Emotional response:

From sensory attributes to

packaging and back again!

By

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This thesis is dedicated to my parents.

For their endless love, support and encouragement.

'Emotions and feelings are not a luxury; they are a means of communicating our states of mind to others. But they are also a way of guiding our own judgments and decisions. Emotions bring the body into the loop of reason.'

Professor Antonio Damasio, 1994

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Abstract

With the rapid proliferation of new products into the marketplace, understanding emotional responses may offer a differential advantage beyond traditional hedonic measures. Thomson et al. (2010) argued that consumers also associate other functional connotations (e.g. refreshing) and abstract feelings (e.g. sophisticated) to a product, referring to these associations (emotional, abstract and functional) as 'conceptualisations'. The aim of this project was to investigate the effect of the sensory attributes and packaging cues of commercial blackcurrant squashes on consumers' liking and conceptualisations.

Initially, the sensory attributes of the squashes were characterised using a sequential approach of quantitative descriptive analysis (QDA) and temporal dominance of sensations (TDS). Using QDA and TDS in tandem was revealed to be more beneficial than each on its own, providing a fuller sensory profile. Next, emotional response and liking within the squash category was measured using the EsSense Profile™, in which consumers rated a predefined emotion lexicon (n=100) under three conditions: (1) blind, (2) pack and (3) informed (product and packaging). The project also measured how emotional, abstract and functional responses changed across blind, pack and informed conditions. A conceptual lexicon was defined by consumers (n=29), after which a different group of subjects (n=100) rated the squashes using the lexicon and a check-

all-that-apply (CATA) approach (CD-CATA). The findings of both EsSense Profile and CD-CATA experiments revealed that intrinsic sensory attributes had more association with emotions and liking, than the packaging. Interestingly, the CD-CATA experiment suggested that extrinsic packaging cues had more association with abstract/functional conceptual responses.

The relationship between liking and emotional responses to debranded squash (sensory attributes) was investigated comparing EsSense Profile and CD-CATA approaches. Both approaches yielded emotional data that clearly discriminated across the products more effectively than the hedonic scores. In addition, both approaches produced similar emotional spaces and product configurations. A two dimensional structure (pleasantness vs. engagement/ activation) corresponding to published circumplex emotion models was observed in each method.

The final phase of the PhD was to determine the relationship between sensory attributes of the squashes (as measured by QDA and TDS) and consumer responses (EsSense Profile and CD-CATA approaches). Sensory attributes in squashes that were found to drive liking and positive conceptual responses in consumers were 'natural processed blackcurrant' and 'natural sweetness'. The study also shows how some temporally dominant sensory attributes (e.g. 'minty') evoked positive conceptual responses in consumers. Throughout the thesis, recommendations regarding practical implications for emotion measurement and general ideas for future research are discussed.

Preface

Sensory science is defined as the qualitative and quantitative measurement of human perceptions, through the five senses, i.e. smell, taste, vision, touch and hearing. This research project is geared towards understanding how sensory perceptions influence consumer emotions and how that might affect consumer preference. This subject is at the forefront of what is an emerging research area in sensory and consumer science. There is a complex intellectual process to understand, as well as significant industrial interest in applying these associations, in order to produce a category model to meet flavour and affective expectations of the target market. As Moskowitz (2007) indicated *'emotion research is becoming a 'hot-topic' for food concept development, but the exact nature of what works in these more ethereal ideas is not clear'*.

Traditional sensory and consumer research in understanding product performance has always tended to focus on the relationship between sensory perceptions and liking measures. In these days of extremely competitive markets, some recent studies have highlighted that using hedonic measurement alone is inadequate in measuring consumer affective product experience (Desmet and Schifferstein, 2008a; King and Meiselman, 2010; Koster, 2009). Very often, consumers rely on unconscious emotions associated with a product via sensory perceptions (Thomson et al., 2010) to make their purchase or consumption decisions (Lehrer, 2006; Walsh et al., 2011). In fact, evidence shows that without emotions, one struggles to make decisions (Damasio, 2006). Damasio illustrated this when recounting the case of a patient, Elliot, with brain damage in ventromedial prefrontal cortex (VPFC) who suffered an inability to experience emotions (Damasio, 1994b). Being so rational, Elliot had to endlessly deliberate over irrelavant details and to reason every decision he had to make; whether to use a blue or black pen and what radio station to listen to. This episode, Damasio said, illustrated the limitation of pure reason in decision making and he believes that, in people with normal brains, decisions are 'weighted' more by emotions enabling them to make decisions quicker compared to patients who suffer an inability to experience emotions. However, Damasio has posited that one should not think that emotions are not independent of rationality - they are part of rationality and they are both inseparably interlinked:

'... emotions probably assist in reasoning, especially when it comes to personal and social matters involving risk and conflict. I suggested that certain levels of emotions processing probably point us to the sector of the decision making space where our reason can operate most effectively.'

(Damasio, 1999)

Interestingly, Thomson et al. (2010) have argued that when consumers associate 'meanings' to product characteristics, the associations are not always emotions (e.g. happy, calm), but they also associate 'functional connotations' (e.g. thirst quenching, refreshing) and 'abstract feelings' (e.g. sophisticated, cheap) to the products. Thomson and his research team refer to these associations (emotional, functional and abstract conceptual responses) as *'conceptualisations'*. They also believe that the key to unlocking the mystery of consumer choice behaviour is to assess and measure these conceptualisations. However, it can be hypothesised that some of these abstract/functional conceptulisations may have already been formed prior to product consumption experience, based on information gained from the product packaging, which are probably induced by cognitive processing.

The main aim of the present research project was to investigate the effects of sensory attributes and packaging cues on consumers' liking and conceptual responses (emotion/functional/abstract).

