. Few studies have investigated the cross-cultural comparison in the emotional responses to music (e.g., Gregory &Varney, 1996; Higgins, 2012) and to odours (e.g., Ayabe-Kanamura et al., 1998; Ferdenzi et al., 2011; Levitan, et. al., 2014) and there is lack of studies on the combined effect of music and odour in different countries.

In general, basic research such as in the present study provides new knowledge on the cross-modal interaction in the context of affective information, in the case of arousal. In doing so, the present study can be expected to stimulate further research in both neuropsychology and sensory marketing. The interaction between different sensory modalities (i.e., vision, audition, olfaction, taste, and touch) in terms of affective responses (i.e., positive and negative emotions) and affective modulation (i.e., reduce or increase an affective reaction), is far to be extensively investigated.

CHAPTER 5 - Crossmodal Correspondences between Odours, Sounds, Shapes, Colours, and Emotions: A Preliminary Study

5.1 Introduction

From birth, humans are surrounded by a myriad of chemical molecules that stimulate the perception of smell in every moment of their life. The olfactory system is virtually able to recognize and discriminate among millions of different chemical compounds (see Chapter 2, paragraph 2.4). However, during the course of evolution, humans have accumulated mutations that disrupted olfactory receptors. Interestingly, those mutations are thought to have occurred faster than in any other species sampled (see vomeronasal organ– VNO, paragraph 2.4), for example apes. This process is probably still in progress, and it is likely due to an increased dependence of humans on sight and, at the same time, to a decreased chemosensory dependence, compared to apes or other animals (Gilad, Man, Lancet, & Pääbo, 2003). Despite this disruptive process of humans' olfactory receptors, recent work using non-invasive near-infrared spectroscopy to detect oxygenation levels during cortical activity has shown that the human olfactory system in infants is perfectly functional from the first months. For instance, vanilla smell can stimulate the olfactory cortex (lateral and anterior orbitofrontal gyri of the frontal lobe) in new-borns from 6 to 8 h after birth (Bartocci et al., 2000). In contrast, some other sensory modalities have not yet matured at birth (i.e. sight). Furthermore, infants whose mothers ate anise during pregnancy have shown a stable behavioural marker of attraction when exposed to anise odour. On the contrary, infants whose mothers had not eaten anise displayed aversion or neutral responses to it. These results surprisingly demonstrated that the mother's diet during pregnancy influences the initial hedonic olfactory responses of their neonates (Schaal, Marlier, & Soussignan, 2000).

However, olfaction remains the least investigated and understood of the senses (Keller & Vosshall, 2004). The combined effects of information from different sensorial modalities directly influence olfactory perception (Marks, 1975). Indeed, these complex crossmodal influences are of paramount importance when studying olfaction, as has already been demonstrated for crossmodal influences on other sensory modalities (see Spence, 2011). In fact, several crossmodal associations have been demonstrated by previous studies, for example between vision and olfaction during grasping movement (Castiello et al., 2006; List, Iordanescu, Grabowecky, & Suzuki, 2012; Chen et al., 2013). Participants were requested to smell an odour and grasp an object (e.g., a strawberry). The results suggested that participants frequently opened their fingers wider when the odour evoked a large object (e.g., orange) as compared to an odour evoking an object of smaller size (e.g., almond) or with no-odour. Similarly, Lundström, Boyle, and Jones-Gotman, (2006) showed that an individual's body position can alter olfactory sensitivity. The authors, during an experiment with phenylethyl alcohol PEA (i.e., rose odour) demonstrated that participants had a greater olfactory sensitivity when smelling the PEA in an upright compared to a supine position.

Moreover, crossmodal associations have also been reported between odours and auditory stimuli. Belkin, Martin, Kemp and Gilbert (1997) demonstrated that a series of smells were differently matched to a scale anchored on one side to a low-pitched tone and on the other side to a high-pitched tone. Recently, crossmodal interactions between smells and sounds have been shown. In fact, Crisinel and Spence (2012) demonstrated that some odours (i.e., apricot, blackberry, musk, vanilla and raspberry) are preferentially matched to a specific kind of instrument (i.e., piano, strings, woodwind and brass) depending on the pitch of the note played. Furthermore, Velasco, Balboa, Marmolejo-Ramos, and Spence (2014) showed that participants rated a series of odours as less pleasant and sweet when matched to a white noise with respect to either a congruent or incongruent music selection.

In a pioneering experiment, Gilbert et al. (1996) used an adapted version of a questionnaire-based experimental paradigm to quantify the synesthetic relations between some sensory modalities and emotions (Rader, 1979; Rader & Tellegen, 1987), and, furthermore, to investigate the link among odours, colour, mood and line elements. This study was composed by two experiments. In Experiment 1, participants matched 20 odours with 11 names of colours. Subsequently, in Experiment 2, participants matched the same sequence of smells (i.e., 20 odours) to a series of Munsell odour chips: 13 essences were matched consistently with the previous associations colour-name of Experiment 1.

Previous research has also demonstrated the existence of crossmodal correspondences between smells and colours (Kemp & Gilbert, 1997; Morrot, Brochet, & Dubourdieu, 2001, Schifferstein, & Tanudjaja, 2004), using a variant of the implicit association test (IAT) (Demattè, Sanabria, & Spence, 2006). The authors found significant associations, for example, between strawberry and pink and red colour, and between spearmint and turquoise. Furthermore, even the crossmodal correspondences between odours and the classical visual "Bouba-Kiki" shapes of Gestalt psychology have been investigated (Hanson-Vaux, Crisinel, & Spence, 2013). The authors used a series of 20 odours and asked their participants to rate them on scales anchored with rounded and angular shapes ("Bouba" and "Kiki", respectively). Hanson-Vaux et al. (2013) found that lemon and pepper odours were significantly associated with the angular shape, while raspberry and vanilla were linked to the rounded shape. Furthermore, Seo et al. (2010) showed that odours generally judged as pleasant are associated with circle or curve-shaped abstract symbols, whereas unpleasant smells are mainly associated with square or angular-shaped symbols. Moreover, these researchers demonstrated that phenylethanol PEA (i.e., violet odour) and 1-butanol (i.e., parmesan odour), rated as pleasant and unpleasant respectively, were judged as more intense when associated with congruent shapes (i.e., rounded or angular) compared to no symbol (i.e., a white area). In addition, Seo et al., (2010) demonstrated that the association between a specific smell and the appropriate congruent shape results in a greater amplitude and shorter latencies in the N1 peak of olfactory event-related potentials. Thus, there seem to be robust associations between visually-presented shapes (i.e., rounded and angular shapes), colours and odours; those associations seem to be ascribed to different to different characteristics of smells themself (e.g., semantic association and hedonic value). Therefore, an increasing body of research confirms the existence of crossmodal associations between the sense of smell and other senses (see Spence, 2011; Stevenson & Boakes, 2004; Stevenson, Rich, & Russell, 2012). Such a conclusion was reached through a series of experiments that have mostly separately investigated crossmodal associations between a large series of odours and specific dimensions of sensorial modalities (e.g., Deroy, Crisinel, & Spence, 2013; Hanson-Vaux et al., 2013; Crisinel et al., 2013). Indeed, those studies have identified some smells connected to certain crossmodal associations (Belkin et al., 1997; Crisinel & Spence, 2012; Stevenson & Boakes, 2004). Starting from these findings, the aim of the present preliminary study is to investigate the effects of crossmodal interactions in smell perception. In particular, crossmodal interactions between smell and different sensory modalities and emotions (Gilbert et al., 1996; Schifferstein, & Tanudjaja, 2004) will be investigated by means of an association task. Indeed, the investigation of those associations (i.e., crossmodal and with emotions) is crucial in order to identify the main attributes related to an odour. The identification of those main attributes allows classifying odours in function of their distinctive attributes, in terms of associations with other sensory modalities and emotions. A restricted pool of common odours was selected as olfactory stimuli, which have already significantly demonstrated their associations and interactions with other senses (i.e., vanilla, lemon, strawberry, and rosemary) (Belkin et al., 1997; Crisinel et al., 2013; Demattè et al., 2006, 2009; Deroy et al., 2013; Hanson-Vaux et al., 2013). To the best of our knowledge, this is the first research that tries to classify smells using attributes distinctive of other sensory modalities.

5.2 Materials and methods

5.2.1 Participants

Seventy participants (*M* = 23 years, *SD* = 2.9, 50 female) took part in the experiment. The procedure followed a between-subject experimental design. All the participants gave written consent prior to their participation. The experiment described here was performed in accordance with the ethical standards laid down in the 2008 Declaration of Helsinki and was approved by the local ethical committee. The experiment lasted for approximately 20-30 minutes. People who reported to be affected by any olfactory or auditory dysfunction, as well as by temporary conditions known for altering the sense of audition and olfaction (i.e., cold or flu) were excluded from the experiment.

5.2.2 Stimuli

Four odours were used as olfactory stimuli. Specifically, vanilla (commercial name 4398), lemon (commercial name 8592), rosemary (commercial name 22331), and strawberry (commercial name 24631) obtained from Agieffe International® (Milan, Italy) were selected as olfactory stimuli. These alcohol-free and water-soluble odours (25% pure essential oil) were diluted at a concentration of 10% in water. The olfactory stimuli were selected based on previous literature (Belkin et al., 1997; Crisinel et al., 2013; Demattè et al., 2006, 2009; Deroy et al., 2013; Hanson-Vaux et al., 2013) arguing that some odours (i.e., vanilla and strawberry) are more frequently associated with rounded shapes, red colour, and low sound pitch, while some other odours (i.e., lemon and rosemary) are frequently associated with angular shapes, yellow colour, and high sound pitch. In addition, a neutral odour (i.e., compressed medical air) was used as control olfactory stimulus.

The olfactory stimuli were delivered by a custom-built computer-controlled olfactometer that allowed regulating the exact timing of the olfactory stimulation and the saturation of the odour perceived by the participants. In addition, the olfactometer permitted the delivery of odourised and odourless air. This airflow was set at pressure of 0.2 Bar, through a manometer. One of the valves was connected with a small glass bottle that contained one odour at a time for each of the experimental sessions. The odour was delivered to the participants' nose through a medical mask.

In order to avoid any habituation effect, the odour was presented at regular intervals rather than in a continuous manner throughout the experimental session. Particularly, the odours were diffused every two stimuli and the stimulation lasted until the participant's response.

The nineteen pairs of attributes selected as visual and auditory stimuli for the evaluation of the four odours (i.e., angular and rounded shapes, colours, emotions, phonemes, hedonic and sensory adjectives, and sounds) were used as anchors of the visual analogue scales (VAS). Specifically, in order to investigate the sound-symbolic associations between odours and graphemes, the visual shape stimuli (Hanson-Vaux et al., 2013)(see Figure 5.1) and two pairs of non-word phonemes (i.e., "bouba-kiki" and "maluma-takete") were used, as originally outlined by Köhler (1929). The colours selected to investigate the associations between odours and colours were two pairs of colours that differed in terms of colour temperature (i.e., yellow-violet and red-blue; Gilbert et al., 1996; Schifferstein & Tanudjaja, 2004). Each colour was presented as a circle with a diameter of 1 cm. The pairs of adjectives used to investigate the emotional valence of the odours were selected on the basis of Ekman's basic emotions (i.e., sad-happy, attracted-disgusted, not scared-scared, indifferent-surprised, not angry-angry; Ekman et al., 1972), with the addition of a state related to the arousal level (i.e., relaxed-energetic). Furthermore, five pairs of adjectives were selected to investigate attributes of odours related to sensory perception (i.e., soft-hard, salt-sweet, short-tall, light-heavy). In addition, two additional pairs of attributes were selected to verify the hedonic characteristics of these odours (i.e., pleasant-unpleasant, embracing - repulsive) and gender traits (i.e., male-female).

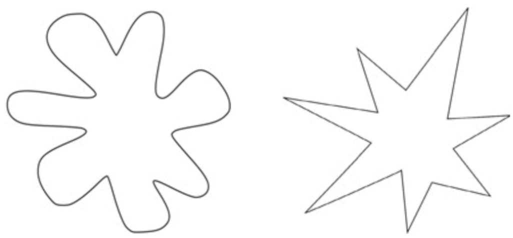


Figure 5.1 The angular and rounded shapes used as visual stimuli during associative task.

The cross-modal association between odours and auditory cues was investigated. The auditory cues were created with the software Audacity (Audacity 2.0.5®, the Free, Cross-Platform Sound Editor) for a duration of 500 ms and were presented over stereo headphones (Sennheiser HD 280 PRO) at a level of 40 dB. The auditory trials consisted of four sine sounds (stereo, 44100 Hz, 32 bit): two low-pitched sounds (110 Hz, A2) and two high-pitched sounds (1500 Hz, between $F^{\#}6$ and G6). The sounds were presented in pairs of two, in a counterbalanced order (i.e., low-pitched and high-pitched; high-pitched and low-pitched). In particular, the sounds were arranged in pairs of two high-pitched and low-pitched sine sounds in a dichotic way (i.e., high-pitched presented on the left ear and low-pitched presented on the right ear); this series of sounds was repeated two times with a pause of 4 ms in-between (i.e., high-pitched/low-pitched, pause, and again high-pitched/low-pitched). In order to simply the association of the odours with the two types of sounds (i.e., low and high pitched) the VAS scales were anchored with the adjectives corresponding to the attributes of sounds (e.g., low pitched-high pitched), presented on the left or on the right.

5.2.3 Procedure

The procedure followed a between-participant experimental design and the experiment was designed and conducted using the E-Prime 2.0 software (Psychology Software Tools, Inc.). The participants were randomly assigned to one of the five experimental sessions, corresponding to the four odour conditions plus the no-odour control condition. The volunteers were comfortably seated on a chair in the experimental booth approximately 60 cm from a laptop (resolution 1024 x 768 pixels, refresh rate 60 Hz) and were asked to wear the earphone and the medical mask to smell the odours.

The participants were instructed to rate the odour presented through all the nineteen pairs of trials, by means of 150 mm long visual analogue scales (VAS)(see Figure 5.2). The VASs were presented in the centre of the PC screen and the participants had to use the mouse, with the right hand, in order to select the desired point on the scale. All the pairs of stimulus to be evaluated in association with the odour were randomly presented in a counterbalanced order of presentation, this was done to avoid any lateralized anchor position effects or order effects. In fact, every participant was exposed to forty-two trials, half of the trials with the order of anchors left-right and the other half of the trials with the reversed order right-left (e.g., “kiki”-“bouba” and “bouba”-“kiki”).

Figure 5.2 An example of the VAS scale used to measure the association between smells and the nineteen-pairs of attributes selected. Participants used the mouse to select the desired point on the scale the VAS presented on the PC screen.

5.3 Results

The data were analysed with STATISTICA 6.0 (StatSoft, Italy). The relationships between all independent variables (i.e., nineteen pairs of attributes) were assessed by calculating the Pearson's correlation coefficients. This analysis revealed the presence of significant positive and negative correlation between some of the variables considered (see Table 5.1).

Afterwards, a between-participant MANOVA was performed to assess score differences of the nineteen pairs of attributes (dependent variables) among the four odour conditions (i.e., vanilla, lemon, rosemary, strawberry) plus the no-odour condition (i.e., air) (independent variables). These analyses of variance revealed a significant main effect of odours on attributes related to the sensory perception of weight ($F(4,65) = 3.32$, $p = .022$) and on auditory cues related to pitch (i.e., low and high pitched). In particular, New-Keuls post-hoc tests showed that pure air was rated as significantly heavier than vanilla ($p = .019$), rosemary ($p = .023$), and strawberry ($p = .032$) (see Figure 5.3, A). Additionally, New-Keuls post-hoc tests indicated that pure air was perceived as more associated to low-pitched sounds than lemon ($p = .049$), rosemary ($p = .012$), and strawberry ($p = .009$), which were perceived as more associated with high-pitched sound (see Figure 5.3, B), instead. No additional significant differences were found for all the remaining attributes (all $1 \leq F$ (4,65) < 2; n.s.).

Moreover, twelve mixed-ANOVAs with type of smell as a between-participants factor and pairs of attributes as a within-participant factor were performed, from the results obtained by the Person's correlation coefficient matrix ($r > .35$, see Table 5.1). In particular, the following differences were tested: (1) between auditory cues (i.e., low-high pitched) and attributes related to weight (i.e., light-heavy), (2) between attributes related to colour (i.e., red-blue) and attributes related to emotional activation (i.e., relaxing-energetic), (3) between the two types of phonemes (i.e., kiki-bouba and maluma-takete), (4) between emotional attributes (i.e., attracted-disgusted and embracing-repulsive), (5) between attributes related to emotions (i.e., attracted-disgusted) and attributes related to hedonic valence (i.e., pleasantness-unpleasantness), (6) between attributes related to hedonic valence (i.e., pleasantness-unpleasantness) and emotional attributes (i.e., embracing-repulsive), (7) between emotional attributes (i.e., not angry-angry) and attributes related to sensory perception (i.e., short-tall), (8) between emotional attributes (i.e., embracing-repulsive) and attributes related to sensory perception (i.e., salt-sweet), (9) between emotional attributes (i.e., embracing-repulsive) and attributes related to sensory perception (i.e., hard-soft), (10) between attributes related to sensory perception (i.e., sweet-salt and hard-soft), (11) between attributes related hedonic valence (i.e., pleasantness-unpleasantness) and phonemes (i.e., maluma-takete), (12) between emotional attributes (i.e., embracing-repulsive and not angry-angry) and phoneme (i.e., maluma-takete). However, the results showed only a significant interaction effect of odours and pairs of attributes (i.e., low-pitched – high-pitched and light – heavy; F (4,65) = 5.787, $p < .01$).

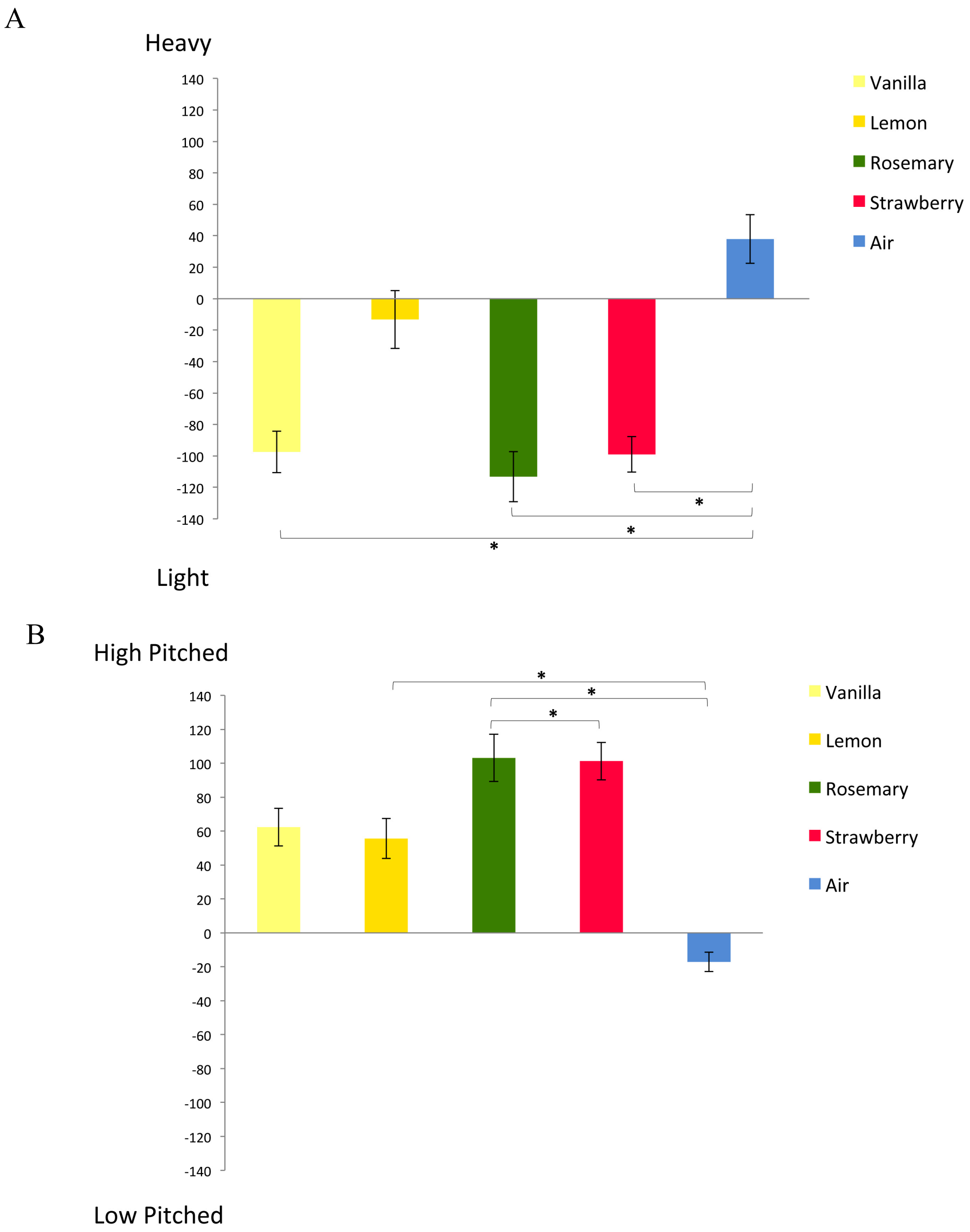


Figure 5.3 Participants' mean association scores of each odour with attributes related to the sensory perception of weight (i.e., light and heavy) (A) and attributes related to pitch of auditory cues (i.e., low and high pitched) (B). Asterisks represent Newman-Keuls significant differences at $p < .05$.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Red-Blue	-																	
2. Violet-Yellow	.207	-																
3. Bouba-Kiki shapes	-.267*	-.109	-															
4. Kiki-Bouba word	.125	-.123	-.181	-														
5. Maluma-Takete word	-263*	.071	.190	-.445*	-													
6. Soft-Hard	.218	-.003	-.305*	.182	-.249*	-												
7. Salt- Sweet	.065	.120	-.071	.175	-.329**	.360**	-											
8. Male-Female	.125	-.068	-.120	.093	-.207	.290*	.323**	-										
9. Short-Tall	-.147	.008	.108	-.175	.282*	-.128	-.163	-.009	-									
10. Pleasant-Unpleasant	.132	.082	-.252*	.179	-.413**	.230	.221	-.282*	-.186	-								
11. Relaxed-Energetic	-.380**	-.029	.291*	-.156	.308**	-.231	-.155	-.298*	.204	-.169	-							
12. Embracing-Repulsive	.200	-.030	-.247*	.023	-.394**	.378**	.366**	.113	-.293*	.466**	-.345**	-						
13. Happy-Sad	-.005	.139	.070	-.051	-.164	.114	.204	.248*	.046	.214	-.207	.135	-					
14. Not scared-Scared	.059	-.033	.180	-.073	.264*	-.150	-.197	-.229	.167	-.247*	.128	-.197	-.164	-				
15. Not angry-Angry	-.094	.018	.066	.023	.362**	-.146	-.066	-.130	.460**	-.295*	.121	-.318**	-.025	.318**	-			
16. Attracted-Disgusted	.043	.004	.273*	-.051	.295*	-.134	-.123	-.224	.104	-.629*	.248*	-.363**	-.152	.171	.314**	-		
17. Indifferent-Surprised	.006	-.293*	.144	-.073	.121	-.247*	.002	.139	.227	-.161	.055	-.186	.000	.253*	.159	-.042	-	
18. Light-Heavy	-.178	.064	.159	.094	-.167	.054	.112	.010	-.040	.137	.136	-.046	.191	-.184	-.064	-.082	-.192	-
19. Low pitched- High pitched	-.218	-.074	.181	.103	-.258*	.105	.134	.148	.075	.061	.099	-.039	.154	-.097	.065	-.061	.016	.772*

*p < .05; **p < .01

Table 5.1 Pearson's correlation coefficients among considered independent variables.

5.4 Discussion and conclusion

The findings of this preliminary study highlight the existence of crossmodal associations among odours, sensorial attributes (i.e., attributes related to the perception of weight), and auditory pitch (i.e., low-pitched and high-pitched sounds).

In particular, the first significant result showed that the majority of the smells that were tested (i.e., lemon, rosemary, and strawberry) were perceived as and associated to high-pitched sounds, compared to the control smell (i.e., air). In fact, the association between odours (i.e., perfume smells) and pitches (see Belkin et al., 1997), as well as the matching of certain odours with specific musical instruments (Crisinel & Spence, 2012) have been previously shown. From these literature findings, it becomes clear that fruit smells would seem to be associated with higher-pitched sounds. The present results thus are in line with previous research that has shown an association of two main qualities of fruit taste (i.e., sour and sweet) with high pitch (Crisinel & Spence, 2010).

Unexpectedly, one out of four smells tested in the present study (i.e., vanilla) did not show this association with high pitch, despite the findings reported in previous studies. In fact, vanilla is a smell that has been linked to high-pitched sounds (Belkin et al., 1997; Crisinel & Spence, 2010, 2012). In the present study, the lack of significant results in the case of vanilla smell might be caused by the specific chemical compounds of vanilla essence that were employed in the present study and that were different compared to earlier studies, and also by the perceived intensity of the smell. However, those issues (i.e., differences in the chemical components and perceived intensity) make it hard to directly compare the evidence of the current study with previous results.

The second significant result obtained showed that the participants perceived the majority of the tested smells (i.e., vanilla, rosemary, and strawberry) as lighter compared to the control smell (i.e., air). This effect, to the best our knowledge, is reported here for the first time in the multisensory literature. Two explanations of this novel finding are possible: First, the association between smells and weight may be driven by the combination of a crossmodal link between odour and size and a link between size and weight. Previous research has demonstrated that odours are related to the perception of the size of an object (Castiello et al., 2006). Then, the automatic semantic association between objects linked to a smell may allow participants to judge that smell as heavier in comparison to a smell linked to a smaller object. Clearly, this kind of interpretation needs to be investigated further. For instance, in a work by Castiello and colleagues (2006), this interaction occurred between smells of two fruits of different dimensions (i.e., orange and strawberry), and not between those smells and air. In fact, even in the present study, air did not show significant this kind of association effect.

Second, the association between smells and weight may be explained by crossmodal links between odours and colours, and between colour and weight. Crossmodal associations between odours and colours have been investigated previously (Demattè et al., 2006; Kemp & Gilbert, 1997; Morrot et al., 2001; Schifferstein, & Tanudjaja, 2004). These automatic crossmodal associations between colours and odours may transfer properties that are usually associated with colour to smell, such as in this case the perception of weight (see Spence, 2011). In parallel, pitch of sounds has been shown to be associated with perceived weight and colour as well (Simpson, Quinn, & Ausubel, 1956; Eitan & Timmers, 2010). Higher-pitched sound is typically associated with brighter colour. This interpretation is also corroborated by the results obtained in the present research regarding auditory pitch. Once again, this kind of interpretation needs to be investigated further.

Moreover, in previous research it has been demonstrated that different sounds differently modulate emotions. For example, low-pitched music is associated with unpleasant emotional states, (i.e. sadness), while high-pitched music is connected to pleasant emotional states (i.e. happiness) (Hevner, 1937; Huron, Yim & Chordia, 2010). Given that such effects have been robustly demonstrated in the literature, the marginal significance of some of the findings in the present study may simply be related to the statistical power of the study. For this reason, some associative effects that were marginally significant in the present study might have reached significance if statistical power would have been higher (e.g., if the sample size would have been bigger).

In the psychological literature, other sensory stimuli have been classified to create a universal database based on the main characteristics of the stimulus's type, see for example the IAPS for pictures (Lang et al., 2005) and the IADS for music (Bradley, & Lang, 1999). However, in the case of odours, this classification seems more difficult to implement, and has barely been attempted (Spangenberg, et al., 1996; Peck & Childers, 2008). In many recent studies, the smells contained in the "Nez du Vin" odour set were used as olfactory stimuli (see cf., Crisinel & Spence, 2012; Hanson-Vaux et al., 2013). However, this odour kit was not originally created for scientific purposes, but rather to train amateur wine testers to recognize and describe different aroma profiles in wine. Usually, this kit is employed in scientific research to cover a broad range of odours and most importantly to compare and generalize results from past studies. Indeed, the issue of using a standardized stimulus (e.g., a previously tested odour) is crucial for olfaction and psychology research. In the case of odorants, this issue seems to be more complex but not completely impossible. In general, in the field of marketing various smells have been classified focusing only on the affective quality of the smell (i.e., pleasantness and arousing effect) and on its intensity (Spangenberg et al., 1996; Peck & Childers, 2008)—a property that is inherently related to the perceived pleasantness of a smell. This preliminary study has attempted to solve this gap in the literature, thus creating new knowledge on the crossmodal associations between olfaction and other sensory modalities, in addition related to the features of emotions.

How can smells be categorized and classified? This question is still largely unanswered. Starting from the attributes related to emotions and crossmodal associations used in the current research, an additional goal of this preliminary study was to extend this classification methodology to a broad range of common smells. Indeed, on one hand the subsequent aim is to create a universal dataset of smells to be used in experimental research. On the other hand, the aim is to create a dataset based on identified features of odours—a sort of classification of the "personality traits" of odours.

Odours are basically a mixture of chemical molecules, the standardization and classification of odours is highly relevant from an applied perspective, especially in order to reduce and understand the complexity of the smell and its effects on consumers' behaviour. For instance, marketers and market researchers would strongly benefit from a systematic and scientifically valid classification of odours—a dataset of the personality traits of smells. Such a classification would allow them to more systematically imbue brands or products with smell in a congruent manner and to create additional identifying olfactory markers for brands or products. Such marketing actions would complement current trends in sensory marketing, such as the frequent use of synesthetic and crossmodal language in advertising and marketing (Nelson & Hitchon, 1999; Hanson-Vaux et al., 2013).

In summary, a classification of odours may be extremely useful for marketers and consumer behaviour researchers. In fact, marketers and consumer behaviour researchers should consider the importance of smell in designing product packaging and or consumption experience. In fact, smells can synergistically enhance consumers' expectation, consumers' experience, consumers' satisfaction, quality perception of products/services, and at the same time elicit consumers' emotional responses (cf., Bone & Jantrania, 1992; Schifferstein et al., 2011; Spence et al., 2014).

However, some limitations of the current study need to be accounted for. First, as mentioned above, some results that were only approaching a significant level, but in line with previous studies, can be expected to become significant when using a larger sample size. Furthermore, increasing the sample size could also allow conducting a series of factorial analyses on the attribute pairs used to classify odours. Second, as previously discussed in Chapter 2, the main issue related to odour pleasantness is the intensity (i.e., the diffusion intensity of an odour can modify the perceived pleasantness of it). For this reason, future research may start by investigating the perceived intensity of each smell that is used. In fact, the modulation of the intensity of odorants by using different levels of concentrations (e.g., more or less dilution in water) allows to test which concentration fits better, in terms of pleasantness, with each smell (e.g., more dilution for odours perceived as "strong" vs. less dilution for "soft" odours). Moreover, perceived intensity is also related to the pressure with which odorants are delivered to the participants. Therefore, future research should account for pressure to modulate intensity and consequentially also pleasantness.

In sum, Spence (2011, p. 973) has defined crossmodal correspondences as "compatibility effects between attributes or dimensions of a stimulus (i.e., an object or event) in different sensory modalities (be they redundant od not)" (see Spence, 2011 for a review). Despite many studies that have previously attempted to identify a set of such attributes and dimensions for odours, no general agreement has been reached (Crisinel & Spence, 2012). Addressing this unresolved question, the present study provided additional evidence as to which attributes from different sensory modalities can best represent the perceptual features of specific odours.

CONCLUSION

"…the present, the (unobserved) past, like the future,

is indefinite and exists only as a spectrum of possibilities."

Stephen Hawking & Leonard Mlodinow (2010), The Grand Design, p.82

This final section attempts to provide a general discussion of the results of the experimental studies presented in this thesis. The idea that inspired the single studies and guided the literature review was to improve our understanding of how olfactory stimuli influence emotions and consumer behaviour. In particular, each of the studies considered one specific aspect of this broader topic, that is: (1) product-related smells, emotions, and intention to consume (Chapter 3); (2) the combined effect of affective stimuli arriving from different sensory modalities (i.e., olfactory, auditory, and visual stimuli) on emotions (Chapter 4); (3) studying olfactory stimuli (i.e., common smells) from a crossmodal perspective (Chapter 5). In doing so, each of the three experimental studies focused on and investigated a single component of the thesis topic (i.e., emotions, consumer behaviour, and the nature of olfactory stimuli).

The first study (Chapter 3) investigated how smells that are associated with food products can stimulate impulse buying of the related food products, through their effect on emotions and by increasing the salience of the products (i.e., perceptual fluency; Coelho, Idler, Werle, & Jansen, 2011). In two experiments, the effect of chocolate and coffee smells on emotion was tested by assessing emotional states using different measures: an implicit measure (liking evaluation of Chinese ideographs; Murphy & Zajonc, 1993) and a self-report measure (a 30-items version of POMS; McNair et al., 1992). Additionally, a discrimination time task and a self-report questionnaire were used to investigate the effect of smells on product salience and willingness to consume, respectively. The results revealed that smell has a significant and positive effect on emotions and on impulse buying. However, the results of the reaction time task that was used to test whether the environment food-related cues (i.e., coffee and chocolate smells) facilitate the categorization of the associated food-products target (e.g., coffee cup or chocolate cake) did not reveal a significant effect. Rather, faster reaction times were obtained for categorizing both congruent and incongruent target products in presence of the smells (compared to the no-scent condition). It was argued that this overall decrease in reaction times is caused by a general activating effect of odours on participants' physiological arousal level even if participants did not report a general increase of arousal level in the self-report questionnaire. Taken together, those findings support the idea that odours operate as a cue that, either consciously or unconsciously, activates target objects information and affective information. Moreover, this first study showed that the hedonic valence of smells has general effects on consumers' emotions; however, significant evidence on the influence of positive emotions on the intention to buy was not found. Nevertheless, from a practical perspective, those results suggest a way to explain how the ambient smell related to products could impact on impulse buying in the shopping context. However, in a real shopping context, more than one emotional cue may reach consumers at the same time. More implications of these results for consumer experience strategies in the retail context were discussed in the chapter.

The second study (Chapter 4) investigated whether the combined influence of olfactory and auditory affective environmental stimuli may influence the processing of affective pictures (IAPS pictures). Emotional responses were measured while participants viewed pictures with different valence (i.e., positive, negative, and neutral valence). Implicit and self-report measures (i.e., liking evaluation of Chinese ideographs and a 30-items version of POMS) and various physiological measures (i.e., heart rate and skin conductance responses) were used to assess the participants' emotional reaction. The results indicated that emotional responses related to affective pictures are affected by the arousal congruency of smell and music. In fact, the combined effect of congruent arousing stimulation, across sensory modalities, markedly enhanced the emotional experience evoked by the affective pictures. In particular, ambient cues that were congruent in terms of arousal enhanced the self-reported rate of a high-arousal emotional state. Surprisingly, congruent arousal levels of ambient cues resulted in increased self-reported arousal even if the two ambient cues (i.e., smell and music) were both low in arousal value. In the case of self-reported emotional state, participants seem to be influenced by the congruence of both ambient cues (i.e., additive congruence effect) more than by the specificity of the stimulus type (i.e., high or low arousal). In contrast, the physiological responses to the affective ambient cues revealed a principal main effect of the congruency, but in this case only for congruent high-arousal ambient cues (i.e., fast-tempo music and orange smell). However, further basic research on the main characteristics of smells (e.g., relaxing vs. arousing effects) is needed, from both a self-perceived and a physiological-reaction perspective. Beside the theoretical implications, those findings have practical implications as well. The investigation and the understanding of multisensory integration in the case of emotions have enormous implications in consumer behaviour research. Consumers generally perceive the world in a multisensory way, and the interaction between sensory information can influence emotional responses differentially. The findings of this study shed light on how (in)-congruent ambient stimulation leads to different emotional reactions depending on the measurement instrument (i.e., self-perceived versus physiological measures).

The third study (Chapter 5) investigated whether everyday smells (e.g., vanilla, rosemary, strawberry, and lemon) may be distinguished and classified using distinctive attributes from other sensory modalities and attributes related to emotional states. In fact, as recently suggested by Deroy et al. (2013), olfactory experiences are a domain to which crossmodal associations can easily be applied (e.g., taste, vision, touch, and hearing). Indeed, attributes from other sensory modalities are reliably used by humans to describe and define differences between odours. A computerized association task was used to assess the main crossmodal interactions between smell, different sensory modalities, and emotions. The results of this preliminary study showed the existence of crossmodal associations between odours, sound pitch, and sensorial attributes (i.e., attributes related to perception of weight). First, the majority of the odours used (i.e., vanilla, rosemary, and strawberry) were perceived as lighter in comparison to a control stimulus (i.e., pure air). Second, the majority of the smells tested (i.e., lemon, rosemary, and strawberry) were more associated with high-pitched sounds than low-pitched sound, as compared to the control stimulus (i.e., air). Interestingly, these findings shed light on new knowledge from the literature on crossmodal correspondences, particularly with regard to crossmodal correspondences between odours and contingent features of other sensory modalities. In addition, the study clearly showed also the importance to consider and to pre-test one of the main issues related to the perceived pleasantness of olfactory stimuli (i.e., the intensity of olfactory stimulation). Finally, those findings may work as an incentive for further research to create a standardized dataset of common odours, which can be used in applied contexts (e.g., part of marketing strategy) or in pure research contexts (e.g., stimuli for lab experiments).