Structure of the thesis

The thesis provides the reader with an insight into the relationship between product sensory/packaging cues and the consumer responses (liking and conceptualisations) using commercial blackcurrant squashes as the vehicle.

The thesis is organised into eight chapters. Chapter 1 reviews pertinent aspects of emotion research and descriptive sensory analysis, and the various approaches available to measure them, discussing their application in the sensory and consumer field. Chapter 2 describes the materials and methods conducted to ascertain the sensory attributes (descriptive analysis) and consumer response (quantiative and qualitative approaches) to commercial blackcurrant squashes. The rich quantitative and qualitative, sensory and consumer datasets required the application of different statistical analysis techniques which are also be described in this chapter. Chapter 3 focuses on the results of the sensory evaluation of the blackcurrant squashes using a sequential approach of QDA (Stone, 1974) and TDS (Pineau et al., 2004). Chapter 4 turns to emotion research, discussing the application of the published EsSense Profile (King and Meiselman, 2010) in measuring how consumer liking and emotion change across blind, pack and informed conditions for blackcurrant squashes. Chapter 5 taps into something more than just emotions, conceptualisation research; looking at emotions, abstract and functional conceptual responses. This chapter discusses the application of a consumer self defined conceptual lexicon check-all-that-apply (CATA) (CD-CATA) method to measure how consumer liking and conceptualisations change across blind, pack and informed conditions. Chapter 6 compares the effectiveness of the published EsSense Profile and the author's newly developed CD-CATA methodology in assessing consumer emotions (data collected from blind condition) and also illustrates how such measures can provide additional data beyond liking measures. Chapter 7 determines the relationship between sensory attributes of the products (as measured by QDA and TDS) and consumer responses (EsSense Profile and CD-CATA methodologies). Finally, chapter 8 provides an overview of the major findings from this research, general conclusions, together with proposed future work.

Publications/ Presentations

Publications:

- M. Ng., J.B. Lawlor., S. Chandra., C. Chaya., L. Hewson., J. Hort. (2012). Using quantitative descriptive analysis and temporal dominance of sensations analysis as complementary methods for profiling commercial blackcurrant squashes, *Food Quality and Preference*, 26(2), 121-134.
- M. Ng., C. Chaya., J. Hort. (2013). Beyond liking: Comparing the measurement of emotional response using EsSense Profile and consumer defined check-all-that-apply methodologies, *Food Quality and Preference*, 26(2), 121-134.
- M. Ng., C. Chaya., J. Hort. (2013). The influence of sensory and packaging cues on liking and emotional, abstract and functional conceptualisations. (*In press*).

Oral communications:

- Topic: 'Emotional factors in beverage choice', *In 9th Pangborn International Sensory Science Symposium, Toronto, Canada , Sept 2011.*
- Topic: 'An emotional journey: from sensory to packaging cues and back again!', *In 5th EuroSense, Bern, Switzerland, Sept 2012.*
- Topic: 'Beyond liking: measuring emotional responses in commercial products', *In IFST PFSG Conference, Chipping Campden, UK, June 2012.*
- Topic: 'Application of EsSense Profile and consumer defined CATA in measuring emotion', *In MOAbout Dutch Sensory Society Symposium, Netherlands, July 2012.*

Poster presentations:

- M. Ng., J.B Lawlor., S. Chandra., L. Hewson., J. Hort. 'A comparison of temporal dominance of sensations and conventional profiling results,' *In 4thEuroSense, Vitoria, Spain, Sept 2010.*
- M. Ng., J.B Lawlor., S. Chandra., L. Hewson., C. Chaya, J. Hort. 'Using quantitative descriptive analysis and temporal dominance of sensations analysis as complementary methods for profiling commercial blackcurrant squashes,' *In IFST PFSG Conference, Chipping Campden, UK, June 2012.*
- M. Ng., C. Chaya., J. Hort. 'Linking sensory cues obtained from quantitative descriptive analysis and temporal dominance of sensations to hedonic and emotional response,' *In 5th EuroSense, Bern, Switzerland, Sept* 2012.
- M. Ng., C. Chaya., J. Hort. 'Application of EsSense Profile in commercial products: from the blind to the informed condition,' *In 5th EuroSense, Bern, Switzerland, Sept 2012.*

List of abbreviations

A	Aroma
ANOVA	Analysis of variance
AS	Added sugar squash
AT	Aftertaste
CATA	Check-All-That-Apply
CD-CATA	Consumer self defined conceptual lexicon Check-All-That-Apply
CES	Consumption emotion set
E-B	Expected minus blind liking mean scores
EEG	Electroencephalography
F	Flavour
fMRI	Functional magnetic resonance imagery
GEOS	Geneva Emotion and Odour scale
GSK	GlaxoSmithKline
I-B	Informed minus blind liking mean scores
I-E	Informed minus expected liking mean scores
I^E-B^E	Informed minus blind emotion mean scores
I^E-P^E	Informed minus pack emotion mean scores
LEOS	Liverpool Emotion and Odour scale
MAACL	Multiple Affect Adjective Check List
MAACL-R	Multiple Affect Adjective Check List Revised
NAS	No added sugar (or artificially sweetened) squash
PC	Principal component
PCA	Principal component analysis
P^E-B^E	Pack minus blind emotion mean scores
POMS	Profiles of Mood States
PrEmo	Product Emotion Measurement instrument
QDA	Quantitative Descriptive Analysis
RATA	Rate-All-That-Apply
RV	Relative Variance
SCRs	Skin conductance responses
SEOS	Singapore Emotion and Odour scale
SSC	Sensory Science Centre
Stdtime	Standardised time
T	Time
TDS	Temporal Dominance of Sensations
TI	Time Intensity
Ts	Taste
UoN	University of Nottingham
VPFC	Ventromedial prefrontal cortex

Tables of contents

1 Literature review

1.1 Introduction

The present chapter is organised into three main sections. Section 1.2 reviews some aspects of emotion research and section 1.3 reviews some aspects of descriptive sensory analysis. Section 1.4 details the aims and objectives of the experimental work carried out for this PhD project.