Taken together, the results summarized above represent a valuable contribution to our understanding of emotions, of olfactory stimuli, and of the influence between emotions and olfactory stimuli on consumer behaviour, from both a theoretical and an empirical perspective. Interestingly, the findings of the first two experiments (Chapter 3 and 4) showed a clear differential effect of smell on the subjective self-reported perception versus the physiological activation dimensions. In fact, on one side, the inability of participants in self-perceiving the effect of the smell on the autonomous nervous system activity is widely supported in the present thesis. Apparently, the relaxing or arousing effect of a smell does not preclude a perceived increase in alertness or vice versa a perceived decrease in relaxation. In the effect of smell on emotions emerged from the self-report measures, the valence level of smell (e.g., pleasant chocolate smell) seems to be preponderant, while in the case of other sensory stimuli (e.g., music), the congruency between those stimuli (e.g., high-arousal music and smell and music and low-arousal smell) appears to be the most influential factor.

On the other side, the physiological activations (i.e., heart rate and skin conductance responses) (Chapter 3) clearly showed, once again, an effect of congruency only in the high-arousal condition (e.g. high-arousal smell and music). These automatic nervous system reactions are due to the distinctive characteristics of the smell in term of emotional arousal, thus humans can be unconsciously alerted by smells. From a neuroanatomical prospective, the impact of the combined stimulation of congruent and incongruent auditory and olfactory ambient cues on the processing of emotional visual stimuli supports the integration theory of emotional neural network substrates (Gottfried et al., 2002; Klinge et al., 2010; Phan et al., 2002).

However, some general shortcomings of the present thesis need to be mentioned. The first limitation arises from intrinsic limits regarding the processing of emotions and the encoding process of olfactory stimuli. In fact, the processing of those two complex constructs (i.e., smells and emotions) is highly dependent on the cultural background of an individual.

Cross-cultural studies have identified intercultural differences in the learnt associations and meanings attributed to smell and emotions. Primarily, using a self-report questionnaire for the explicit assessment of the emotional experience may potentially lead to linguistic and/or cultural biases (e.g., different meaning of shame in function of which country participants belonged to). To mitigate the potential influence of this limitation, the second study used physiological measures in addition to self-report measures in order to check the emotional reactions of the participants. Secondly, further research to classify some of the basic common smells, as well as other emotional stimuli (especially cross-culturally), is indeed needed. The third experiment represented a preliminary effort in this direction; however, the high level of complexity of the olfactory stimulus itself made this goal hard to accomplish. A third limitation stems from the restricted types of consumer behaviour that were taken into account in the present thesis. As already mentioned in Chapter 3, only consumers' consumption of food products was considered. This kind of behaviour has specific characteristics, which are different, for example, from the consumption of other product types (e.g., beauty products or clothes). Indeed, using food products necessarily involves all attitudes related with eating behaviours (e.g., dietary treatments or eating disorders). Further studies should extend these findings to other types of products and consumers' choices and other aspects of consumer behaviour. Finally, several measurement methods have been employed in the present thesis to investigate the effect of smell on emotions and on consumer behaviour (i.e., implicit, self-report, physiological measures). Additional research methods (e.g., fMRI), however, could be employed in future studies to contribute to an even deeper understanding of the effects of smell and to highlight the effect of olfactory stimuli on emotions and consumer behaviour in terms of neural activation.

Nevertheless, in the discussion section of each chapter, some new interesting research questions and some practical implications have already been proposed. Those new potential research questions may enhance and broaden the range of aspects considered compared to those addressed in the present work. Certainly, future research perspectives may consider two-step study designs consisting of laboratory testing and field studies (see Olivero & Maggioni, 2013a for an example). In fact, a synergetic combination of lab studies and field studies can be expected to strongly advance the theoretical knowledge, specifically when it comes to the practical application of scent marketing in real store environments. The current findings can be applied in other areas covering a wide spectrum of applied contexts, from health care spaces (e.g., hospital environment or intensive-care facilities) and work places (e.g., manufacturing company) to entertainment/cultural venues (e.g., cinema or museum). The implementation of a multisensory congruence strategy seems to be a cutting-edge method to drive and influence consumers' behaviour (see Spence et al., 2014 for an example), besides providing new knowledge about the decision-making processes that determinate humans' behaviour. Undoubtedly, more empirical research is needed to clarify the relative contribution of the diverse ambient stimuli on both the general hedonic experience of the consumer and the specific neurocognitive correlates beyond decision making and buying behaviours. Moreover, as already discussed in Chapter 1, an important issue that has not received attention in the literature is whether specific receptors of emotions can be identified in humans. In fact, pain and pleasure can be conceptualised as the extremes of a continuum defining the emotional experience. While pain receptors have been extensively investigated in previous research (e.g., see Hagelberg et al., 2004, for a review or Woolf, 2011), to the best of our knowledge, research has not been conducted on positive emotions' receptors (Kringelbach, & Berridge, 2009).

To conclude, the present findings provide corroborating evidence in support of the initial hypothesis stating that olfactory stimuli influence consumer behaviour. Specifically, olfactory stimuli have been shown to unconsciously act both as emotional triggers and as priming cues of product information. In fact, among the senses, olfaction generally has a double function as a communicative tool and as an emotional trigger, potentially outside human consciousness. Therefore, emotions triggered by smells can be used as a cognitive heuristic when buying everyday products (e.g., not high-involvement products; see Olivero & Maggioni, 2013b for an additional example).

REFERENCES

Abraham, M. H., Sánchez-Moreno, R., Cometto-Muñiz, J. E., & Cain, W. S. (2011). An algorithm for 353 odor detection thresholds in humans. *Chemical Senses*, *37*, 207–218.

Abratt, R., & Goodey, S. D. (1990). Unplanned buying and in-store stimuli in supermarkets. *Managerial and Decision Economics*, *11*(2), 111–121.

Ackerl, K., Atzmueller, M., & Gramme, K. (2002). The scent of fear. *Neuroendocrinology Letters*, *23*(2), 77–82.

Adamson, J.D., Romano, K.R., Burdick, J.A., Corman, C.L., & Chebib, F.S. (1972). Physiological responses to sexual and unpleasant film stimuli. *Journal of Psychosomatic Research, 16*(3), 153–162.

Adelmann, P. K., & Zajonc, R. B. (1989). Facial efference and the experience of emotion. *Annual Review of Psychology*, *40*(1), 249–280.

Aggleton, J. P., & Waskett, L. (1999). The ability of odours to serve as state-dependent cues for real-world memories: Can Viking smells aid the recall of Viking experiences? *British Journal of Psychology*, *90*(1), 1–7.

Ahern, G. L., & Schwartz, G. E. (1985). Differential lateralization for positive and negative emotion in the human brain: EEG spectral analysis. *Neuropsychologia*, *23*(6), 745–755.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179–211.

Alaoui-Ismaïli, O., Robin, O., Rada, H., Dittmar, A., & Vernet-Maury, E. (1997a). Basic emotions evoked by odorants: comparison between autonomic responses and self-evaluation. *Physiology and Behavior*, *62*(4), 713–720.

Alaoui-Ismaïli, O., Vernet-Maury, E., Dittmar, A., Delhomme, G., & Chanel, J. (1997b). Odor hedonics: Connection with emotional response estimated by autonomic parameters. *Chemical Senses*, *22*(3), 237–248.

Altenmüller, E., Schürmann, K., Lim, V. K., & Parlitz, D. (2002). Hits to the left, flops to the right: different emotions during listening to music are reflected in cortical lateralisation patterns. *Neuropsychologia*, *40*(13), 2242–2256.

Anderson, A. K., Christoff, K., Stappen, I., Panitz, D., Ghahremani, D. G., Glover, G., Gabrieli, J. D. E., & Sobel, N. (2003). Dissociated neural representations of intensity and valence in human olfaction. *Nature Neuroscience*, *6*(2), 196–202.

Andrade, E. B. (2005). Behavioral consequences of affect: Combining evaluative and regulatory mechanisms. *Journal of Consumer Research*, *32*(3), 355–362.

Angie, A. D., Connelly, S., Waples, E. P., & Kligyte, V. (2011). The influence of discrete emotions on judgement and decision-making: A meta-analytic review. *Cognition & Emotion*, *25*(8), 1393–1422.

Argyriou, E., & Melewar, T. C. (2011). Consumer attitudes revisited: a review of attitude theory in marketing research. *International Journal of Management Reviews*, *13*(4), 431–451.

Aristotle. (1954). *Rhetoric*. (W. R. Roberts, Translator.). New York, NY, US: Modern Library.

Armony, J. L. (2013). Current emotion research in behavioral neuroscience: the role (s) of the amygdala. *Emotion Review*, *5*(1), 104–115.

Arnold, M. B. (1960). *Emotion and Personality*. New York, NY, US: Columbia University Press.

Arnould, E. J., Price, L., & Zinkhan, G. M. (2002). *Consumers*. New York: McGraw-Hill/Irwin.

Aue, T., Flykt, A., & Scherer, K.R. (2007). First evidence for differential and sequential efferent effects of stimulus relevance and goal conduciveness appraisal. *Biological Psychology*, *74*(3), 347–357.

Auffarth, B. (2013). Understanding smell—the olfactory stimulus problem. *Neuroscience & Biobehavioral Reviews*, *37*(8), 1667–1679.

Averill, J.R. (1968). Grief: its nature and significance. *Psychological Bulletin*, *70*(6), 721–748.

Ayabe-Kanamura, S., Schicker, I., Laska, M., Hudson, R., Distel, H., Kobayakawa, T., & Saito, S. (1998). Differences in perception of everyday odors: a Japanese-German cross-cultural study. *Chemical Senses*, *23*(1), 31–38.

Baayen, R. H., Davidson, D. J., & Bates, D. M. (2008). Mixed-effects modeling with crossed random effects for subjects and items. *Journal of Memory and Language*, *59*(4), 390–412.

Babin, B. J., & Darden, W. R. (1995). Consumer self-regulation in a retail environment. *Journal of Retailing*, *71*(1), 47–70.

Babin, B. J., Darden, W. R., & Griffin, M. (1994). Work and/or fun: measuring hedonic and utilitarian shopping value. *Journal of Consumer Research*, *2*(4), 644–656.

Baddeley, A. (1990). *Human Memory*. London, UK: Lawrence Erlbaum Associates.

Bagozzi, R. P., Gopinath, M., & Nyer, P. U. (1999). The role of emotions in marketing. *Journal of the Academy of Marketing Science*, *27*(2), 184–206.

Baker, J., Grewal, D., & Parasuraman, A. (1994). The influence of store environment on quality inferences and store image. *Journal of the Academy of Marketing Science*, *22*(4), 328–339.

Balch, W. R., & Lewis, B. S. (1999). Music-dependent memory: The roles of tempo changes and mood mediation. *Journal of Experimental Psychology: Learning, Memory and Cognition*, *22*(6), 1354–1363.

Baldaro, B., Battachi, M.W., Codispoti, M., Tuozzi, G., Trombini, G., Bolzani, R., Palomba, D. (1996). Modifications of electrogastrographic activity during the viewing of brief film sequences. *Perceptual and Motor Skills*, *82*(3c), 1243–1250.

Banks, S. J., Ng, V., & Jones-Gotman, M. (2012). Does good+ good= better? A pilot study on the effect of combining hedonically valenced smells and images. *Neuroscience Letters*, *514*(1), 71–76.

Bard, P., & Rioch, D. M. (1937). A study of four cats deprived of neocortex and additional portions of the forebrain. *Bulletin Johns Hopkins Hospital*, *60*(73), 73–153.

Barrett, L. F. (1997). Descriptions, and retrospective ratings of emotion. *Personality & Social Psychology Bulletin*, *23*(10), 1–14.

Barrett, L. F. (2006). Are emotions natural kinds? *Perspectives on Psychological Science*, *1*(1), 28–58.

Barrett, L. F., & Russell, J. A. (1998). Independence and bipolarity in the structure of current affect. *Journal of Personality and Social Psychology*, *74*(4), 967–984.

Barrett, L. F., Mesquita, B., Ochsner, K. N., & Gross, J. J. (2007). The experience of emotion. *Annual Review of Psychology*, *58*, 373–403.

Bartocci, M., Winberg, J., Ruggiero, C., Bergqvist, L. L., Serra, G., & Lagercrantz, H. (2000). Activation of Olfactory Cortex in Newborn Infants after Odor Stimulation: A Functional Near-Infrared Spectroscopy Study. *Pediatric Research*, *48*(1), 18–23.

Bass, D., Aleman, A., & Kahn, R. (2004). Lateralization of amygdala activation: a systematic review of functional neuroimaging studies. *Brain Research Reviews*, *45*(2), 96– 103.

Bates, D., Meachler, M. & Bolker, B. (2013). Lme4: linear mixed-effects models using S4 classes. R package.http://cran.rproject.org/web/packages/lme4/index.html.

Baumgartner, T., Esslen, M., & Jäncke, L. (2006). From emotion perception to emotion experience: Emotions evoked by pictures and classical music. *International Journal of Psychophysiology*, *60*(1), 34–43.

Baxter, M. G., & Murray, E. A. (2002). The amygdala and reward. *Nature Reviews Neuroscience*, *3*(7), 563–573.

Bechara, A., Damasio, H., & Damasio, A. R. (2000). Emotion, decision making and the orbitofrontal cortex. *Cerebral Cortex*, *10*(3), 295-307.

Beck, A. T. (1988). *Beck Anxiety Inventory*. San Antonio, TX, US: Psychological Corporation.

Beck, A. T., Ward, C., & Mendelson, M. (1961). Beck depression inventory (BDI). *Archives General Psychiatry*, *4*(6), 561–571.

Belk, R. W. (1975). Situational variables and consumer behavior. *Journal of Consumer Research*, *2*(3), 157–164.

Belkin, K, M. R., Kemp, S. E., & Gilbert, A. N. (1997). Auditory pitch as a perceptual analogue to odor quality. *Psychological Science, 8*(4), 340–342.

Bensafi, M., Rouby, C., Farget, V., Bertrand, B., Vigouroux, M., & Holley, A. (2002a). Autonomic nervous system responses to odours: The role of pleasantness and arousal. *Chemical Senses*, *27*(8), 703-709.

Bensafi, M., Rouby, C., Farget, V., Bertrand, B., Vigouroux, M., Holley, A. (2002b). Psychophysiological correlates of affects in human olfaction. *Neurophysiologie Clinique*, 32(5), 326–32.

Bensafi, M., Rouby, C., Farget, V., Bertrand, B., Vigouroux, M., & Holley, A. (2002c). Influence of affective and cognitive judgments on autonomic parameters during inhalation of pleasant and unpleasant odors in humans. *Neuroscience Letters*, *319*(3), 162–166.

Bensafi, M., Rouby, C., Farget, V., Bertrand, B., Vigouroux, M., & Holley, A. (2003d). Perceptual, affective, and cognitive judgments of odors: pleasantness and handedness effects. *Brain and Cognition*, *51*(3), 270–275.

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.

Berkowitz, L. (1993). Towards a General Theory of Anger and Emotional Aggression: Implications of the Cognitive-Neoassociationistic Perspective for the Analysis of Anger and Other Emotions. In R. S. Wyer & T. K. Srull (Eds.), *Advances in Social Cognition* (6th ed., pp. 1–46). Hillsdale, NJ, US: Erlbaum.

Bernat, E., Patrick, C.J., Benning, S.D., & Tellegen, A. (2006). Effects of picture content and intensity on affective physiological response. *Psychophysiology*, *43*(1), 93–103.

Bettman, J. R. (1979). Memory factors in consumer choice: A review. *The Journal of Marketing*, *43*(2), 37–53.

Boedeker, M. (1995). New-type and traditional shoppers: a comparison of two major consumer groups. *International Journal of Retail & Distribution Management*, *23*(3), 17–26.

Boiten, F. A. (1998). The effects of emotional behaviour on components of the respiratory cycle. *Biological Psychology*, *48*(1), 29–51.

Bone P. F., & Scholder, E. P. (1994). Olfaction and marketing: does it make sense to use scents? *Working Paper*, *Department of Marketing*, West Virginia University.

Bone, P. F., & Jantrania, S. (1992). Olfaction as a cue for product quality. *Marketing Letters*, *3*(3), 289–296.

Bosmans, A. (2006). Scents and sensibility: When do (in)congruent ambient scents influence product evaluations? *Journal of Marketing*, *70*(3), 32–43.

Bowman, N. E., Kording, K. P., & Gottfried, J. A. (2012). Temporal integration of olfactory perceptual evidence in human orbitofrontal cortex. *Neuron*, *75*(5), 916–927.

Bowlby, J. (1969). *Attachment and Loss: VoL. 1, Attachment.* New York, NY, US: Basic Books.

Bradford, K. D., & Desrochers, D. M. (2009). The use of scents to influence consumers: The sense of using scents to make cents. *Journal of Business Ethics*, *90*(2), 141–153.

Bradley, M. M., & Lang, P. J. (1994). Measuring emotion: the self-assessment manikin and the semantic differential. *Journal of Behavior Therapy and Experimental Psychiatry*, *25*(1), 49–59.

Bradley, M. M., & Lang, P. J. (1999). *International affective digitized sounds (IADS): Stimuli, instruction manual and affective ratings* (Tech. Rep. No. B-2). Gainesville, FL: The Center for Research in Psychophysiology, University of Florida.

Bradley, M. M., & Lang, P. J. (2000). Emotion and motivation. In J. T. Cacioppo, L. G. Tassinary, & G. Berntson (Eds.), *Handbook of Psychophysiology* (2nd ed., pp. 602–642). New York, NY, US: Cambridge University Press.

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.

Brand, G. (2006). Olfactory/trigeminal interactions in nasal chemoreception. *Neuroscience & Biobehavioral Reviews*, *30*(7), 908–917.

Britton, J. C., Phan, K. L., Taylor, S. F., Welsh, R. C., Berridge, K. C., & Liberzon, I. (2006). Neural correlates of social and nonsocial emotions: An fMRI study. *Neuroimage*, *31*(1), 397–409.