1.2 Emotion research

1.2.1 What is emotion?

An emotion has been defined as '*a mental state of readiness that arises from cognitive appraisals of events or thoughts; has a phenomenological tone; is accompanied by physiological processes; is often expressed physically (e.g., in gestures, posture, facial features); and may result in specific actions to affirm or cope with the emotion, depending on its nature and meaning for the person having it*' (Bagozzi et al., 1999). In other definitions, emotions have been described as brief, intense and often focused on a referent (e.g. 'the comment made him angry') (Clore et al., 1987; King and Meiselman, 2010). However, efforts to confirm a widely acceptable definition of emotion have proven to be unsuccessful (Panksepp, 2003). Nevertheless, emotions do matter, as, according to Damasio (2006), as they are 'in the loop of reason' which guides thought and deeds.

Some researchers have argued that there are different types of emotions which range from 'lower-order' through 'basic' to 'higher-order', on an emotional continuum (see Figure 1.1) (Poels and Dewitte, 2006). 'Lower-order emotions' that are placed at the left of the continuum denote emotional reactions that are spontaneous and uncontrollable (LeDoux, 1996; Shiv and Fedorikhin, 1999), whereas 'higher-order emotions' at the right end of the continuum refer to emotional reactions that are more complex and involve cognitive processing (Frijda et al., 1989; Lazarus, 1991). Some basic emotions, e.g. fear, anger and happiness, however, are situated in between lower-order and higher-order emotions. For example, standing face to face with a lion will automatically fulfil an individual with lower-order 'fear' but on the other hand, they may also experience higher-order 'fear' after conscious appraisal of the situation, i.e. fear at being eaten by the lion. Therefore, basic emotions can be experienced both automatically and after cognitive processing.

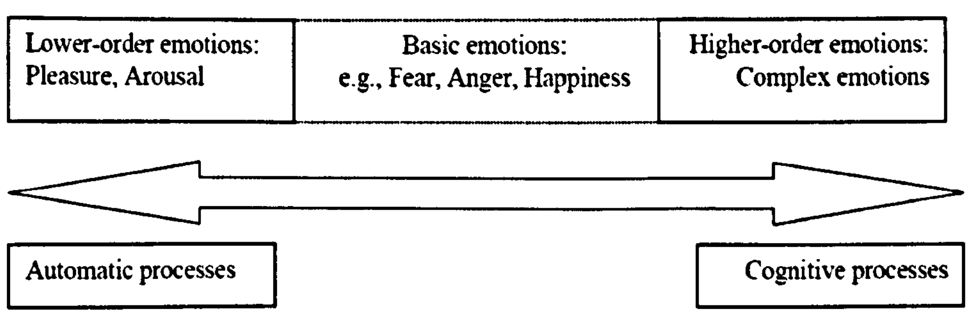


Figure 1.1: The Emotional Continuum adapted from Poels and Dewitte (2006)

Furthermore, some researchers have proposed multidimensional circumplex models to organise human emotions (Figure 1.2) (Larsen and Diener, 1992; Russell, 1980; Watson and Tellegen, 1985). These circumplex models are two-dimensional, circular structures in which single emotions correlate highly with those emotions nearby on the circumference of the circle, but do not correlate with those emotions one-quarter way round (90^0). The models are used to describe the dimensionality of human emotion where the dimensions are bipolar; emotion terms represent a continuity of mood state from pleasant/positive to unpleasant/negative on one dimension and different levels of engagement/arousal on the other.

Alternatively, some researchers have proposed appraisal theory to define and study emotional experience (see Scherer et al. (2001) for a review). The main assumption of appraisal theory is '*that emotions arise, and are distinguished, on the basis of a person's subjective evaluation of an event of appraisal dimensions such as novelty, urgency, goal congruence, coping potential and norm compatibility*' (Juslin and Vastfjall, 2008). In addition, appraisal theory also claims that emotions can be elicited by physiological arousal (e.g. facial expression), or by action tendencies (e.g. hunger leading to an infant's distress) (Scherer et al., 2001).