Buck, L. B. (2000). The molecular architecture of odor and pheromone sensing in mammals. *Cell*, *100*(6), 611–618.

Cacioppo, J. T., & Berntson, G. G. (1994). Relationship between attitudes and evaluative space: A critical review, with emphasis on the separability of positive and negative substrates. *Psychological Bulletin*, *115*(3), 401–423.

Cacioppo, J. T., Gardner, W. L., & Berntson, G. G. (1999). The affect system has parallel and integrative processing components: Form follows function. *Journal of personality and Social Psychology*, *76*(5), 839–855.

Cacioppo, J. T., Priester, J. R., & Berntson, G. G. (1993). Rudimentary determinants of attitudes: II. Arm flexion and extension have differential effects on attitudes. *Journal of Personality and Social Psychology*, *65*(1), 5–17.

Cahill, L., Babinsky, R., Markowitsch, H. J., & McGaugh, J. L. (1995). The amygdala and emotional memory. *Nature*, *377*(6547), 295–296.

Cain, W. S. (1969). Olfactory adaptation and direct scaling of odor intensity. *Dissertation Abstract International*, *30*, 696.

Cain, W. S. (1989). Testing olfaction in a clinical setting. *Ear, Nose, & Throat Journal*, *68*(4), 316–322.

Cain, W. S., & Johnson, F. (1978). Lability of odor pleasantness: influence of mere exposure. *Perception*, *7*(4), 459–465.

Campbell, R. (2008). The processing of audio-visual speech: empirical and neural bases. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *363*(1493), 1001–1010.

Cannon, W. B. (1939). *The Wisdom of the Body.* New York, NY, US: Norton.

Cannon, W. B. (1987). The James-Lange Theory of Emotions: A Critical Examination and an Alternative Theory. *The American Journal of Psychology*, *100*(3/4), 567–586.

Carr, H. A. (1929). *Psychology, A study of Mental Activity.* New York, NY, US: McKay.

Carretié, L., Hinojosa, J. A., & Mercado, F. (2003). Cerebral patterns of attentional habituation to emotional visual stimuli. Psychophysiology, *40*(3), 381–388.

Castaldo, S., & Botti, S. (1999). La dimensione emozionale dello shopping. *Economia & Management*, *1*, 17–37.

Castellucci, V. F. (1985). The chemical senses: taste and smell. In E. R. Kandel & J. H. Schwartz (Eds.), *Principal of Neural Science* (2nd ed., 409–425). New York, NY, US: Elsevier Science.

Castiello, U., Zucco, G. M., Parma, V., Ansuini, C., & Tirindelli, R. (2006). Cross-modal interactions between olfaction and vision when grasping. *Chemical Senses*, *31*(7), 665-671.

Chabris, C. F. (1999). Prelude or requiem for the 'Mozart effect'? *Nature*, *400*(6747), 826–827.

Chaplin, J. P. (1975). *Dictionary of Psychology*. New York, NY, US: Dell.

Charles, S. T., Mather, M., & Carstensen, L. L. (2003). Aging and emotional memory: the forgettable nature of negative images for older adults. *Journal of Experimental Psychology: General*, *132*(2), 310–324.

Chaudhuri, A. (2006). *Emotion and reason in consumer behavior.* Burlington, MA, US: Elsevier.

Chen, D., & Haviland-Jones, J. M. (2000). Human olfactory communication of emotion. *Perceptual and Motor Skills*, *91*(3), 771–781.

Chen, D., Katdare, A., & Lucas, N. (2006). Chemosignals of fear enhance cognitive performance in humans. *Chemical Senses*, *31*(5), 415–423.

Chen, K., Zhou, B., Chen, S., He, S., & Zhou, W. (2013). Olfaction spontaneously highlights visual saliency map. *Proceedings of the Royal Society B: Biological Sciences, 280*(1768), 1–7.

Cheng, F., Wu, C., & Yen, D. C. (2009). The effect of online store atmosphere on consumer's emotional responses –An experimental study of music and colour. *Behaviour and Information Technology*, *28*(4), 323–334.

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

Christie, I. C., & Friedman, B. H. (2004). Autonomic specificity of discrete emotion and dimensions of affective space: a multivariate approach. *International Journal of Psychophysiology*, *51*(2), 143–153.

Chu, S., & Downes, J. J. (2002). Proust nose best: Odors are better cues of autobiographical memory. *Memory & Cognition*, *30*(4), 511–518.

Clore, G. L., & Huntsinger, J. R. (2009). How the object of affect guides its impact. *Emotion Review*, *1*(1), 39–54.

Clore, G. L., & Ortony, A. (2013). Psychological construction in the OCC model of emotion. *Emotion Review*, *5*(4), 335–343.

Coan, J. A., & Allen, J. J. B. (2007). *Handbook of emotion elicitation and assessment*. New York, NY, US: Oxford University Press.

Codispoti, M., & De Cesarei, A. (2000). Arousal and attention: picture size and emotional reactions. *Psychophysiology*, *44*(5), 680–686.

Codispoti, M., Surcinelli, P., & Baldaro, B. (2008). Watching emotional movies: Affective reactions and gender differences. *International Journal of Psychophysiology*, *69*(2), 90-95.

Coelho, J. S., Idler, A., Werle, C. O., & Jansen, A. (2011). Sweet temptation: Effects of exposure to chocolate-scented lotion on food intake. *Food Quality and Preference*, *22*(8), 780–784.

Cohen, N. J., & Eichenbaum, H. (1993). *Memory, amnesia, and the hippocampal system*. Cambridge, MA, US: MIT Press.

Collet, C., Vernet-Maury, E., Delhomme, G., & Dittmar, A. (1997). Autonomic nervous system response patterns specificity to basic emotions. *Journal of Autonomic Nervous System*, *62*(1-2), 45–57.

Cometto-Muñiz, J. E. (2001). Physicochemical basis for odor and irritation potency of VOCs. In J. D. Spengler, J. Samet, & J. F. McCarthy (Eds.), *Indoor air Quality Handbook* (pp. 20-1–20.21). New York, NY, US: Mcgraw-Hill.

Cometto-Muñiz, J. E., & Abraham, M. H. (2008). Human olfactory detection of homologous n-alcohols measured via concentration-response functions. *Pharmacology Biochemistry and Behavior*, *89*(3), 279–291.

Cometto-Muñiz, J. E., & Cain, W. S. (1990). Thresholds for odor and nasal pungency. *Physiology & Behavior*, *48*(5), 719–725.

Compton, R. J. (2003). The interface between emotion and attention: A review of evidence from psychology and neuroscience. *Behavioral and Cognitive Neuroscience Reviews*, *2*(2), 115–129.

Cotton, J. L. (1981). A review of research on Schachter's theory of emotion and the misattribution of Arousal. *European Journal of Social Psychology*, *11*(4), 365–397.

Crisinel, A. -S., & Spence, C. (2012). A fruity note: crossmodal associations between odors and musical notes. *Chemical Senses, 37*(2)**,** 151-158.

Crisinel, A. -S., & Spence, C. (2010). A sweet sound? Food names reveal implicit associations between taste and pitch. *Perception*, *39*(3), 417–425.

Crisinel, A. -S., Jacquier, C., Deroy, O., & Spence, C. (2013). Composing with Cross-modal Correspondences: Music and Odors in Concert. *Chemosensory Perception*, *6*(1), 45–52.

Croy, I., Maboshe, W., & Hummel, T. (2013). Habituation effects of pleasant and unpleasant odors. *International Journal of Psychophysiology*, *88*(1), 104–108.

Dalgleish, T. (2004). The emotional brain. *Nature Reviews Neuroscience*, *5*(7), 583–589.

Damasio, A. R. (1994). *Descartes' error: Emotion, reason, and the human brain*. New York, NY, US: Grosset/Putnam.

Damasio, A. R., & Carvalho, G. B. (2013). The nature of feelings: evolutionary and neurobiological origins. *Nature Reviews Neuroscience*, *14*(2), 143–152.

Damasio, A. R., Everitt, B. J., & Bishop, D. (1996). The somatic marker hypothesis and the possible functions of the prefrontal cortex. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences*, *351*(1346), 1413-1420.

Damasio, A. R., Grabowski, T. J., Bechara, A., Damasio, H., Ponto, L. L., Parvizi, J., & Hichwa, R. D. (2000). Subcortical and cortical brain activity during the feeling of self-generated emotions. *Nature Neuroscience*, *3*(10), 1049–1056.

Darwin, C. (1872). *The expression of the emotions in man and animals*. London, UK: John Murray.

Daucé, B., & Rieunier, S. (2002). Le marketing sensoriel du point de vente. *Recherche et Applications en Marketing*, *17*(4), 45–65.

Davidson, R. J., Scherer, K. R., & Goldsmith, H. (2003). *Handbook of Affective Sciences*. Oxford, UK: University Press.

Dawson, S., Bloch, P. H., & Nancy, R. M. (1990). Shopping motives, emotional states, and retail outcomes. *Journal of Retailing, 66*(4), 408-427.

de Gelder, B. (2006). Towards the neurobiology of emotional body language. *Nature Reviews Neuroscience*, *7*(3), 242–249.

de Gelder, B., & Vroomen, J. (2000). The perception of emotion by ear and by eye. *Cognition and Emotion*, *14*(2), 289-311.

de Gelder, B., Böcker, K. B. E., Tuomainen, J., Hensen, M., & Vroomen, J. (1999). The combined effect of emotion from voice and face: Early interaction revealed by human electric brain responses. *Neuroscience Letters*, *2*(29), 133-136.

de Gelder, B., Van Honk, J., & Tamietto, M. (2011). Emotion in the brain: of low roads, high roads and roads less travelled. *Nature Reviews Neuroscience*, *12*(7), 425-425.

de Groot, J. H., Semin, G. R., & Smeets, M. A. (2014). I can see, hear, and smell your fear: Comparing olfactory and audiovisual media in fear communication. *Journal of Experimental Psychology: General*, *143*(2), 825–834.

de Lemos, J., Sadeghnia, G. R., Ólafsdóttir, Í., & Jensen, O. (2008). Measuring emotions using eye tracking. *Proceedings of Measuring Behavior*, *226*, 225–226.

De Wijk, R. A., & Zijlstra, S. M. (2012). Differential effects of exposure to ambient vanilla and citrus aromas on mood, arousal and food choice. *Flavour*, *1*(1), 1-7.

Degel, J., Piper, D., & Köster, E. P. (2001). Implicit learning and implicit memory for odors: the influence of odor identification and retention time. *Chemical Senses*, *26*(3), 267–280.

Delgado, J. M. R. (1973). Emotions. In J. Vernon & P. Suedfeld (Eds.), *Introduction to General Psychology: A self-Selection Textbook* (2nd ed.). Dubuque, IO, US: Wm. C. Brown,

Demaree, H., Schmeichel, B., Robinson, J., & Everhart, D.E. (2004). Behavioural, affective, and physiological effects of negative and positive emotional exaggeration. *Cognition and Emotion*, *18*(8), 1079–1097.

Demattè, M. L., Sanabria, D., & Spence, C. (2006). Cross-modal associations between odors and colors. *Chemical Senses, 31*(6)**,** 531–538.

Demattè, M. L., Sanabria, D., Sugarman, R., & Spence, C. (2006). Cross-modal interactions between olfaction and touch. *Chemical Senses*, *31*(4), 291–300.

Denton, D. (2005). *The Primordial Emotions: The dawning of Consciousness*. New York, NY, US: Oxford University Press.

Deonna, J. A., & Scherer, K. R. (2010). The Case of the Disappearing Intentional Object: Constraints on a Definition of Emotion. *Emotion Review*, *2*(1), 44–52.

Deroy, O., Crisinel, A. S., & Spence, C. (2013). Crossmodal correspondences between odors and contingent features: odors, musical notes, and geometrical shapes. *Psychonomic Bulletin & Review*, *20*(5), 878–896.

Diego, M. A., Jones, N. A., Field, T., Hernandez-Reif, M., Schanberg, S., Kuhn, C., Galamaga, M., McAdam, V., & Galamaga, R. (1998). Aromatherapy positively affects mood, EEG patterns of alertness and math computations. *International Journal of Neuroscience*, *96*(3-4), 217–224.

Dimberg, U. (1986). Facial reactions to fear-relevant and fear-irrelevant stimuli. *Biological Psychology*, *23*(2), 153–161.

Dimberg, U., & Thunberg, M. (2007). Speech anxiety and rapid emotional reactions to angry and happy facial expressions. *Scandinavian Journal of Psychology*, *48*(4), 321–328.

Dittmar, H. (2000). The role of self-image in excessive buying. In A. L. Benson (Ed.), *I shop, therefore I am: Compulsive buying and the search for self* (pp. 105–132). Northvale, NJ: Jason Aronson Inc.

Dittmar, H. (2001). Impulse buying in ordinary and “compulsive” consumers. In E. U. Weber, J. Baron, & G. Loomes (Eds.), *Conflict and Trade offs in Decision Making* (pp. 110–135). Cambridge, UK: University Press.

Dittmar, H., Beattie, J., & Friese, S. (1996). Objects, decision considerations and self-image in men's and women's impulse purchases. Acta Psychologica, *93*(1), 187–206.

Dommermuch, W. P., & Millard, W. J., Jr. (1967). Consumption coincidence in product evaluation. *Journal of Marketing Research*, *4*(4), 388–390.

Donovan, R. J., & Rossiter, J. (1982). Store atmosphere: An environmental psychology approach. *Journal of Retailing*, *58*(1), 34–57.

Donovan, R. J., Rossiter, J. R., Marcoolyn, G., & Nesdale, A. (1994). Store atmosphere and purchasing behavior. *Journal of Retailing*, *70*(3), 283–294.

Driver, J., & Spence, C. (2000). Multisensory perception: beyond modularity and convergence. *Current Biology*, *10*(20), R731–R735.

Ehrlichman, H., & Bastone, L. (1992). Olfaction and emotion. In M. Serby, & K. Chobor (Eds.), *Science of Olfaction* (pp. 410-438). New York, NY, US: Springer.

Eisenberg, N., Fabes, R.A., Bustamante, D., Mathy, R.M., Miller, P.A., & Lindholm, E. (1988). Differentiation of vicariously induced emotional reactions in children. *Developmental Psychology*, *24*(2), 237–246.

Eitan, Z., & Timmers, R. (2010). Beethoven’s last piano sonata and those who follow crocodiles: Cross-domain mappings of auditory pitch in a musical context. *Cognition*, *114*(3), 405–422.

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

Ekman, P. (1999). Facial expressions. In T. Dalgleish, & M. Power (Eds.), *Handbook of Cognition and Emotion* (pp. 301–320). New York, NY, US: Wiley.

Ekman, P., & Friesen, W. V. (1978). *Facial action coding system*. Palo Alto, CA, US: Consulting Psychologists Press.

Ekman, P., Friesen, W.V, & Ellsworth, P. (1972). *Emotion in the human face: Guidelines for research and an integration of findings*. New York, NY, US: Pergamon Press.

Ellis, H. C., & Moore, B. A. (1999). Mood and Memory. In Dalgleish, T. and Power, M.J. (Eds.), *Handbook of cognition and emotion* (pp. 193–210), New York, NY, US: John Wiley & Sons Ltd.

Elsinger, P.J., Damasio, A.R., & Van Hoesen, S.W. (1982). Olfactory dysfunction in man: Anatomical and behavioral aspects. *Brain and Cognition*, *1*(3), 259-285.

Emery, N. J., & Amaral, D. G. (2000). The role of the amygdala in primate social cognition. In R. D. Lane & L. Nadel (Eds.), *Cognitive Neuroscience of Emotion* (pp. 156–191). New York, NY, US: Oxford University Press.

Emsenhuber, B. (2011). Scent Marketing: Making Olfactory Advertising Pervasive. In J. Müller, F. Alt, D. Michelis (Eds.), *Pervasive Advertising* (pp. 343–360). London, UK: Springer London.

Engen, T. (1982). *The perception of odors*. London, UK: Academic Press.

Epple, G., & Herz, R. S. (1999). Ambient odors associated to failure influence cognitive performance in children. *Developmental Psychobiology*, *35*(2), 103–107.

Etkin, A., Egner, T., & Kalisch, R. (2011). Emotional processing in anterior cingulate and medial prefrontal cortex. *Trends in Cognitive Sciences*, *15*(2), 85–93.

Etzel, J. A., Johnsen, E. L., Dickerson, J. A., Tranel, D., & Adolphs, R. (2006). Cardiovascular and respiratory responses during musical mood induction. *International Journal of Psychophysiology 61*(1), 57–69.

Fasunla, A. J., Douglas, D. D., Adeosun, A. A., Steinbach, S., & Nwaorgu, O. G. B. (2014). Effect of Strong Fragrance on Olfactory Detection Threshold. *Otolaryngology-Head and Neck Surgery, 151,* 438–442

Ferdenzi, C., Poncelet, J., Rouby, C., & Bensafi, M. (2014). Repeated exposure to odors induces affective habituation of perception and sniffing. *Frontiers in Behavioral Neuroscience*, *8*(119), 1–10.

Ferdenzi, C., Schirmer, A., Roberts, S. C., Delplanque, S., Porcherot, C., Cayeux, I., Schirmer, A., Delplanque, S., 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.

Finger, S. (1994). *Origins of Neuroscience*. New York, NY, US: Oxford University Press.

Finucane, M. L., Alhakami, A., Slovic, P., & Johnson, S. M. (2000). The affect heuristic in judgments of risks and benefits. *Journal of Behavioral Decision Making*, *13*(1), 1–17.

Firestein, S. (2001). How the olfactory system makes sense of scents. *Nature*, *413*(6852), 211–218.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: An introduction to Theory and Research*. Reading, MA, US: Addison-Wesley Publishing Co.

Flykt, A., Esteves, F., & Öhman, A. (2007). Skin conductance responses to masked conditioned stimuli: Phylogenetic/ontogenetic factors versus direction of threat? *Biological Psychology*, *74*(3), 328–336.

Fontaine, J. R., Scherer, K. R., Roesch, E. B., & Ellsworth, P. C. (2007). The world of emotions is not two-dimensional. *Psychological Science*, *18*(12), 1050–1057.

Forgas, J. P. (2003). Affective influences on attitudes and judgments. In R. J. Davidson, K. J. Scherer, & H. H. Goldsmith (Eds.), Handbook of affective sciences (pp. 596-618). New York, NY, US: Oxford University Press.

Fox, E. (2008). Emotion Science, Cognitive and neuroscientific approaches to understanding human emotions. New York, NY, US: Palgrave MacMillan.

Frank, R. A., Dulay, M. F., & Gesteland, R. C. (2003). Assessment of the Sniff Magnitude Test as a clinical test of olfactory function. *Physiology & Behavior*, *78*(2), 195–204.