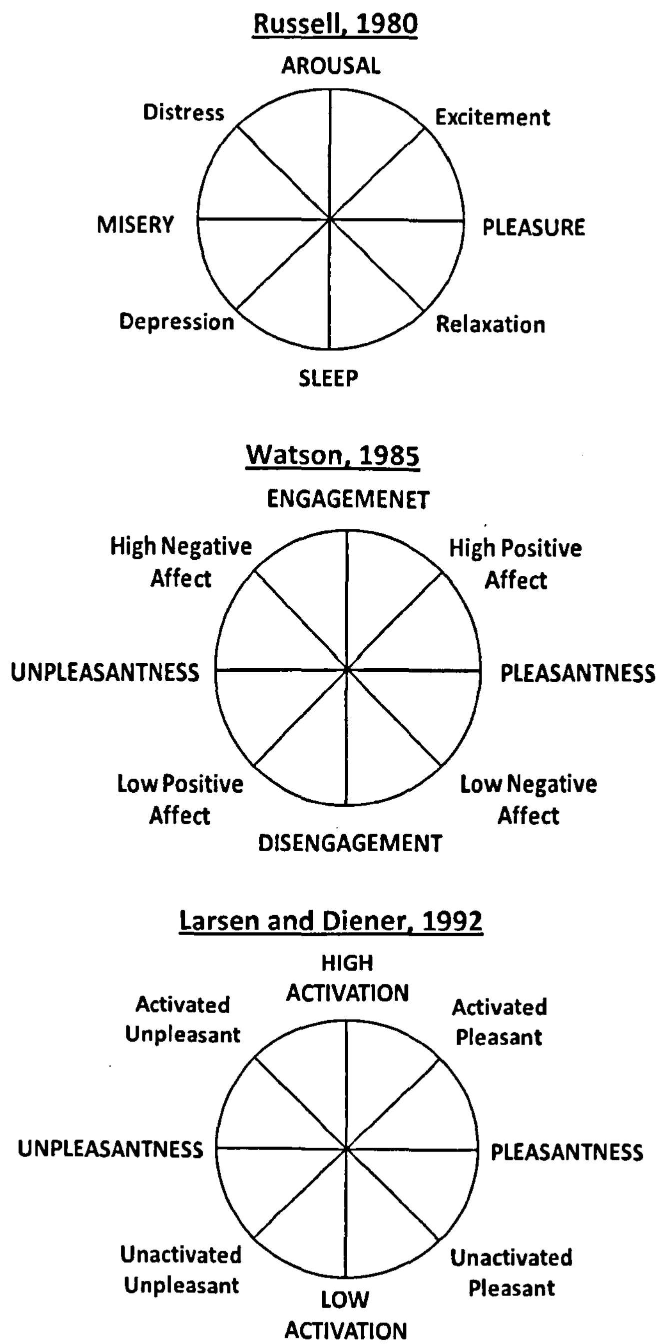


Figure 1.2: Multidimensional circumplex models of emotion ((Russell, 1980), (Larsen and Diener, 1992; Watson and Tellegen, 1985))

1.2.2 Why measure emotions in sensory and consumer science?

Advances in neuroscience and psychology in recent years have not only identified some key brain regions that process emotions (i.e. the prefrontal cortex, amygdala, hypothalamus and anterior cingulate cortex), but also evidently illustrated that emotions guide and bias our decision-making (see (Bechara, 2004; Dalgleish, 2004)for reviews). Without emotions we make poor decisions, and in fact we struggle to make decisions at all (Damasio, 2006). In a famous study by Bechara, Damasio et al. (1994), the somatic state activation of two groups of subjects: normal subjects versus patients with VPFC damage was assessed, when they were making decisions during a gambling task. Somatic state activation refers to physiological reactions that have had emotion-related consequences in the past (Dalgleish, 2004). In this study, the subjects' skin conductance responses (SCRs) were recorded after they picked a card and were told that they had won or lost money. The study revealed that, as normal controls became experienced with the task, they began to generate SCRs prior to the selection of any cards, and learned to perform the task better than patients with VPFC damage who failed to generate any SCRs before picking a card. The study clearly demonstrated that decision-making is guided by emotional signals (or somatic states), which are generated in anticipation of future events.

Not surprisingly, since the 1980s emotion research has gained renewed attention in the marketing and advertising field as a tool to predict consumer choice behaviour measures such as purchase intent, brand choice and actual purchase (Poels and Dewitte, 2006). Marketing researchers often sit on innovation teams together with sensory scientists; where marketing researchers are responsible for consumer insights whereas sensory scientists are responsible for all consumer product insights (Lundahl, 2012). However, recently, sensory scientists have also started to delve into emotion research in guiding food product innovation.

Food and emotions are very much linked together, even from the moment a parent first offers milk to comfort and quiet a child, food has then become a way of nourishing the soul as well as the body. We also celebrate successes and drown sorrows with foods. Given the fundamental importance of food, there are also surprisingly few genetically based constraints in humans, according to Rozin (Rozin, 1999) who stated that: '*in humans (and rats), genetic factors include: 1) biases to prefer sweet tastes and to avoid bitter taste; 2) a tendency to be interested in new potential food (neophilia), but at the same time to be cautious about trying them (neophobia); and 3) some special abilities, that allow for learning the relationship between a food and the consequences of its ingestion, which may occur hours later.*' Indeed, some recent studies have also highlighted the important role of emotions in influencing our decision making concerning food. For example, Laros and Steenkamp (2005) assessed consumer emotional response (n=645 Dutch) towards different food types (i.e. genetically modified food, functional food, organic food, and regular food). The study revealed that different food types elicited different emotional responses which might therefore influence consumer choice behaviour. For example, genetically modified food elicited a strong association of risk and uncertainty leading to feelings of fear, and reducing the likelihood of purchase.

Furthermore, in these days of competitive and mature markets, the emotional quality of products is becoming increasingly important for differential advantage, especially when products within the same category are often similar with respect to quality and price (Schifferstein et al., 2013). In addition, emotions evoked by products also enhance the pleasure of buying, owning, and using them (Hirschman and Holbrook, 1982). Packaging should help in making the product stand out from its competitors on the shelves (Schifferstein et al., 2013) because it is known to affect how the food is perceived and experienced by suggesting a certain identify for its content (Cardello, 2007; Piqueras-Fiszman and Spence, 2012).

1.2.3 Approaches to measure emotions

Different approaches have been used to measure emotions across many disciplines, including psychology, social science, health and nutrition, and consumer research. These can generally be divided into three categories: autonomic measures, brain imaging techniques and self report measures (verbal/visual) (see (Mauss and Robinson, 2009) for review).

The autonomic nervous system is a general-purpose physiological system responsible for modulating peripheral functions (see (Kreibig, 2010) for review). Autonomic measures rely on bodily reactions, e.g. heart rate, skin conductance, and pupil dilation. Autonomic measures are partially beyond an individual's control, and therefore should overcome the cognitive bias that is linked to self report measures (Poels and Dewitte, 2006). However, one of the downsides of autonomic measures is that they need to be taken in a very controlled environment as physiological and neuronal responses are affected by external or internal stimuli present during the experience (e.g. light intensity changes, sudden unrelated thoughts etc) (Mauss and Robinson, 2009). In addition, the accuracy of autonomic measures at depicting emotions and quantifying emotional response is questionable.

On the other hand, brain imagining techniques allow scientists to visualise the regions of the brain that are activated when stimuli are presented. There are several brain imaging techniques and these include functional magnetic resonance imagery (fMRI), electroencephalography (EEG) (Mauss and Robinson, 2009). fMRI has contributed significantly to the progress in cognitive neuroscience and has entered consumer research focusing on emotional aspects and decision making (Mauss and Robinson, 2009). However, this method is extremely expensive and requires special equipment and expert knowledge.

Although autonomic measures and brain imaging techniques provide direct evidence of emotional engagement, they are not articulate enough to describe what or how this emotional engagement has come about. Self report measures have the advantage of being more articulate than autonomic measures. In addition, they are relatively cheap and simple as no complex instruments or programs are required. In general, there are two types of self report measure: visual or verbal.

In visual self report, subjects are asked to express their emotions visually by means of images or animation. Some examples of visual self report measures include Product Emotion Measurement instrument (PrEmo) (Desmet et al., 2000) and mood portraits (Churchill and Behan, 2010). The PrEmo program consists of 12 different characters expressing six positive and six negative emotions and subjects are asked to rate each emotion on a five-point scale from 'I do not feel this' to 'I do feel this strongly' in relation to a product or scenario (see Figure 1.3). Although visual self report may be a valuable alternative for the rather cumbersome verbal self report, visual self report can only measure perception of an emotional reaction (Poels and Dewitte, 2006). Therefore, many researchers have chosen to use verbal self report measures (i.e. emotion words) to evaluate emotional responses.

In verbal self report, subjects are asked to express their emotions verbally by means of open-ended questions or to rate their emotions using Likert (or intensity) scales, CATA or Best-Worst-Scaling (BWS) approaches. Unlike Likert scales, CATA questions allow subjects to simply check (or select) emotion words that are relevant to them without having to be forced to rate all words on a scale. For BWS, subjects are presented with a set of either four or five words (quads or quins) and asked to choose the 'best' as well as the 'worst' words in terms of describing their emotions (Thomson et al., 2010). Several researchers (e.g. (Chrea et al., 2009; Clore et al., 1987; King and Meiselman, 2010; Laros and Steenkamp, 2005; Thomson et al., 2010)) have also developed comprehensive emotion lexicons associated with consumption experiences, which will be discussed in more detail in the following section.

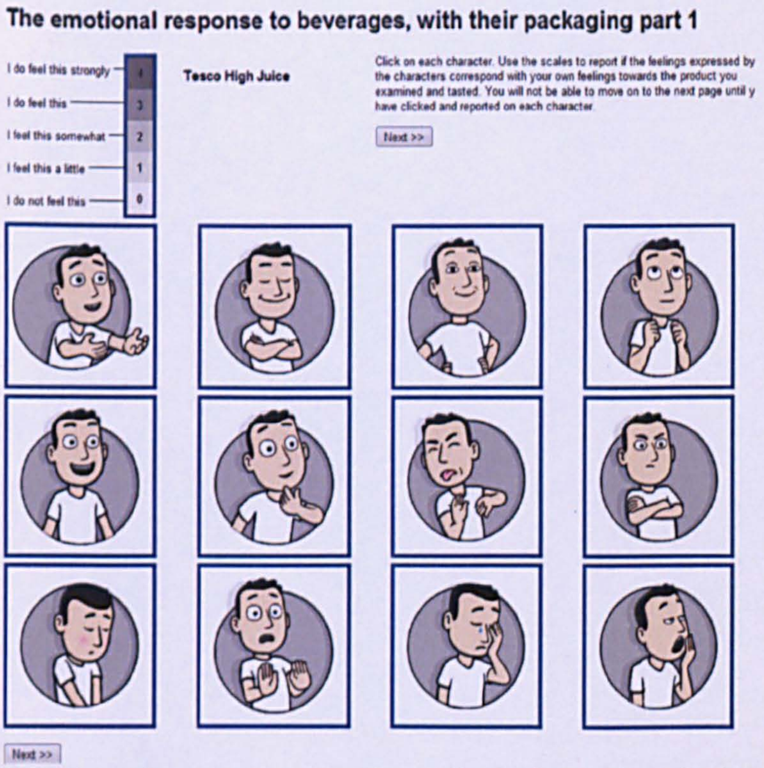


Figure 1.3: PrEmo characters expressing individual emotions (left to right): desire, satisfaction, pride, hope, joy, fascination, disgust, dissatisfaction, shame, fear, sadness and boredom (PrEmo, 2012).

1.2.4 Verbal self report emotion lexicon

Early verbal self report emotion scales were developed for use in clinical psychiatry, e.g. the Profiles of Mood States (POMS) (McNair et al., 1971). The POMS questionnaire asks subjects to rate 65 mood terms on a five-point scale measuring mood on six dimensions: tension-anxiety, depression-dejection, anger-hostility, vigour-activity, fatigue-inertia, and confusion-bewilderment. Another mood questionnaire which is used extensively in clinical psychiatric settings is known as the Multiple Affect Adjective Check List (MAACL) (Zuckerman and Lubin, 1965) which was also revised and known as the MAACL-R (Zuckerman and Lubin, 1985). It asks subjects to rate 135 mood terms using CATA approach and it measures moods on five dimensions: anxiety, depression, hostility, positive effect and sensation seeking.