Fredrickson, B.L., & Levenson, R.W. (1998). Positive emotions speed recovery from the cardiovascular sequelae of negative emotions. *Cognition and Emotion*, *12*(2), 191–220.

Friedman, B. H. (2010). Feelings and the body: The Jamesian perspective on autonomic specificity of emotion. *Biological Psychology*, *84*(3), 383–393.

Frijda, N. H. (1986). *The emotions*. New York, NY, US: Cambridge University Press.

Frijda, N. H. (2007). The laws of emotion. Mahwah, NJ, US: Erlbaum.

Gabrielsson, A., & Lindström, E. (2001). The influence of musical structure on emotional expression. In P. N. Juslin & J. A. Sloboda (Eds.), *Music and Emotion: Theory and Research* (pp. 223–248). New York, NY, US: Oxford University Press.

Gabrielsson, A., & Lindström, E. (2010). The role of structure in the musical expression of emotions. In P. N. Juslin & Sloboda (Eds.), *Handbook of Music and Emotion: Theory, Research, Applications* (pp. 367–400). New York, NY, US: Oxford University Press.

Gallace, A., & Spence, C. (2014). In touch with the future: the sense of touch from cognitive neuroscience to virtual reality. New York, NY, US: Oxford University Press.

Gazzaniga, M. S., Steen, D., & Volpe, B. T. (1979). *Functional Neuroscience.* New York, NY, US: Harper & Row.

Gerdes, A. B., Wieser, M. J. & Alpers, G. W. (2014). Emotional pictures and sounds: A review of multimodal interactions of emotion cues in multiple domains. *Frontiers in Psychology*, *5*(1351), 1–13.

Gigerenzer, G., & Gaissmaier, W. (2011). Heuristic decision making. *Annual Review of Psychology*, *62*, 451–482.

Gilad, Y., Man, O., Pääbo, S., & Lancet, D., (2003). Human specific loss of olfactory receptor genes. *Proceeding of the National Academy of Sciences of the United States of America, 100*(6)**,** 3324–3327.

Gilbert, A. N., Martin, R., & Kemp, S. E. (1996). Cross-modal correspondence between vision and olfaction: the color of smells. *American Journal of Psychology, 109*(3), 335–351.

Gilissen, R., Bakermans-Kraneburg, M.J., van Ijzendoorn, M.H., & van der Veer, R. (2008). Parent–child relationship, temperament, and physiological reactions to fearinducing film clips: further evidence for differential susceptibility. *Journal of Experimental Child Psychology*, *99*(3), 182–195.

Gilissen, R., Koolstra, C.M., van Ijzendoorn, M.H., Bakermans-Kraneburg, M.J., & van der Veer, R. (2007). Physiological reactions of preschoolers to fear-inducing film clips: effects of temperamental fearfulness and quality of the parent–child relationship. *Developmental Psychobiology, 49*(2), 187–195.

Gomez, P., & Danuser, B. (2004). Affective and physiological responses to environmental noises and music. *International Journal of Psychophysiology*, *53*(2), 91–103.

Gordon, S. L. (1989). Institutional and impulsive orientations in selectively appropriating emotions to self. *The sociology of emotions: Original Essays and Research Papers*, 115–135.

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.

Gottfried, J. A., Deichmann, R., Winston, J. S., & Dolan, R. J. (2002). Functional heterogeneity in human olfactory cortex: An event-related functional magnetic resonance imaging study. *Journal of Neuroscience*, *22*(24), 10819–10828.

Graham, F. K. (1979). Distinguishing among orienting, defense, and startle reflexes. In H. D. Kimmel, E. H. van Olst, & J. F. Orlebeke (Eds.), *The orienting reflex in humans. An international conference sponsored by the Scientific Affairs Division of the North Atlantic Treaty Organization* (pp. 137–167). Hillsdale, NJ, US: Erlbaum.

Grecucci, A., & Sanfey, A. G. (2013). Emotion regulation and decision making. In J. J. Gross, (Ed.), *Handbook of Emotion Regulation* (2nd ed., pp. 140-153). New York, NY, US: The Guilford Press.

Gregory, A. H., & Varney, N. (1996). Cross-cultural comparisons in the affective response to music. *Psychology of Music*, *24*(1), 47–52.

Griffiths, P. E., & Scarantino, A. (2009). Emotions in the wild: The situated perspective on emotion. In M. Aydede & P. Robbins (Eds.), *The Cambridge Handbook of Situated Cognition* (pp. 437–454). New York, NY: Cambridge University Press.

Gross, J. J., Fredrickson, B. L., & Levenson, R. W. (1994). The psychophysiology of crying. *Psychophysiology*, *31*(5), 460–468.

Gross, J. J., & Levenson, R. W. (1997). Hiding feelings: the acute effects of inhibiting negative and positive emotion. *Journal of Abnormal Psychology*, *106*(1), 95–103.

Gross, J. J., & Levenson, R.W. (1993). Emotional suppression: physiology, self-report, and expressive behavior. *Journal of Personality and Social Psychology*, *64*(6), 970–986.

Gross, J.J. (1998). Antecedent- and response-focused emotion regulation: divergent consequences for experience, expression, and physiology. *Journal of Personality and Social Psychology*, *74*(1), 224–237.

Gruber, J. J., Johnson, S.L., Oveis, C., & Keltner, D. (2008). Risk for mania and positive emotional responding: too much of a good thing? *Emotion, 8*(1), 23–33.

Gulas, C. S., & Bloch, P. H. (1995). Right under our noses: ambient scent and consumer responses. *Journal of Business and Psychology*, *10*(1), 87–98.

Haag, A., Goronzy, S., Schaich, P., & Williams, J. (2004). Emotion recognition using bio-sensors: First steps towards an automatic system. *Affective Dialogue Systems*, 3068, 36-48.

Hagelberg, N., Jääskeläinen, S. K., Martikainen, I. K., Mansikka, H., Forssell, H., Scheinin, H., ... & Pertovaara, A. (2004). Striatal dopamine D2 receptors in modulation of pain in humans: a review. *European Journal of Pharmacology*, *500*(1), 187–192.

Hamann, S. B., Ely, T. D., Hoffman, J. M., & Kilts, C. D. (2002). Ecstasy and Agony: Activation of the Human Amygdala in Positive and Negative Emotion. *Psychological Science*, *13*(2), 135–141.

Han, S., Lerner, J. S., & Keltner, D. (2007). Feelings and consumer decision making: The appraisal-tendency framework. *Journal of Consumer Psychology*, *17*(3), 158–168.

Hanson-Vaux, G., Crisinel, A.-S., & Spence, C. (2013). Smelling shapes: crossmodal correspondences between odors and shapes. *Chemical Senses*, *38*(2), 161–166.

Harrison, L., Carroll, D., Burns, V., Corkill, A., Harrison, C., Ring, C., & Drayson, M. (2000). Cardiovascular and secretory immunoglobulin A reactions to humorous, exciting, and didactic film presentations. *Biological Psychology*, *52*(2), 113–126.

Haviland-Jones, J. M., & Wilson, P. W. (2010). A “Nose” for Emotion: Emotional Information and Challenges in odors and semiochemicals. In M. Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of Emotions* (3rd ed., pp. 235–248). New York, NY, US: Guilford Press.

Hebb, D. O. (1966). *A Textbook of Psychology* (2nd ed.). Philadelphia, US: Saunders.

Hermans, F., Baeyens, P., & Eelen, D. (1998). Odours as affective-processing context for word evaluation: A case of cross-modal affective priming. *Cognition & Emotion*, *12*(4), 601–613.

Herz, R. S. (2004). A naturalistic analysis of autobiographical memories triggered by olfactory visual and auditory stimuli. *Chemical Senses*, *29*(3), 217–224.

Herz, R. S. (2009). Aromatherapy facts and fictions: a scientific analysis of olfactory effects on mood, physiology and behavior. *International Journal of Neuroscience*, *119*(2), 263–290.

Herz, R. S., & Cupchik, G. C. (1995). The emotional distinctiveness of odor-evoked memories. *Chemical Senses*, *20*(5), 517–528.

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

Herz, R. S., & Schooler, J. W. (2002). A naturalistic study of autobiographical memories evoked by olfactory and visual cues: testing the Proustian hypothesis. *American Journal of Psychology*, *115*(1), 21–32.

Herz, R. S., Eliassen, J., Beland, S., & Souza, T. (2004). Neuroimaging evidence for the emotional potency of odor-evoked memory. *Neuropsychologia*, *42*(3), 371–378.

Heuberger, E., Hongratanaworakit, T. & Buchbauer, G. (2006). East Indian sandalwood and α-santalol odor increase physiological and self-rated arousal in humans. *Planta Medica*, *72*, 792-800.

Hevner, K., (1937). The affective value of pitch and tempo in music. *American Journal of Psychology,* *49*(4), 621–630.

Hevner, K., (1935). The affective character of the major and minor modes in music. American *Journal of Psychology*, *47*(1), 103–118.

Higgins, K. M. (2012). Biology and culture in musical emotions. *Emotion Review, 4*(3), 273–282.

Hochel, M., Milán, E. G., Martín, J. M., González, A., García, E. D., Tornay, F., & Vila, J. (2009). Congruence or coherence? Emotional and physiological responses to colours in synaesthesia. *European Journal of Cognitive Psychology*, *21*(5), 703–723.

Hoffman, K. D., & Turley, L. W. (2002). Atmospherics, service encounters and consumer decision making: an integrative perspective. *Journal of Marketing Theory and Practice*, *10*(3), 33–47.

Holbrook, M. B., & Anand, P. (1990). Effects of tempo and situational arousal on the listener's perceptual and affective responses to music. *Psychology of Music*, *18*(2), 150–162.

Holbrook, M. B., & Hirschman, E. C. (1982). The experiential aspects of consumption: consumer fantasies, feelings, and fun. *Journal of Consumer Research*, *9*(2), 132–140.

Hongratanaworakit, T. (2004). Physiological effects in aromatherapy. *Songklanakarin J Sci Technol*, *26*(1), 117–125.

Huber, J., & McCann, J. (1982). The impact of inferential beliefs on product evaluations. *Journal of Marketing Research*, *19*(3), 324–333.

Hubert, W., & de Jong-Meyer, R. (1990). Psychophysiological response patterns to positive and negative film stimuli. *Biological Psychology*, *31*(1), 73–93.

Hubert, W., & de Jong-Meyer, R. (1991). Autonomic, neuroendocrine, and subjective responses to emotion-inducing film stimuli. *International Journal of Psychophysiology*, *11*(2), 131–140.

Hui, M. K., & Bateson, J. E. (1991). Perceived control and the effects of crowding and consumer choice on the service experience. *Journal of Consumer Research*, *18*(2), 174–184.

Hui, M. K., Dube, L., & Chebat, J. C. (1997). The impact of music on consumers' reactions to waiting for services. *Journal of Retailing*, *73*(1), 87–104.

Hume, D. (1969). *A Treatise of Human Nature*. (Original work published 1739–1740). Harmondsworth, UK: Penguin.

Huron, D., Yim, G., & Chordia, P. (2010). The effect of pitch exposure on sadness judgments: An association between sadness and lower than normal pitch. *In Proceedings of the 11th International Conference on Music Perception and Cognition*, 63–66.

Husain, G., Thompson, W. F., & Schellenberg, E. G. (2002). Effects of musical tempo and mode on arousal, mood, and spatial abilities. *Music Perception*, *20*(2), 151–171.

Ilmberger, J., Heuberger, E., Mahrhofer, C., Dessovic, H., Kowarik, D., & Buchbauer, G. (2001). The influence of essential oils on human attention. I: alertness. *Chemical Senses*, *26*(3), 239–245.

Imada, T., & Ellsworth, P. C. (2011). Proud Americans and lucky Japanese: cultural differences in appraisal and corresponding emotion. *Emotion*, *11*(2), 329–345.

Isen, A. M. (2000). Positive affect and decision making. In M. Lewis & J. M. Haviland-Jones (Eds.), *Handbook of Emotions* (2nd ed., pp. 417–435). New York, NY, US: Guilford Press.

Isen, A. M. (2001). An influence of positive affect on decision making in complex situations: Theoretical issues with practical implications. *Journal of Consumer Psychology*, *11*(2), 75–85.

Isen, A. M. (2008). Positive affect and decision processes: Some recent theoretical developments with practical implications. In C. Haugdvedt, P. M. Herr, & F. R. Kardes (Eds.), *Handbook of Consumer Psychology* (pp. 273–296). New York, NY, US: Psychology Press.

Isen, A. M., & Reeve, J. (2005). The influence of positive affect on intrinsic and extrinsic motivation: Facilitating enjoyment of play, responsible work behavior, and self-control. *Motivation and Emotion*, *29*(4), 295–323.

Isen, A. M., Shalker, T. E., Clark, M., & Karp, L. (1978). Affect, accessibility of material in memory, and behavior: A cognitive loop? *Journal of Personality and Social Psychology*, *36*(1), 1-12.

Izard, C. E. (1994). Innate and universal facial expressions: evidence from developmental and cross-cultural research. *Psychological Bulletin*, *115*(2), 288–299.

James, W. (1884). What is an Emotion? *Mind*, *9*(34), 188–205.

James, W. (1894). Discussion: The physical basis of emotion. *Psychological Review*, *1*(5), 516–529.

Jerritta, S., Murugappan, M., Nagarajan, R., & Wan, K. (2011). Physiological signals based human emotion Recognition: a review. In *2011 IEEE 7th International Colloquium on Signal Processing and its Applications (CSPA)*, 410–415.

Johnson, B. N., Mainland, J. D., & Sobel, N. (2003). Rapid olfactory processing implicates subcortical control of an olfactomotor system. *Journal of Neurophysiology*, *90*(2), 1084–1094.

Johnson, R. D. (1987). Making judgements when information is missing: inferences, biases, and framing effects. *Acta Psychologica*, *66*(1), 69–82.

Johnson, R. D., & Levin, I. P. (1985). More than meets the eye: The effect of missing information on purchase evaluations. *Journal of Consumer Research*, *12*(2), 169–177.

Jones, G. E. & Johnson, H. J. (1978). Physiological responding during self generated imaginary of contextually complete stimuli. *Psychophysiology*, *15*(5), 439–446.

Jönsson, P., & Sonnby-Borgström, M. (2003). The effects of pictures of emotional faces on tonic and phasic autonomic cardiac control in women and men. *Biological Psychology*, *62*(2), 157–173.

Juslin P. N., & Sloboda J. (2010.), *Handbook of Music and Emotion: Theory, Research, Applications*. New York, NY, US: Oxford University Press.

Juslin, P. N., & Laukka, P. (2003). Communication of emotions in vocal expression and music performance: Different channels, same code? *Psychological Bulletin*, *129*(5), 770–814.

Kahneman, D. (2003). A perspective on judgment and choice: mapping bounded rationality. *American Psychologist*, *58*(9), 697–720.

Kaiser, C., Roessler, R. (1970). Galvanic skin responses to motion pictures. *Perceptual and Motor Skills*, *30*(2), 371–374.

Kay, L. M. (2011). Olfactory coding: random scents make sense. *Current Biology*, *21*(22), 928–929.

Keller, A., & Vosshall, L. B. (2004). A psychophysical test of the vibration theory of olfaction. *Nature Neuroscience*, *7*(4), 337–338.

Keller, A., & Vosshall, L. B. (2008). Better smelling through genetics: mammalian odor perception. *Current Opinion in Neurobiology*, *18*(4), 364–369.

Kemp, S. E., & Gilbert, A. N. (1997). Odor intensity and color lightness are correlated sensory dimensions. *The American Journal of Psychology, 110*(1), 35–46.

Khalfa, S., Isabelle, P., Jean-Pierre, B., & Manon, R. (2002). Event-related skin conductance responses to musical emotions in humans. *Neuroscience Letters*, *328*(2), 145–149.

Khalfa, S., Roy, M., Rainville, P., Bella, S.D., & Peretz, I. (2008). Role of tempo entrainment in psychophysiological differentiation of happy and sad music? *International Journal of Psychophysiology*, *68*(1), 17–26.

Khan, R. M., Luk, C. H., Flinker, A., Aggarwal, A., Lapid, H., Haddad, R., & Sobel, N. (2007). Predicting odor pleasantness from odorant structure: pleasantness as a reflection of the physical world. *The Journal of Neuroscience*, *27*(37), 10015–10023.

King, J., & Slovic, P. (2014). The affect heuristic in early judgments of product innovations. *Journal of Consumer Behaviour*, *13*(6), 411–428.

Kirk-Smith, M. D., Van Toller, C., & Dodd, G. H. (1983). Unconscious odour conditioning in human subjects. *Biological Psychology*, *17*(2), 221–231.

Kivetz, R., & Simonson, I. (2000). The effects of incomplete information on consumer choice. *Journal of Marketing Research*, *37*(4), 427–448.

Kleinginna Jr, P. R., & Kleinginna, A. M. (1981). A categorized list of emotion definitions, with suggestions for a consensual definition. *Motivation and Emotion*, *5*(4), 345–379.

Klinge, C., Eippert, F., Röder, B., & Büchel, C. (2010). Corticocortical connections mediate primary visual cortex responses to auditory stimulation in the blind. *The Journal of Neuroscience*, *30*(38), 12798–12805.

Klorman, R., Weissberg, R.P., & Wiesenfeld, A.R. (1977). Individual differences in fear and autonomic reactions to affective stimulation. *Psychophysiology*, *14*(1), 45–51.

Klüver, H., & Bucy, P. C. (1937). "Psychic blindness" and other symptoms following bilateral temporal lobectomy in Rhesus monkeys. *American Journal of Physiology*, *119*, 352–354.

Knasko, S. C. (1989). Ambient odor and shopping behavior. *Chemical Senses*, *14*(94), 719–725.

Knasko, S. C. (1992). Ambient odor's effect on creativity, mood, and perceived health. *Chemical Senses*, *17*(1), 27–35.

Knasko, S. C. (1993). Lingering time in a museum in the presence of congruent and incongruent odors. *Chemical Senses*, *18*(5), 581–588.

Knasko, S. C. (1995). Pleasant odors and congruency: Effects on approach behavior. *Chemical Senses*, *20*(5), 479–487.

Knasko, S., (1989). Ambient odor and shopping behavior. *Chemical Senses*, *14*(5), 719–720.

Knecht, M., Lundström, J. N., Witt, M., Hüttenbrink, K. B., Heilmann, S., & Hummel, T. (2003). Assessment of olfactory function and androstenone odor thresholds in humans with or without functional occlusion of the vomeronasal duct. *Behavioral Neuroscience*, *117*(6), 1135–1141.