However, as the emotion lexicons that were developed in the field of psychology do not focus on emotions experienced during product consumption, they are probably more applicable for clinical practice than consumer research. Since the 1990's, many consumer researchers have also attempted to refine emotion terminology related to consumption experience. One key example of this is known as the consumption emotion set (CES) which was developed by Richins (1997) based on the work of Ortony, Clore et al. (1988). The CES questionnaire consists of 47 emotion terms which are divided into 17 categories (i.e. anger, discontent, worry, sadness, fear, shame, envy, loneliness, romantic love, love, peacefulness, contentment, optimism, joy, excitement, surprise, other items). Later in 2005, Laros and Steenkamp (2005) reviewed 173 negative emotions, 143 positive emotions and 39 basic emotions that were drawn from the literature and developed a hierarchical model of consumer emotions. The latter model consists of three levels: the superordinate level with positive and negative affects, the basic level with four positive (i.e. contentment, happiness, love and pride) and four negative emotions (anger, fear, sadness and shame), and the subordinate level of specific emotions (Figure 1.4). They tested the structural model across different food types (i.e. genetically-modified food, functional food, organic food and regular food) and revealed that *'basic emotions'* provide more information about the feelings of the consumer over and above *'positive and negative emotions'* (Laros and Steenkamp, 2005). Nevertheless, the study revealed that, *'positive and negative emotions'* are the most frequently employed emotion dimension in the food consumption context. Following that, Desmet and Schifferstein (2008b) identified five main sources of positive and negative emotion related to food experience; i.e. sensory attributes, experienced consequences, anticipated consequences, personal or cultural meanings and actions of associated agents. In addition, they also showed that pleasant emotions were reported more often than unpleasant emotions in response to eating and tasting food.

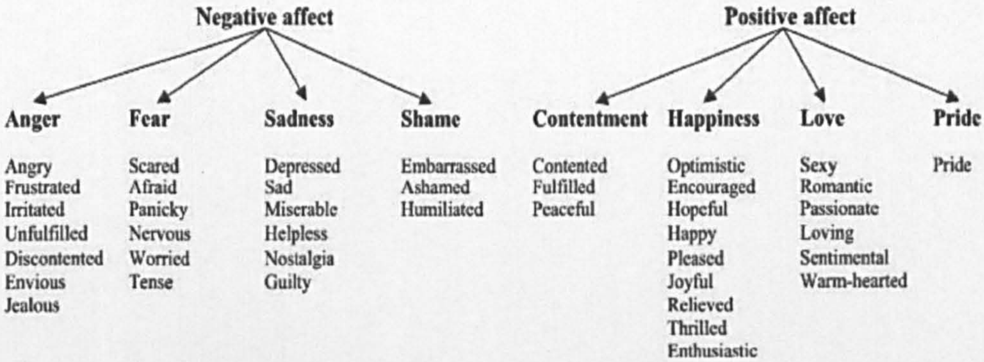


Figure 1.4: Hierarchy of consumer emotions, adapted from Laros and Steenkamp (2005)

1.2.5 Application of verbal self report emotion techniques in sensory and consumer field

Some verbal self report emotion techniques have been developed in the sensory and consumer field in recent years and some key examples will be discussed below. Most of the lexicons have generally been drawn from published literature, e.g. EsSense Profile (King and Meiselman, 2010) and Geneva Emotion and Odour scale (GEOS) (Chrea et al., 2009).

King and Meiselman (2010) developed an emotion lexicon for EsSense Profile using adjectives from clinical psychiatry, POMS and MAACL questionnaires. Terms were validated based on a few criteria such as frequency of use and consumer feedback to ensure that they could be applied to a range of products. The final emotion lexicon for EsSense Profile consisted of 39 terms which were classified as 'positive', 'negative' or 'unclassified'. Terms were labelled as 'unclassified' if more than 50% of the participants had rated them as neither 'positive' nor 'negative'. EsSense Profile incorporates emotion measures (five-point scale, anchored from 'not at all' to 'extremely') with measures of overall acceptability (nine-point scale, anchored from 'dislike extremely' to 'like extremely') in order to differentiate the liking and emotional responses among and within product categories. King and Meiselman (2010) have highlighted that emotion measures provide better discrimination than liking measures and can therefore provide a competitive advantage in the food industry. The EsSense Profile was also validated using different food categories for its discriminating power; however, little data is available in the literature to understand its application in a commercial context within a single product category.

Chrea and colleagues (2009) developed the Geneva Emotion and Odour scale (GEOS) questionnaire using adjectives from literature on emotions and on olfaction. Terms were validated based on a series of exploratory factor analyses of the data collected from consumers evaluating different odours. Terms were reduced from 480 terms down to 36 terms and were divided into six dimensions, i.e. 'pleasant feeling', 'unpleasant feeling', 'sensuality', 'relaxation', 'refreshment' and 'sensory pleasure' (see Table 1.1). Instead of rating 36 terms, the modified GEOS questionnaire asks consumers to rate each of the six emotion dimension; each dimension consisting of three terms (see terms highlighted with in Table 1.1).

Table 1.1: List of emotion terms within six dimensions in the original and modified* GEOS questionnaire

Dimension	Emotion terms
Pleasant feeling	Pleasant, wellbeing*, pleasantly surprise*, feeling awe, attracted, happiness*
Unpleasant feeling	Dirty, unpleasant, disgusted*, unpleasantly surprised*, dissatisfaction, sickening, irritated*, angry
Sensuality	Desire*, romantic*, sensual, in love*, excited, admiration, sexy
Relaxation	Relaxed*, soothed, reassured*, light, serene*
Refreshment	Revitalised, energetic*, refreshed, stimulated, invigorated*, shivering, clean*
Sensory pleasure	Nostalgic*, mouthwatering*, amusement*

****Terms that were kept for the modified GEOS questionnaire***

The modified GEOS questionnaire has been applied to different perfumery and flavour products and the results revealed that the most frequently used dimension was the 'pleasant feeling', whereas the least used dimension was the 'unpleasant-feeling' (Porcherot et al., 2010). Intriguingly, Ferdenzi et al. (2011b) highlighted that emotion response to odours vary as a function of culture. These authors have developed two self report scales, one in Liverpool (United Kingdom) and another in the city of Singapore following the same procedure previously used to develop GEOS (Chrea et al., 2009). Therefore the authors named the questionnaire after the name of the city; Liverpool Emotion and Odour scale (LEOS) and SEOS for Singapore. LEOS and SEOS questionnaires were found to generate a total of seven emotion dimensions as opposed to six dimensions in GEOS. These included dimensions that were common across three cultures, i.e. 'disgust', 'happiness/well being', 'sensuality/desire' and 'energy', and common to two European populations, i.e. 'soothing/peacefulness'. Dimensions that were culture specific included:

'sensory pleasure' for Geneva populations; 'nostalgic' and 'hunger thirst' for Liverpool; and 'intellectual stimulation', 'spirituality' and 'negative feelings' for Singapore.