Koelsch, S., Kasper, E., Sammler, D., Schulze, K., Gunter, T., Friederici, A. D. (2004). Music, language and meaning: brain signatures of semantic processing. *Nature Neuroscience*, *7*(3), 302–307.

Köhler W. (1929). *Gestalt Psychology*. New York, NY, US: Liveright.

Kory, J. M., & D'Mello, S. K. (2014). Affect Elicitation for Affective Computing. In R. A. Calvo, S.K. D'Mello, J. Gratch, & A. Kappas (Eds.) *The Oxford Handbook of Affective Computing* (pp. 371–383). Oxford, UK: Oxford University Press.

Kotler, P. (1973). Atmospherics as a marketing tool. *Journal of Retailing, 49*(4), 48–64.

Kreibig, S. D. (2010). Autonomic nervous system activity in emotion: A review. *Biological Psychology*, *84*(3), 394–421.

Kreibig, S.D., Wilhelm, F.H., Roth, W.T., & Gross, J.J. (2007). Cardiovascular, electrodermal, and respiratory response patterns to fear and sadness-inducing films. *Psychophysiology*, *44*(5), 787–806.

Kring, A.M., & Gordon, A.H. (1998). Sex differences in emotion: expression, experience, and physiology. *Journal of Personality and Social Psychology*, *74*(3), 686–703.

Kring, A.M., & Neale, J.M. (1996). Do schizophrenic patients show a disjunctive relationship among expressive, experiential, and psychophysiological components of emotion? *Journal of Abnormal Psychology*, *105*(2), 249–257.

Kringelbach, M. L., & Berridge, K. C. (2009). Towards a functional neuroanatomy of pleasure and happiness. *Trends in Cognitive Sciences*, *13*(11), 479–487.

Krishna, A. (2012). An integrative review of sensory marketing: Engaging the senses to affect perception, judgment and behaviour. *Journal of Consumer Psychology*, *22*(3), 332–351.

Krishna, A., Lwin, M. O., & Morrin, M. (2010). Product scent and memory. *Journal of Consumer Research*, *37*(1), 57–67.

Krumhansl, C. L. (1997). An exploratory study of musical emotions and psychophysiology. *Canadian Journal of Experimental Psychology*, *51*(4), 336–353.

Kunzmann, U., & Grühn, D. (2005). Age differences in emotional reactivity: the sample case of sadness. *Psychology and Aging*, *20*(1), 47–59.

Kunzmann, U., Kupperbusch, C.S., & Levenson, R.W. (2005). Behavioral inhibition and amplification during emotional arousal: a comparison of two age groups. *Psychology and Aging*, *20*(1), 144–158.

Lacey, J. I. (1967). Somatic response patterning and stress: Some revisions of activation theory. In M. H Appley, & R. Trumbell (Eds.), *Psychological Stress* (pp. 14–37). New York, NY, US: Appleton-Century-Crofts.

Laing, D. G. (1983). Natural sniffing gives optimum odour perception for humans. *Perception*, *12*(2), 99–117.

Laing, D. G., & Francis, G. W. (1989). The capacity of humans to identify odors in mixtures. *Physiology & Behavior*, *46*(5), 809–814.

Lane, R. D., & Nadel, L. (2002). *Cognitive neuroscience of emotion*. New York, NY, US: Oxford University Press.

Lane, R. D., Ahern, G. L., Schwartz, G. E., & Kaszniak, A. W. (1997). Is alexithymia the emotional equivalent of blindsight? *Biological Psychiatry*, *42*(9), 834–844.

Lang, P. J. (1979). A bio–informational theory of emotional imagery. *Psychophysiology*, *16*(6), 495–512.

Lang, P. J. (1995). The emotion probe: Studies of motivation and attention. *American Psychologist*, *50*(5), 372–385.

Lang, P. J. (2014). Emotion's Response Patterns: The Brain and the Autonomic Nervous System. *Emotion Review*, *6*(2), 93–99.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1993). Emotion, arousal, valence, and the startle reflex. In N. Birbaumer & A. Öhman, (Eds.), *The Structure of Emotion: Psychophysiological, Cognitive and Clinical Aspects* (pp. 243–251). Seattle, US: Hogrefe & Huber Publishers.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1997). Motivated attention: Affect, activation, and action. In P. J. Lang, R. F. Simon, & M. Balaban (Eds.), *Attention and orienting: Sensory and Motivational Processes* (pp. 97-135). New York, NY, US: Psychological Press

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1999). *International affective picture system (IAPS): Technical manual and affective ratings*. NIMH Center of Study Emotion and Attention, Gainesville, FL: University of Florida.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (2005). *International affective picture system (IAPS): Affective ratings of pictures and instruction manual*. Technical Report A-6, Gainesville, FL: University of Florida.

Lang, P. J., Kozak, M. J., Miller, G. A., Levin, D. N., & McLean, A., Jr. (1980). Emotional imagery: Conceptual structure and pattern of somato-visceral response. *Psychophysiology*, *17*(2), 179–92.

Lang, P., & Bradley, M. M. (2007). The International Affective Picture System (IAPS) in the study of emotion and attention. In J. A. Coan, J. J. B. Allen (Eds.), *Handbook of Emotion Elicitation and Assessment* (pp. 29–46). New York, NY, US: Oxford University Press.

Lapid, H., Seo, H. S., Schuster, B., Schneidman, E., Roth, Y., Harel, D., Sobel, N., & Hummel, T. (2009). Odorant concentration dependence in electroolfactograms recorded from the human olfactory epithelium. *Journal of Neurophysiology*, *102*(4), 2121–2130.

Laros, F. J. M., & Steenkamp, J. E. M. (2005). Emotions in consumer behavior: A hierarchical approach. *Journal of Business Research*, *58*(10), 1437-1445.

Larsen, J. T., Berntson, G. G., Poehlmann, K. M., Ito, T. A., & Cacioppo, J. T. (2008). The psychophysiology of emotion. In R. Lewis, J. M. Haviland-Jones, & L. Feldman-Barrett (Eds.), *The Handbook of Emotions* (3rd ed.). New York, NY, US: Guilford.

Larsen, R. J., & Prizmic-Larsen, Z. (2006). Measuring emotions: Implications of a multimethod perspective. In M. Eid & E. Diener (Eds.), *Handbook of Multimethod Measurement in Psychology* (pp. 337–351). Washington, DC, US: American Psychological Association.

Larsson, M., Willander, J., Karlsson, K., & Arshamian, A. (2014). Olfactory LOVER: behavioral and neural correlates of autobiographical odor memory. *Frontiers in Psychology*, *5*(312), 1–5.

Lazarus, R. S. (1966). *Psychological Stress and the Coping Process*. New York, NY, US: McGraw-Hill.

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

Lebergott, S., (1993). *Pursuing Happiness*. Princeton, US: Princeton University Press.

LeDoux, J. E. (2012). Rethinking the emotional brain. *Neuron*, *73*(4), 653-676.

LeDoux, J. E. (1992). Emotion and the amygdala. In J. P. Aggleton (Ed.), The Amygdala: *Neurobiological Aspects of Emotion, Memory, and Mental Dysfunction*. New York, NY, US: Wiley.

LeDoux, J. E. (1996). *The Emotional Brain*. New York, NY, US: Simon & Schuster.

LeDoux, J. E. (2000). Emotion circuits in the brain. *Annual Review of Neuroscience*, *23*, 155-184.

LeDoux, J. E., & Phelps, E. A. (2011). In M. Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of Emotions* (3rd ed., pp. 159–170). New York, NY, US: Guilford Press.

Leenders, M. A., Smidts, A., & Langeveld, M. (1999). Effects of ambient scent in supermarkets: a field experiment. In L. Hildebrandt, D. Annackee, & D. Klapper (Eds), *Marketing and Competition in the Information Age*. Proceedings of the 28th EMAC conference, Humboldt University, Berlin.

Leeper, R. W. (1948). A motivational theory of emotion to replace emotion as disorganized response. *Psychological Review, 55*(1)*,* 5-21.

Lehrner, J., Marwinski, G., Lehr, S., Johren, P., & Deecke, L. (2005). Ambient odors of orange and lavender reduce anxiety and improve mood in a dental office. *Physiology & Behavior*, *86*(1), 92-95.

Lerner, J. S., & Keltner, D. (2001). Fear, anger, and risk. *Journal of Personality and Social Psychology*, *81*(1), 146–159.

Levenson, R. W. (2011). Basic Emotion Questions. *Emotion Review*, *3*(4), 379–386.

Levenson, R. W., Ekman, P., Heider, K., & Friesen, W. V. (1992). Emotion and autonomic nervous system activity in the Minangkabau of West Sumatra. *Journal of Personality and Social Psychology*, *62*(6), 972–988.

Levenson, R.W. (1994). Human emotions: A functional view. In P. Ekman & R.J. Davidson (Eds.), *The nature of emotion: Fundamental Questions* (pp. 123–126). New York: Oxford University Press.

Leventhal, H. (1980). Toward a comprehensive theory of emotion. In L. Berkowitz (Ed.), *Advances in Experimental Social Psychology* (23, pp. 139–207). New York, NY, US: Academic Press.

Leventhal, H. (1984). A perceptual-motor theory of emotion. In L. Berkowitz (Ed.), *Advances in Experimental Social Psychology* (17, pp. 117–182). New York, NY, US: Academic Press.

Levin, I. P., Johnson, R. D., & Faraone, S. V. (1984). Information integration in price-quality tradeoffs: The effect of missing information. *Memory & Cognition*, *12*(1), 96–102.

Levitan, C. A., Ren, J., Woods, A. T., Boesveldt, S., Chan, J. S., McKenzie, K. J., Dodson, M., Levin, J. A., Leong, X. R., Jasper, J. F., & van den Bosch, J. J. (2014). Cross-cultural color-odor associations. *PloS One*, *9*(7), e101651.

Li, X. (2008). The effects of appetitive stimuli on out-of-domain consumption impatience. *Journal of Consumer Research*, *34*(5), 649–656.

Lindstrom, M. (2008). *Brand sense: sensory secrets behind the stuff we buy*. New York, NY, US: Simon and Schuster Inc.

List, A., Iordanescu, L., Grabowecky, M., & Suzuki, S. (2012). Haptic shape guides visual search. *Journal of Vision, 12*(9), 1320–1320.

Loewenstein, G. F., & Lerner, J. S. (2003). The role of affect in decision making. In R. J. Davidson , K. R. Scherer , & H. H. Goldsmith (Eds.), In Handbook of Affective Sciences (pp. 619–642). Oxford, UK: Oxford University Press.

Logeswaran, N., & Bhattacharya, J. (2009). Crossmodal transfer of emotion by music. *Neuroscience Letters*, *455*(2), 129–133.

Lorig, T. S., & Roberts, M. (1990). Odor and cognitive alteration of the contingent negative variation. *Chemical Senses*, *15*(5), 537–545.

Luminet, O., Rimé, B., Bagby, R.M., & Taylor, G.J. (2004). A multimodal investigation of emotional responding in alexithymia. *Cognition and Emotion, 18*(6), 741–766.

Lundström, J. N., & Olsson, M. J. (2010). Chapter one-functional neuronal processing of human body odors. *Vitamins & Hormones*, *83*, 1–23.

Lundström, J. N., Boyle, J. A., Zatorre, R. J., & Jones-Gotman, M. (2008). Functional neuronal processing of body odors differs from that of similar common odors. *Cerebral Cortex*, *18*(6), 1466–1474.

Lundström, J. N., Boyle, J., & Jones-Gotman, M., (2006). Sit up and smell the roses better: olfactory sensitivity to phenyl ethyl alcohol is dependent on body position. *Chemical Senses, 31*(3)**,** 249–252.

Macfarlane, A. (1975). Olfaction in the development of social preferences in the human neonate. *Parent-Infant Interaction*, *33*, 103–113.

Mackie, D. M., & Worth, L. T. (1989). Processing deficits and the mediation of positive affect in persuasion. *Journal of Personality and Social Psychology*, *57*(1), 27–40.

Mackie, D. M., & Worth, L. T. (1991). Feeling good, but not thinking straight: The impact of positive mood on persuasion. In J. P. Forgas (Ed.), *Emotion and Social Judgments* (pp. 210–219). Oxford, UK: Pergamon.

Magnée, M. J., De Gelder, B., Van Engeland, H., & Kemner, C. (2007). Facial electromyographic responses to emotional information from faces and voices in individuals with pervasive developmental disorder. *Journal of Child Psychology and Psychiatry*, *48*(11), 1122–1130.

Mallet, P., & Schaal, B. (1998). Rating and recognition of peers' personal odors by 9-year-old children: an exploratory study. *The Journal of General Psychology*, *125*(1), 47–64.

Mandler, G. (1962). From association to structure. *Psychological Review*, *69*(5), 415–427.

Marin, M. M., Gingras, B., & Bhattacharya, J. (2012). Crossmodal transfer of arousal, but not pleasantness, from musical to the visual domain. *Emotion*, *12*(3), 618–631.

Markin, R. J., Lillis, C. M., & Narayana, C. L. (1976). Social-psychological significance of store space. *Journal of Retailing*, *52*(1), 43–54.

Marks, L. E. (1975). On colored-hearing synesthesia: Cross-modal translations of sensory dimensions. *Psychological Bulletin*, *82*(3), 303–331.

Marsh, P., Beauchaine, T.P., & Williams, B. (2008). Dissociation of sad facial expressions and autonomic nervous system responding in boys with disruptive behavior disorders. *Psychophysiology, 45*(1), 100–110.

Martin, M. (1990). On the induction of mood. *Clinical Psychology Review*, *10*(6), 669-697.

Mather, M., & Carstensen, L. L. (2003). Aging and attentional biases for emotional faces. *Psychological Science*, *14*(5), 409–415.

Mattila, A. S., & Wirtz, J. (2001). Congruency of scent and music as a driver of in-store evaluations and behavior. *Journal of Retailing*, *77*(2), 273–289.

Mauss, I. B., & Robinson, M. D. (2009). Measures of emotion: A review. *Cognition and Emotion*, *23*(2), 209–237.

Mayne, T., & Bonanno, G. A. (2001). *Emotions: Current Issues and Future Directions*. New York, NY, US: Guilford Press.

McDougall, W. (1921). *An Introduction to Socialpsychology.* Boston, US: Luce.

McLean, P. D. (1952). Some psychiatric implications of physiological studies on frontotemporal portion of limbic system (visceral brain). *Electroencephalography and Clinical Neurophysiology*, *4*(4), 407–418.

McNair, D. M., Lorr, M., & Droppleman, L. F. (1992). Revised manual for the Profile of Mood States. San Diego, CA, US: Educational and Industrial Testing Services.

Mehrabian, A. & Russell, J. (1974). *An approach to environmental psychology*. Cambridge, MA: MIT Press.

Meredith, M. (2001). Human vomeronasal organ function: a critical review of best and worst cases. *Chemical Senses*, *26*(4), 433–445.

Meyer, R. J. (1981). A model of multiattribute judgments under attribute uncertainty and informational constraint. *Journal of Marketing Research*, *18*(4), 428–441.

Michon, R., Chebat, J. -C., & Turley, L. W. (2002). Mall atmospherics: The interaction effects of the mall environment on shopping behavior. *Journal of Business Research*, *58*(5), 576–583.

Miller, G. A., Galanter, E. H., & Pribram, K. (1960). *Plans and Structure of Behavior*. New York, NY, US: Holt.

Miller, G. A., Levin, D. N., Kozak, M. J., Cook, E. W. III, McLean, A. & Lang, P. J. (1987). Individual differences in perceptual imagery and psychophysiological response in emotion. *Cognition and Emotion*, *1*(4), 367–390.

Millot, J. L., Brand, G., & Morand, N. (2002). Effects of ambient odors on reaction time in humans. *Neuroscience Letters*, *322*(2), 79–82.

Milner, P. M. (1970). *Physiological Psychology.* New York, NY, US: Holt, Rinehart & Winston.

Milotic, D. (2001). The impact of fragrance on consumer choice. *Journal of Consumer Behaviour*, *3*(2), 179–191.

Mitchell, D. J., Kahn, B. E., & Knasko, S. C. (1995). There's something in the air: Effects of congruent or incongruent ambient odor on consumer decision making. *Journal of Consumer Research*, *22*(2), 229–238.

Mobley, A. S., Rodriguez-Gil, D. J., Imamura, F., & Greer, C. A. (2014). Aging in the olfactory system. *Trends in Neurosciences*, *37*(2), 77-84.

Mombaerts, P. (1999). Seven-transmembrane proteins as odorant and chemosensory receptors. *Science*, *286*(5440), 707-711.

Montoya, P., Campos, J.J., & Schandry, R. (2005). See red? Turn pale? Unveiling emotions through cardiovascular and hemodynamic changes. *The Spanish Journal of Psychology*, *8*(01), 79–85.

Moors, A. (2009). Theories of emotion causation: A review. *Cognition & Emotion*, *23*(4), 625–662.

Moors, A. (2014). Flavors of Appraisal Theories of Emotion. *Emotion Review*, *6*(4), 303–307.

Moors, A., Ellsworth, P. C., Scherer, K. R., & Frijda, N. H. (2013). Appraisal Theories of Emotion: State of the Art and Future Development. *Emotion Review*, *5*(2), 119–124.

Morgan, C. T., King, R. A., & Robinson, N. M. (1979). *Introduction to Psychology* (6th ed.). New York, NY, US: McGraw-Hill.

Mori, K., & Sakano, H. (2011). How is the olfactory map formed and interpreted in the mammalian brain? *Annual Review of Neuroscience*, *34*, 467–499.

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.

Morrin, M., & Ratneshwar, S. (2000). The impact of ambient scent on evaluation, attention, and memory for familiar and unfamiliar brands. *Journal of Business Research*, *49*(2), 157–165.

Morrin, M., & Ratneshwar, S. (2003). Does it make sense to use scents to enhance brand memory? *Journal of Marketing Research*, *40*(1), 10–25.

Morrison, M., Gan, S., Dubelaar, C., & Oppewal, H. (2011). In-store music and aroma influences on shopper behavior and satisfaction. *Journal of Business Research*, *64*(6), 558–564.

Morrot, G., Brochet, F., & Dubourdieu, D. (2001). The color of odors. *Brain and Language*, *79*(2), 309–320.

Murphy, S. T., & Zajonc, R. B. (1993). Affect, cognition, and awareness: Affective priming with optimal and suboptimal stimulus exposures. *Journal of Personality and Social Psychology*, *64*(5), 723–739.