Whilst some lexicons have been drawn from published literature, some researchers have developed emotion lexicons using consumer language. One example of this is a study conducted by Thomson et al. (2010). Unlike previous emotion research, the authors delved into something more than just emotions. They believe that when consumers see a product, they do not just attach 'emotions' to product characteristics, but also other 'meanings' which they referred to as '*conceptualisations*'. The latter can be reduced into three broad categories: emotional (e.g. 'will make me happy', 'will calm me', 'will annoy me', etc), abstract (e.g. 'is sophisticated', 'is trustworthy', 'is feminine' etc) and functional ('will refresh me', 'will wash my clothes cleaner', 'will kill germs', etc). In a study of Thomson et al. (2010), a conceptual lexicon (24 words) was developed for chocolate, by a small group of reasonably articulate subjects who tasted and discussed the products under the guidance of a suitably qualified moderator. Subjects were then asked to rate their conceptual responses on nine sensorially differentiated UK commercial dark chocolates using BWS scales. Unlike other scales, BWS does not produce a score, so complex statistics are needed for data analysis and this involves using specialised statistical software. In fact, one of the most rigorous approaches to analysing best-worst data is to first model the probability that an individual will choose a particular best-worst pair over all other possible best-worst pairs (Thomson et al., 2010). However, the BWS does provide an interesting way of visualizing the dataset ranking emotions (see Figure 1.5 for illustration). Figure 1.5 shows the conceptual profile of Cadbury's Bournville Deeply Dark; where conceptualisations (e.g. 'sociable' and 'easygoing' in particular) which scored the highest scale values (situated on the right side of the line) were the most relevant to this chocolate. On the other hand, conceptualisations like 'arrogant' and 'aggressive' scored the lowest scale values (situated on the left side of the line) and were least associated with this chocolate.

Figure 1.5: Conceptual profile of Cadbury's Bournville Deeply Dark Chocolate

How does conceptualisation work in practice? According to Thomson (Gschwandtner, 2004), Red Bull is a good example of a successful product that does not perform well in taste tests with new consumers, but the associated conceptualisation created by Red Bull's brand's signature 'Give you wings', 'Vitalizes body and mind' positioning, coupled with its distinctive flavour, has led to its global success. Red Bull's distinctive 'medicinal' flavour was formulated to fit with people's perception that the product is a stimulant, a chemical and therefore should taste rather unpleasant (Davis, 2010).

At present, it is not clear whether one comprehensive list of emotions covers all food categories (King and Meiselman, 2010). Therefore, not surprisingly, different emotion or conceptual lexicons have been developed to measure emotion in response to consumption experience. Despite this, emotional profiling has been shown to provide data beyond liking. In some cases, products which were equally liked evoked different emotional profiles (e.g. (King and Meiselman, 2010; Porcherot et al., 2010; Thomson et al., 2010)). This could affect the performance of a product in the marketplace. However, what is key to the success of the product is being able to align the emotions projected from the product with other aspects of product, which includes the brand, packaging and sensory attributes. In fact, sensory attributes have been suggested to *'have the potential to communicate something of the emotionality and the functionality of the brand as well as adding distinctiveness to the brand's persona by adding a unique sensory signification'* (Thomson, 2007). Developments in emotional profiling and its relationship to liking and food sensory attributes are currently being actively explored in the sensory and consumer field.

In order to link emotion profiles to food sensory attributes, it is useful to understand how sensory attributes are measured and analysed. The following section provides an overview of descriptive sensory analysis and its application in the sensory and consumer science field.

1.3 Descriptive sensory analysis

1.3.1 What is sensory science?

Sensory science is defined as a scientific method used to evoke, measure, analyse and interpret sensory responses to products as perceived through the senses of sight, smell, touch, taste and hearing (Lawless, 1999). Different approaches are used for analytical (discrimination or descriptive test) and affective (hedonic or liking) measurement (Lawless, 1999). However, no sensory method calls for a more comprehensive and wiser use of each of the functions of evoking, measuring, analyzing and interpreting sensory responses than descriptive sensory analysis.

1.3.2 Why use descriptive sensory techniques to measure sensory attributes?

Descriptive sensory techniques are one of the analytical tests used to describe the nature and magnitude of the differences between stimuli using human subjects who have been specifically trained for this purpose under controlled conditions (Murray, 2001). Descriptive analysis usually covers all sensory modalities from aroma to aftertaste and even sound, and also allows intercomparison of multiple sensory characteristics. In addition, it can also be used to monitor intensity of a sensory modality over time using time dependent methodology.