Muruganantham, G., & Bhakat, R. S. (2013). A Review of impulse buying behavior. *International Journal of Marketing Studies*, *5*(3), 149–160.

Nagata, Y. (2003). Odor measurement review. Tokyo (Japan): Office of Odor, Noise and Vibration. *Environmental Management Bureau, Ministry of Environment*, 118–127.

Nagpal, A., Khare, A., Chowdhury, T., Labrecque, L. I., & Pandit, A. (2011). The impact of the amount of available information on decision delay: The role of common features. *Marketing Letters*, *22*(4), 405–421.

Nef, P., Hermans-Borgmeyer, I., Artieres-Pin, H., Beasley, L., Dionne, V. E., & Heinemann, S. F. (1992). Spatial pattern of receptor expression in the olfactory epithelium. *Proceedings of the National Academy of Sciences*, *89*(19), 8948–8952.

Nelson, M. R., & Hitchon, J. C. (1999). Loud tastes, colored fragrances, and scented sounds: How and when to mix the senses in persuasive communications. *Journalism & Mass Communication Quarterly*, *76*(2), 354–372.

Noda, M., Takai, J., & Yoshida, T. (2007). The influence of time pressure on mood-congruent effects: Evaluating products with limited information. *Journal of Applied Social Psychology*, *37*(2), 403–425.

Nyklicek, I., Thayer, J. F., & Van Doornen, L. J. P. (1997). Cardiorespiratory differentiation of musically-induced emotions. *Journal of Psychophysiology*, *11*(4), 304–321.

Oatley, K., & Johnson-Laird, P. N. (2014). Cognitive approaches to emotions. *Trends in Cognitive Sciences*, *18*(3), 134–140.

Ochs, S. (1965). *Elements of Neurophysiology.* New York, NY, US: Wiley.

Ochsner, K. N., & Feldman Barrett, L. (2001). A multiprocess perspective on the neuroscience of emotion. In T. Mayne & G. Bonnano (Eds.), *Emotion: Current Issues and Future Directions*. (pp. 38–81). New York, NY, US: Guilford Press.

Ochsner, K. N., & Gross, J. J. (2005). The cognitive control of emotion. *Trends in Cognitive Sciences*, *9*(5), 242–249.

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.

Ogren, B. (2004). Aristotle's Rhetoric and the Cognition of Being: Human Emotions and the Rational-Irrational Dialectic. *Minerva - An Internet Journal of Philosophy*, *8*, 1–19.

Öhman, A., Carlsson, K., Lundqvist, D., & Ingvar, M. (2007). On the unconscious subcortical origin of human fear. *Physiology & Behavior*, *92*(1), 180–185.

Olivero, N. & Russo, V. (2013). *Manuale di Psicologia dei Consumi*. (2nd ed.). Milano, IT: McGraw-Hill.

Olivero, N., & Maggioni, E. (2013a). Olfactory Marketing: from the lab to the store. The case study of Puro Gusto, Autogrill (Marketing Olfattivo: dal laboratorio al punto vendita. Il caso di Puro Gusto, Autogrill). In N. Olivero & V. Russo, V. (Eds.), *Handbook of Consumer Psychology* (Manuale di Psicologia dei Consumi)(2nd ed., pp. 220–225). Milano, IT: McGraw-Hill.

Olivero, N., & Maggioni, E. (2013b). Physiological and implicit attitude measures in the explanation of scent effects on emotions and impulse buying (Misure neurofisiologiche e di atteggiamento implicito per la spiegazione degli effetti dell'odore su emozioni e acquisto d'impulso). In N. Olivero & V. Russo, V. (Eds.), *Handbook of Consumer Psychology* (Manuale di Psicologia dei Consumi)(2nd ed., pp. 551–561). Milano, IT: McGraw-Hill.

Pachauri, M. (2002). Researching online consumer behaviour: current positions and future perspectives. *Journal of Customer Behaviour*, *1*(2), 269–300.

Palomba, D., & Stegagno, L. (1993). Physiology, perceived emotion, and memory: responding to film sequences. In N. Birbaumer & A. Öhman (Eds.), *The Structure of Emotion* (pp. 156–167). Seattle, US: Hogrefe & Huber Publishers.

Palomba, D., Sarlo, M., Angrilli, A., Mini, A., & Stegagno, L. (2000). Cardiac responses associated with affective processing of unpleasant film stimuli. *International Journal of Psychophysiology, 36*(1), 45–57.

Panksepp, J. (1998). Affective neuroscience: The foundations of human and animal emotions. New York, NY, US: Oxford University Press.

Panksepp, J. (2000). The neuro-evolutionary cusp between emotions and cognitions: Implications for understanding consciousness and the emergence of a unified mind science. *Consciousness & Emotion*, *1*(1), 15–54.

Panksepp, J. (2007). Neurologizing the psychology of affects: How appraisal-based constructivism and basic emotion theory can coexist. *Perspectives on Psychological Science*, *2*(3), 281–296.

Papez, J. W. (1937). A proposed mechanism of emotion. *Archives of Neurology and Psychiatry*, *38*(4), 725–743.

Partan, S. R., & Marler, P. (2005). Issues in the classification of multimodal communication signals. *The American Naturalist*, *166*(2), 231–245.

Pause, B. M. (2012). Processing of body odor signals by the human brain. *Chemosensory Perception*, *5*(1), 55–63.

Peck, J., & Childers, T. L. (2008). If it tastes, smells, sounds, and feels like a duck, then it must be a...: Effects of sensory factors on consumer behaviors. In C. P. Haugtvedt, P. M. Herr, & F. R. Kardes (Eds.), *Handbook of Consumer Psychology* (pp. 193–219). Florence, KY: Psychology Press.

Penning, W., Roi, R., & Boni, M. (1990). Ecdin-the European databank on environmental chemicals. *Toxicological & Environmental Chemistry, 25*(4), 251-264.

Peretz, I. (2006). The nature of music from a biological perspective. *Cognition*, *100*(1), 1–32.

Pessoa, L., & Adolphs, R. (2011). Emotion and the brain: multiple roads are better than one. *Nature Reviews Neuroscience*, *12*(7), 425–425.

Peters, E., Västfjäll, D., Gärling, T., & Slovic, P. (2006). Affect and decision making: A "hot" topic. *Journal of Behavioral Decision Making*, *19*(2), 79–85.

Peters, R. S. The education of the emotions (1970). In M. B. Arnold (Ed.), *Feelings and Emotions: Loyola Symposium.* New York, NY, US: Academic Press.

Peyk, P., Schupp, H. T., Elbert, T., & Junghöfer, M. (2008). Emotion processing in the visual brain: a MEG analysis. *Brain Topography*, *20*(4), 205–215.

Pham, M. T. (2007). Emotion and rationality: A critical review and interpretation of empirical evidence. *Review of General Psychology*, *11*(2), 155–178.

Phan, K. L., Wager, T., Taylor, S. F., & Liberzon, I. (2002). Functional Neuroanatomy of Emotion: A Meta-Analysis of Emotion Activation Studies in PET and fMRI. *NeuroImage*, *16*(2), 331–348.

Phelps, E. A., Ling, S., & Carrasco, M. (2006). Emotion facilitates perception and potentiates the perceptual benefits of attention. *Psychological Science*, *17*(4), 292–299.

Pierce Jr, J. D., Doty, R. L., & Amoore, J. E. (1996). Analysis of position of trial sequence and type of diluent on the detection threshold for phenyl ethyl alcohol using a single staircase method. *Perceptual and Motor Skills*, *82*(2), 451–458.

Pine, B. J., & Gilmore, J. H. (2004). Experience is marketing. *Brand Strategy, 187*, 50–54.

Pine, B.J., & Gilmore, J.H. (1999). *The Experience Economy*. Boston, MA, US: Harvard Business School Press.

Planalp, S. (1998). Communicating emotion in everyday life: Cues, channels, and processes. In P. A. Andersen & L. K. Guerrero (Eds.), *Handbook of Communication and Emotion: Research, Theory, Applications, and Contexts* (pp. 29–48). San Diego, CA, US: Academic Press.

Plutchik, R. (1980). *Emotion: A Psychoevolutionary Synthesis.* New York, NY, US: Harper & Row.

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.

Pouliot, S., & Jones-Gotman, M. (2008). Medial temporal-lobe damage and memory for emotionally arousing odors. *Neuropsychologia*, *46*(4), 1124–1134.

Power, M., & Dalgleish, T. (2007). *Cognition and emotion: From order to disorder*. New York, NY, US: Psychology Press.

Price, J. L. (1999). Prefrontal cortical networks related to visceral function and mood. *Annals of the New York Academy of Sciences*, *877*(1), 383–396.

Proust M. (1922). *Swann's Way: Remembrance of Things Past. Vol. 1* (Scott Moncrieff. C. K., translator). New York, NY: Henry Holt.

Rader, C. M., (1979). *Explorations in synesthesia*. Unpublished doctoral dissertation, Minneapolis, US: University of Minnesota.

Rader, C. M., & Tellegen, A., (1987). An investigation of synesthesia. *Journal of Personality and Social Psychology, 52*(5)**,** 981–987.

Rado, S. (1969). *Adaptational psychodynamics: Motivation and Control*. New York, NY, US: Science House.

Rauscher, F. H. (1999). Prelude or requiem for the 'Mozart effect'? *Nature, 400*(6747), 827–828.

Recanzone, G. H. (2009). Interactions of auditory and visual stimuli in space and time. *Hearing Research*, *258*(1), 89–99.

Reddon, J. R., Marceau, R., & Holden, R. R. (1985). A confirmatory evaluation of the Profile of Mood States: Convergent and discriminant item validity. *Journal of Psychopathology and Behavioral Assessment*, *7*(3), 243–259.

Reimann, M., & Bechara, A. (2010). The somatic marker framework as a neurological theory of decision-making: Review, conceptual comparisons, and future neuroeconomics research. *Journal of Economic Psychology*, *31*(5), 767–776.

Reisenzein, R. (1983). The Schachter theory of emotion: two decades later. *Psychological Bulletin*, *94*(2), 239–264.

Ressler, K. J., Sullivan, S. L., & Buck, L. B. (1994). Information coding in the olfactory system: evidence for a stereotyped and highly organized epitope map in the olfactory bulb. *Cell*, *79*(7), 1245–1255.

Rimm-Kaufman, S.E., & Kagan, J. (1996). The psychological significance of changes in skin temperature. *Motivation and Emotion*, *20*(1), 63–78.

Ritz, T., George, C., & Dahme, B. (2000). Respiratory resistance during emotional stimulation: evidence for a nonspecific effect of emotional arousal? *Biological Psychology*, *52*(2), 143–160.

Ritz, T., Thöns, M., Fahrenkrug, S., & Dahme, B. (2005). Airways, respiration, and respiratory sinus arrhythmia during picture viewing. *Psychophysiology*, *42*(5), 568–578.

Ritz, T., Wilhelm, F.H., Gerlach, A.L., Kullowatz, A., & Roth, W.T. (2005). End-tidal pCO2 in blood phobics during viewing of emotion- and disease-related films. *Psychosomatic Medicine*, *67*(4), 661–668.

Robin, O., Alaoui-Ismaïli, O., Dittmar, A., & Vernet-Maury, E. (1998). Emotional responses evoked by dental odors: an evaluation from autonomic parameters. *Journal of Dental Research*, *77*(8), 1638–1646.

Rodriguez, I., Greer, C. A., Mok, M. Y., & Mombaerts, P. A. (2000). Putative pheromone receptor gene expressed in human olfactory mucosa. *Nature Genetics*, *26*(1), 18–19.

Rohrmann, S., & Hopp, H. (2008). Cardiovascular indicators of disgust. *International Journal of Psychophysiology*, *68*(3), 201–208.

Rolls, E. T. (2004). The functions of the orbitofrontal cortex. *Brain and Cognition*, *55*(1), 11–29.

Rolls, E. T. (2005). *Emotion Explained*. Oxford, UK: Oxford University Press.

Rook, D. W. (1987). The buying impulse. *The Journal of Consumer Research*, *14*(2), 189–199.

Roseman, I. J. (2013). Appraisal in the emotion system: coherence in strategies for coping. *Emotion Review*, *5*(2), 141–149.

Rottenberg, J., Ray, R. D., & Gross, J. J. (2007). Emotion elicitation using films. In J. A. Coan & J. J. B. Allen (Eds.), *The handbook of Emotion Elicitation and Assessment* (pp. 9–28). London, UK: Oxford University Press.

Rottenberg, J., Salomon, K., Gross, J.J., & Gotlib, I.H. (2005). Vagal withdrawal to sad film predicts subsequent recovery from depression. *Psychophysiology*, *42*(3), 277–281.

Rottenberg, J., Wilhelm, F.H., Gross, J.J., & Gotlib, I.H. (2003). Vagal rebound during resolution of tearful crying among depressed and nondepressed individuals. *Psychophysiology*, *40*(1), 1–6.

Roxana, O. M., & Ioan, P. (2013). The effects of ambient scent on consumer behavior: A review of the literature. *Annals of Faculty of Economics*, *1*(1), 1797–1806.

Royet, J. P., Plailly, J., Delon-Martin, C., Kareken, D. A., & Segebarth, C. (2003). fMRI of emotional responses to odors: influence of hedonic valence and judgment, handedness, and gender. *Neuroimage*, *20*(2), 713–728.

Rubin, B. D. & Katz, L. C. (1999). Optical imaging of odorant representations in the mammalian olfactory bulb. *Neuron*, *23*(3), 499–511.

Russell, J. A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology*, *39*(6), 1161–1178.

Rutledge, L. L., & Hupka, R. B. (1985). The facial feedback hypothesis: Methodological concerns and new supporting evidence. *Motivation and Emotion*, *9*(3), 219–240.

Sabatinelli, D., Lang, P. J., Bradley, M. M., Costa, V. D., & Keil, A. (2009). The timing of emotional discrimination in human amygdala and ventral visual cortex. *Journal of Neuroscience*, *29*(47), 14864–14868.

Sadler, G. (2007). Aristotle's Psychology, Emotion's Rationality, and Cognition of Being: A Critical Note on Ogren's Position. *Minerva-An Internet Journal of Philosophy*, *11*, 30–53.

Sanfey, A. G. (2007). Social decision-making: Insights from game theory and neuroscience. *Science*, *318*(5850), 598–602.

Sartre, J. P. (1939). *Esquisse d'une théorie phénomenologique des émotions*. Paris, FR: Hermann.

Savic, I. (2001). Processing of odorous signals in humans. *Brain Research Bulletin*, *54*(3), 307–312.

Savic, I. (2005). Brain imaging studies of the functional organization of human olfaction. *Chemical Senses*, *30*(1), i222–i223.

Schaal, B. (1986). Presumed olfactory exchanges between mother and neonate in humans. In J. Le Camus & J. Cosnier (Eds.), *Ethology and Psychology—International Ethology Conference, Private,* Toulouse, 101–110.

Schaal, B., & Durand, K. (2012). The role of olfaction in human multisensory development. In A. J. Brenner, D. Lewkowicz & C. Spence (Eds.), *Multisensory Development* (pp. 29–62). Oxford, UK: Oxford University Press.

Schaal, B., Marlier, L., & Soussignan, R. (2000). Human Foetuses Learn Odours from their Pregnant Mother 's Diet. *Chemical Senses, 25*(6)**,** 729–737.

Schab, F. R., & Crowder, R. G. (2014). *Memory for Odors*. New York, NY, US: Psychology Press.

Schachter, S. (1964). The Interaction of Cognitive and Physiological Determinants of Emotional State. In L. Berkowitz (Ed.), *Advances in Experimental Social Psychology* (pp. 49–80). New Yok, NY, US: Academic Press.

Schachter, S. (1970). The assumption of identity and peripheralist-centralist controversies in motivation and emotion. In M. B. Arnold (Ed.), *Feelings and Emotions: The Loyola Symposium.* New York, NY, US: Academic Press.

Schachter, S., & Singer, J. E. (1962). Cognitive, social, and physiological determinants of emotional state. *Psychological Review*, *69*(5), 379–399.

Scherer, K. R. (2005). What are emotions? And how can they be measured? *Social Science Information*, *44*(4), 695–729.

Scherer, K. R. (2009). The dynamic architecture of emotion: Evidence for the component process model. *Cognition and Emotion*, *23*(7), 1307–1351.

Scherer, K. R., & Zentner, M. R. (2001). Emotional effects of music: Production rules. In P. N Juslin & J. Sloboda (Eds.), *Music and Emotion: Theory and Research* (pp. 361–392). Oxford, UK: Oxford University Press.

Scherer, K. R., Coutinho, E., Cochrane, T., Fantini, B., & Scherer, K. R. (2013). How music creates emotion: a multifactorial process approach. In T. Cochrane, B. Fantini, & K. S. Scherer (Eds.), *The Emotional Power of Music: Multidisciplinary Perspectives on Musical Arousal, Expression, and Social Control* (pp. 121–146). Oxford, UK: Oxford University Press.

Schifferstein, H. N. J., Talke, K. S. S., & Oudshoorn, D.J. (2011). Can ambient scent enhance the nightlife experience? *Chemosensory Perception*, *4*(1-2), 55–64.

Schifferstein, H. N., & Blok, S. T. (2002). The signal function of thematically (in)congruent ambient scents in a retail environment. *Chemical Senses*, *27*(6), 539–549.

Schifferstein, H. N., & Tanudjaja, I. (2004). Visualising fragrances through colours: the mediating role of emotions. *Perception-London*, *33*(10), 1249–1266.

Schiffman, S. S., Miller, E. A. S., Suggs, M. S., & Graham, B. G. (1995). The effect of environmental odors emanating from commercial swine operations on the mood of nearby residents. *Brain Research Bulletin*, *37*(4), 369–375.

Schmidt, L. A., & Trainor, L. J. (2001). Frontal brain electrical activity (EEG) distinguishes valence and intensity of musical emotions. *Cognition & Emotion*, 15(4), 487–500.

Schmitt, B. H. (2006). *Experiential Marketing*. Barcelona, ES: Deusto Press.

Schmitt, B. H., & Shultz, C. J. (1995). Situational effects on brand preferences for image products. *Psychology & Marketing*, *12*(5), 433–446.

Schneider, F., Habel, U., Reske, M., Toni, I., Falkai, P., & Shah, N. J. (2007). Neural substrates of olfactory processing in schizophrenia patients and their healthy relatives. *Psychiatry Research: Neuroimaging*, *155*(2), 103–112.

Schwarz, N. (2006). Feelings, fit, and funny effects: A situated cognition perspective. *Journal of Marketing Research*, *43*(1), 20–23.

Schwarz, N., & Clore, G. L. (1983). Mood, misattribution, and judgments of well-being: Informative and directive functions of affective states. *Journal of Personality and Social Psychology*, *45*(3), 1–12.

Schwarz, N., & Clore, G. L. (1988). How do I feel about it? The informative function of affective states. In K. Fiedler & J. P. Forgas (Eds.), *Affect, Cognition, and Social Behavior* (pp. 44–62). Toronto, CA: Hogrefe International.

Sela, L., & Sobel, N. (2010). Human olfaction: a constant state of change-blindness. *Experimental Brain Research*, *205*(1), 13–29.

Semin, G. R. (2007). Grounding communication: synchrony. In A.W. Kruglanski & E.T. Higgins (Eds.), *Social Psychology: Handbook of Basic Principles* (2nd ed., pp. 630–644,). New York, NY, US: Guilford Publications.

Semin, G. R., & de Groot, J. H. (2013). The chemical bases of human sociality. *Trends in Cognitive Sciences*, *17*(9), 427–429.

Semin, G. R., & Smith, E. R. (2013). Socially situated cognition in perspective. *Social Cognition*, *31*(2), 125–146.

Seo, H. S., Roidl, E., Müller, F., & Negoias, S. (2010). Odors enhance visual attention to congruent objects. *Appetite*, *54*(3), 544–549.

Seo, H.-S., Arshamian, A., Schemmer, K., Scheer, I., Sander, T., Ritter, G., & Hummel, T. (2010). Cross-modal integration between odors and abstract symbols. *Neuroscience Letters, 478*(8)**,** 175–178.

Shepherd, G. M. (2004). The human sense of smell: are we better than we think? *PLoS Biology*, *2*(5), 0572–0575.

Sherman, E., & Smith, R. B. (1987). Mood states of shoppers and store image: promising interactions and possible behavioral effects. *Advances in Consumer Research*, *14*(1), 251–254.

Sherman, E., Mathur, A., & Smith, R. B. (1997). Store environment and consumer purchase behavior: mediating role of consumer emotions. *Psychology & Marketing*, *14*(4), 361–378.

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.

Simon, H. A. (1972). Theories of bounded rationality. In C. B. McGuire & R. Radner (Eds.), *Decision and Organization* (pp. 161–176). Amsterdam, NED: Elsevier-North-Holland.

Simon, H. A. (1986). Rationality in psychology and economics. *Journal of Business*, *59*(2), 209–224.

Simonov, P. V. (1970). The information theory of emotion. In M. B. Arnold (Ed.), *Feelings and Emotions: The Loyola Symposium.* New York, NY, US: Academic Press.

Simpson, R. H., Quinn, M., & Ausubel, D. P. (1956). Synaesthesia in children: Association of colors with pure tone frequencies. *The Journal of Genetic Psychology*, *89*(1), 95–103.

Sloboda, J. A., & Juslin, P. N. (2001). Psychological perspectives on music and emotion. In P. N. Juslin & J. A. Sloboda (Eds), *Music and Emotion: Theory and Research. Series in affective science* (pp. 71–104). New York, NY, US: Oxford University Press.

Smith, E. R., & Semin, G. R. (2004). Socially situated cognition: Cognition in its social context. *Advances in Experimental Social Psychology*, *36*, 53–117.

Smith, M. M. (2007). Sensing the past: Seeing, hearing, smelling, tasting and touching in history. Oxford, UK: University of California Press.

Sobel, N., Khan, R. M., Hartley, C. A., Sullivan, E. V., & Gabrieli, J. D. (2000). Sniffing longer rather than stronger to maintain olfactory detection threshold. *Chemical Senses*, *25*(1), 1–8.

Sobel, N., Prabhakaran, V., Desmond, J. E., Glover, G. H., Goode, R. L., Sullivan, E. V., & Gabrieli, J. D. E. (1998). Sniffing and smelling: separate subsystems in the human olfactory cortex. *Nature*, *392*(6673), 282–286.

Sokhadze, E.M. (2007). Effects of music on the recovery of autonomic and electrocortical activity after stress induced by aversive visual stimuli. *Applied Psychophysiology, and Biofeedback*, *32*, 31–50.

Solomon, M. (1997). *Consumer Behavior: Buying, Having and Being* (3rd ed.), Englewood Cliffs, NJ, US: Prentice-Hall.

Solomon, M., Bermossy, G. & Askegaard, S. (2002), *Consumer Behavior: A European Perspective* (2nd ed.). Englewood Cliffs, NJ, US: Prentice-Hall.

Soudry, Y., Lemogne, C., Malinvaud, D., Consoli, S. M., & Bonfils, P. (2011). Olfactory system and emotion: Common substrates. *European Annals of Otorhinolaryngology*, *Head and Neck Diseases, 128*(1), 18–23.

Spangenberg, E. R., Crowley, A. E., & Henderson, P. W. (1996). Improving the store environment: Do olfactory cues affect evaluations and behaviours? *Journal of Marketing*, *60*(2), 67–80.

Spangenberg, E. R., Grohmann, B., & Sprott, D. E. (2005). It's beginning to smell (and sound) a lot like Christmas: the interactive effects of ambient scent and music in a retail setting. *Journal of Business Research*, *58*(11), 1583–1589.

Spangenberg, E. R., Sprott, D. E., Grohmann, B., & Tracy, D. L. (2006). Gender-congruent ambient scent influences on approach and avoidance behaviors in a retail store. *Journal of Business Research*, *59*(12), 1281-1287.

Spence, C. (2011). Crossmodal correspondences: A tutorial review. *Attention, Perception, & Psychophysics*, *73*(4), 971–995.

Spence, C. (2012). Auditory contributions to flavour perception and feeding behaviour. *Physiology & Behaviour*, *107*(4), 505–515.

Spence, C., & Gallace, A. (2011). Multisensory design: Reaching out to touch the consumer. *Psychology & Marketing*, *28*(3), 267–308.

Spence, C., Puccinelli, N. Grewal, D., & Roggeveen, A. L. (2014). Store atmospherics: A multisensory perspective. *Psychology & Marketing*, *31*(7), 472–488.

Spence, C., Shankar, M. U., & Blumenthal, H. (2011). 'Sound bites': Auditory contributions to the perception and consumption of food and drink. In F. Bacci & D. Melcher (Eds.), *Art and the Senses* (pp. 207–238). Oxford: Oxford University Press.

Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. (1983). Manual for the State-Trait Anxiety Inventory. Palo Alto, CA, US: Consulting Psychologists Press.

Spinoza, B. (1989). *Ethica* (G. H. R. Parkinson, Translator). London, UK: Everyman's Library. (Original work published 1677).

Spreckelmeyer, K. N., Kutas, M., Urbach, T. P., Altenmüller, E., & Münte, T. F. (2006). Combined perception of emotion in pictures and musical sounds. *Brain Research*, *1070*(1), 160–170.

Squire, L. R., & Zola, S. M. (1996). Structure and function of declarative and nondeclarative memory systems. *Proceedings of the National Academy of Sciences*, *93*(24), 13515–13522.

Stearns, D. C., & Parrott, W. G. (2012). When feeling bad makes you look good: Guilt, shame, and person perception*. Cognition & Emotion, 26(3), 407–430.*

Stein, B. E., & Stanford, T. R. (2008). Multisensory integration: Current issues from the perspective of the single neuron*. Nature Reviews Neuroscience, 9*(4)*, 255–266.*

Stellar, J. R., & Stellar, E. (1985). *The Neurobiology of Motivation and Reward*. NewYork: Springer-Verlag.

Stern, J. A. (1972). Physiological response measures during classical conditioning. In N. S. Greenfield & P. A. Sternbach (Eds.), *Handbook of psychophysiology* (pp. 197–227). New York, NY, US: Holt, Rinehart & Winston.

Stern, K., & McClintock, M. K. (1998). Regulation of ovulation by human pheromones. *Nature*, *392*(6672), 177–179.

Sternbach, R.A. (1962). Assessing differential autonomic patterns in emotion. *Journal of Psychosomatic Research*, *6*(2), 53–68.

Stevenson, R. J. (2009). Phenomenal and access consciousness in olfaction. *Consciousness and Cognition*, *18*(4), 1004–1017.

Stevenson, R. J., & Boakes, R. A. (2004). Sweet and sour smells: learned synesthesia between the senses of taste and smell. In G. Calvet, C. Spence, & B. E. Stein (Eds.), *The Handbook of Multisensory Processes* (pp. 69–83). Cambridge, MA, US: MIT press.

Stevenson, R. J., & Case, T. I. (2005). Olfactory imagery: a review. *Psychonomic Bulletin & Review*, *12*(2), 244–264.

Stevenson, R. J., Rich, A., & Russell, A. (2012). The nature and origin of cross-modal associations to odours. *Perception-London*, *41*(5), 606–619.

Strack, F., Werth, L., & Deutsch, R. (2006). Reflective and impulsive determinants of consumer behavior. *Journal of Consumer Psychology*, *16*(3), 205–216.

Swinyard, W. R. (1993). The effects of mood, involvement, and quality of store experience on shopping intentions. *Journal of Consumer Research, 20*(2), 271–280.

Tai, S. H., & Fung, A. M. (1997). Application of an environmental psychology model to in-store buying behaviour. *The International Review of Retail, Distribution and Consumer Research*, *7*(4), 311–337.

Teller, C., & Dennis, C. (2012). The effect of ambient scent on consumer's perception, emotions and behavior: A critical review. *Journal of Marketing Management*, *28*(1-2), 14–36.

Theall-Honey, L. A., & Schmidt, L. A. (2006). Do temperamentally shy children process emotion differently than nonshy children? Behavioral, psychophysiological, and gender differences in reticent preschoolers. *Developmental Psychobiology*, *48*(3), 187–196.

Thompson, W. F., & Robitaille, B. (1992). Can composers express emotions through music? *Empirical Studies of the Arts*, *10*(1), 79–89.

Toffolo, M. B., Smeets, M. A., & Van den Hout, M. A. (2012). Proust revisited: odours as triggers of aversive memories. *Cognition & Emotion*, *26*(1), 83–92.

Tourangeau, R., & Ellsworth, P. C. (1979). The role of facial response in the experience of emotion. *Journal of Personality and Social Psychology*, *37*(9), 1519–1531.

Tracy, J. L., & Matsumoto, D. (2008). The spontaneous expression of pride and shame: Evidence for biologically innate nonverbal displays. *Proceedings of the National Academy of Sciences*, *105*(33), 11655–11660.

Traylor, M. B. (1981). Product involvement and brand commitment. *Journal of Advertising Research*, *21*(6), 51–56.

Tsai, J. L., Levenson, R.W., & Carstensen, L. L. (2000). Autonomic, subjective and expressive responses to emotional films in older and younger Chinese Americans and European Americans. *Psychology and Aging*, *15*(4), 684–693.

Tsai, J. L., Pole, N., Levenson, R.W., & Munoz, R.F. (2003). The effects of depression on the emotional responses of Spanish-speaking Latinas. *Cultural Diversity and Ethnic Minority Psychology, 9*, 49–63.

Turley, L. W., & Milliman, R. E. (2000). Atmospheric effects on shopping behaviour: A review of the experimental evidence. *Journal of Business Research*, *49(2)*, 193–211.

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. S*cience*, *185*(4157), 1124-1131.

Van den Stock, J., Rightart, R., & de Gelder, B. (2007). Body expressions influence recognition of emotions in the face and voice. *Emotion*, *7*(3), 487–494.

Van Kenhove, P., & Desrumaux, P. (1997). The relationship between emotional states and approach or avoidance responses in a retail environment. *The International Review of Retail, Distribution and Consumer Research*, *7*(4), 351–368.

Van Toller, S. (1999). Assessing the impact of anosmia: review of a questionnaire's findings. *Chemical Senses*, *24*(6), 705–712.

Vanderploeg, R. D., Brown, W. S., & Marsh, J. T. (1987). Judgements of emotion in words and faces: ERP correlates. *International Journal of Psychophysiology*, *5*(3), 193–205.

Vasey, M. W., & Thayer, J. F. (1987). The continuing problem of false positives in repeated measures ANOVA in psychophysiology: A multivariate solution. *Psychophysiology*, *24*(4), 479–486.

Vassar, R., Chao, S. K., Sitcheran,R., Nunez, J. M. Vosshall, L. B. & Axel, R. (1994). Topographic organization of sensory projections to the olfactory bulb. *Cell*, *79*, 981–991.

Velasco, C., Balboa, D., Marmolejo-Ramos, F., & Spence, C. (2014). Crossmodal effect of music and odor pleasantness on olfactory quality perception. *Frontiers in Psychology, 5*(1352), 1–9.

Vernet-Maury, E., Alaoui-Ismaili, O., Dittmar, A., Delhomme, G., & Chanel, J. (1999). Basic emotions induced by odorants: A new approach based on autonomic pattern results. *Journal of the Autonomic Nervous System*, *75*(2), 176–183.

Vianna, E.P.M., & Tranel, D. (2006). Gastric myoelectrical activity as an index of emotional *arousal*. *International Journal of Psychophysiology, 61*(1), 70–76.

Vrana, S.R., & Gross, D. (2004). Reactions to facial expressions: effects of social context and speech anxiety on responses to neutral, anger, and joy expressions. *Biological Psychology*, *66*(1), 63–78.

Wakefield, K. L., & Baker, J. (1998). Excitement at the mall: determinants and effects on shopping response. *Journal of Retailing*, *74*(4), 515–539.

Waldstein, S.R., Kop, W.J., Schmidt, L.A., Haufler, A.J., Krantz, D.S., & Fox, N.A. (2000). Frontal electrocortical and cardiovascular reactivity during happiness and anger. *Biological Psychology, 55*(1), 3–23.

Walsh, G., Shiu, E., Hassan, L. M., Michaelidou, N., & Beatty, S. E. (2001). Emotions, store-environmental cues, store choice criteria, and marketing outcomes. *Journal of Business Research*, *64*(7), 737-744.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: the PANAS scales. *Journal of Personality and Social Psychology*, *54*(6), 1063–1072.

Watson, J. B. (1924). *Psychology from the Standpoint of a Behaviorist* (2nd ed.). Philadelphia, US: Lippincott.

Watson, L. & Spence, M. T. (2007). Causes and consequences of emotions on consumer behaviour: A review and integrative cognitive appraisal theory. *European Journal of Marketing*, *41*(5/6), 487–511.

Wedekind, C., & Füri, S. (1997). Body odour preferences in men and women: do they aim for specific MHC combinations or simply heterozygosity?. *Proceedings of the Royal Society of London. Series B: Biological Sciences*, *264*(1387), 1471–1479.

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

Weiskrantz, L. (1956). Behavioral changes associated with ablation of the amygdaloid complex in monkeys. *Journal of Comparative and Physiological Psychology*, *49*(4), 381–391.

Welte, J. W., & Russell, M. (1993). Influence of socially desirable responding in a study of stress and substance abuse. *Alcoholism: Clinical and Experimental Research*, *17*(4), 758-761.

Wiens, S., Peira, N., Golkar, A., & Öhman, A. (2008). Recognizing masked threat: Fear betrays, but disgust you can trust. *Emotion*, *8*(6), 810–819.

Willander, J., & Larsson, M. (2006). Smell your way back to childhood: Autobiographical odor memory. *Psychonomic Bulletin & Review*, *13*(2), 240–244.

Willander, J., & Larsson, M. (2007). Olfaction and emotion: The case of autobiographical memory. *Memory & Cognition*, *35*(7), 1659–1663.

Willander, J., & Larsson, M. (2008). The mind's nose and autobiographical odor memory. *Chemosensory Perception*, *1*(3), 210–215.

Williams, J. M. G., Mathews, A., & MacLeod, C. (1996). The emotional Stroop task and psychopathology. *Psychological Bulletin*, *120*(1), 3–24.

Williams, L.A., Das, P., Liddell, B., Olivieri, G., Peduto, A., Brammer, M., & Gordon, E. (2005). BOLD, sweat and fears: fMRI and skin conductance distinguish facial fear signals. *Neuroreport*, *16*(1), 49–52.

Winton, W.M., Putnam, L.E., & Krauss, R.M. (1984). Facial and autonomic manifestations of the dimensional structure of emotion. *Journal of Experimental Social Psychology*, *20*(3), 195–216.

Wolman, B. B. (1973). *Dictionary of Behavioral Science.* New York, NY, US: Van Nostrand Reinhold.

Woolf, C. J. (2011). Central sensitization: implications for the diagnosis and treatment of pain. *Pain*, *152*(3), S2-S15.

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.

Young, M. P., Scanneil, J. W., Burns, G. A., & Blakemore, C. (1994). Analysis of connectivity: neural systems in the cerebral cortex. *Reviews in the Neurosciences*, *5*(3), 227–250.

Young, P. T. (1943). Emotion in Man and Animal: Its Nature and Relation to Attitude and Motive. New York, NY, US: Wiley.

Zajonc, R. B. (1980). Feeling and thinking: Preferences need no inferences. *American psychologist*, *35*(2), 151–175.

Zajonc, R. B. (2000). Feeling and thinking: Closing the debate over the independence of affect. In J. P. Forgas, (Ed.), *Feeling and thinking: The Role of Affect in Social Cognition* (pp. 31–58). New York, NY, US: Cambridge University Press.

Zald, D. H., & Pardo, J. V. (1997). Emotion, olfaction, and the human amygdala: amygdala activation during aversive olfactory stimulation. *Proceedings of the National Academy of Sciences*, *94*(8), 4119–4124.

Zatorre, R. J., Jones-Gotman, M., Evans, A. C., & Meyer, E. (1992). Functional localization and lateralization of human olfactory cortex. *Nature Letters*, *360*, 339–340

Zelano, C., & Sobel, N. (2005). Humans as an animal model for systems-level organization of olfaction. *Neuron*, *48*(3), 431–454.

Zentner, M., Grandjean, D., & Scherer, K. R. (2008). Emotions evoked by the sound of music: Characterization, classification, and measurement. *Emotion*, *8*(4), 494–521.

Zhou, W., & Chen, D. (2009). Fear-related chemosignals modulate recognition of fear in ambiguous facial expressions. *Psychological Science*, *20*(2), 177–183.

Zillmann, D. (1978). Attribution and misattribution of excitatory reactions. In J. Harvey, W. Ickes, & R. Kidd (Eds.), *New Directions in Attribution Research* (2nd ed., pp. 335–368). Hillsdale, N.J.: Erlbaum.

Zuckerman, M., & Lubin, B. (1965). *Manual for the Multiple Affect Adjective Check List*. San Diego, CA, US: Educational and Industrial Testing Service.

Zurawicki L. (2010). *Neuromarketing, Exploring the Brain of the Consumer*. New York, NY, US: Springer.