1.3.3 Descriptive sensory approaches

The success of descriptive analysis is down to its stringent panel screening, training, proper sensory execution and management, which are rarely inexpensive and easy. In general, there are a few key generics steps in carrying out descriptive analysis which are common across most descriptive methods: screening and selection of assessors, training of assessors for the study (i.e. attributes generation, assessment protocol, intensity calibration, performance check) and data analysis and reporting (Kemp, 2009). It requires a long term commitment from the company or research centre. However, the benefits of having this important and sensitive analytical descriptive analysis usually outweigh the disadvantages. For this reason, descriptive analysis remains the important tool it has always been since its emergence in 1940s. The main descriptive sensory tests include Flavour Profile Method (Cairncross and Sjostrum, 1950), Texture Profile Method (Brandt et al., 1963; Szczesniak, 1963a; Szczesniak, 1963b), QDA (Stone, 1974) and Spectrum Analysis (Civille and Dus, 1991).

QDA is one of the most common descriptive sensory techniques used to describe the nature and the intensity of sensory properties from a single evaluation of a product. This method not only relies on sound sensory procedures, but it is also fully amenable to statistical analysis which made it stand out from previous methodology. Essential features of QDA are the use of a screened and trained panel of 8 to 15 assessors guided by a trained panel leader; the use of effective descriptive terms generated by the panel themselves; the use of unstructured line scales and repeat evaluations and the use of statistical analysis by analysis of variance (ANOVA) (Gacula, 1997; Stone, 1974). The latter features of QDA not only enabled sensory scientists to obtain descriptions of product differences, but also facilitate panel performance monitoring and variability between products. Nevertheless, one limitation of QDA is that it is difficult to compare results between panels and between laboratories (Murray, 2001). In addition, similar to other conventional profiling methods, these techniques require extensive training and are costly to set up and maintain.

Perception of aroma, taste and texture in foods is not a static phenomenon as the processes of eating and drinking, e.g. mastication and salivation are dynamic sensory processes. For example, the appreciation of the bitterness of beer and the taste of chewing gum depends on the timely release of taste and flavour substances. However, conventional techniques like QDA only make single point evaluation of sensory properties (Cliff and Heymann, 1993) and thus only provide an overall impression of attribute maximum intensity, not the time course of a sensation. Therefore, temporal methodologies have been developed to measure dynamic processes involved in flavour perception over time.

The most widely used temporal method is time-intensity (TI) analysis (Larsonpowers and Pangborn, 1978) which is an extension of conventional sensory profiling that records the evolution of a given sensory characteristic over a period of time. The result of TI measurement is typically a curve showing how the intensity of the sensation rises and falls during consumption of a product. The technique was primarily developed to study the persistence of tastes such as sweetness, bitterness and astringency (Cliff and Heymann, 1993). It has also been used for intensity evaluation on a variety of products and compounds to evaluate sourness, saltiness, irritation, flavour and aftertaste as well as to describe various textural perceptions, for a review see Piggott (2000). TI has become one of the important tools in sensory evaluation research. However, TI is time consuming as evaluation is limited to one attribute at a time and requires a large number of runs. In addition, it may also induce a 'halo dumping' effect where ratings for changes in other attributes are recorded on the given scale (Clark and Lawless, 1994). For example, when subjects are provided with only one intensity scale (sweetness) to rate a mixture of two sensations (sugar and strawberry), they may 'dump' the second sensation onto the only available scale. Analysis of time intensity data for multiple products can also be difficult. Large inter-individual differences between assessors are the main issue for most of the methodological papers (Dijksterhuis et al., 1994; Eilers and Dijksterhuis, 2004; Ledauphin et al., 2006). These papers are usually focused on the description of products differences attribute by attribute, but the simultaneous analysis of time intensity data for multiple products across several attributes has also been reported by other authors (Chaya et al., 2004a; Cordella et al., 2011; Ovejero-López et al., 2005).

TDS has been introduced as a different approach to the field of temporal evaluation (Pineau et al., 2004). It consists of presenting the panel with a list of attributes on a computer screen and asking them to identify, and sometimes rate, sensations perceived as dominant until perception ends. Unlike other temporal methods, TDS enables several attributes to be evaluated simultaneously at different time points during the tasting of a product and shows the sequence of the dominant sensations. This new approach has not only reduced the duration of the experiment, it is also believed to avoid any halo-dumping effect (Pineau et al., 2004). It is claimed that the TDS methodology makes it possible to obtain temporal information for as many as 10 attributes during an evaluation but panellists have commented that it is difficult to keep in mind all the attributes simultaneously above this limit (Pineau et al., 2004). It has also been suggested not to over train panellists on using TDS method as over-trained panellist tends to quote descriptors in the same order for all products (Pineau et al., 2009) and the product evaluation may become less intuitive. It is also difficult to assess individual panellist performance in a TDS experiment due to the nature of the data. However, work measuring individual performance based on the computation of a distance index between sequences of sensations, is ongoing (Pineau et al., 2009).

Typically, TDS has been compared with TI methodology. Le Reverend et al. (2008) concluded that TI and TDS brought similar information in terms of differences between products, attributes, and evolution over time. However, the authors indicated that TDS enabled the interaction between the evolutions of attributes to be recorded in addition to the sequence of dominant sensations. TI may be better suited if the determination of the kinetic of one specific attribute is required. As it is also possible to measure the intensity of dominant sensations with TDS, some scholars have attempted to relate data obtained from TDS with conventional QDA profiling (Labbe et al., 2009; Meillon et al., 2009). The authors revealed that TDS provided information on the dynamic of perception that was not available using conventional sensory profiling (e.g. QDA). Such information on the dynamic of perception might be useful to study the relationship between sensory perception and consumer response, e.g. understanding which dominant flavour attributes are related to certain product experiences or emotions (e.g. thirst quenching, refreshing etc). Therefore, for the present PhD research, a sequential approach of QDA and TDS is used to measure sensory attributes of the commercial blackcurrant squashes.

1.3.4 Application of descriptive sensory analysis in sensory and consumer science field

Descriptive analysis has evolved from an early reliance on 'golden tongue' experts such as brew masters and wine tasters (1930 to 1950) in the field of quality assurance or quality control to use of trained panels in producing structured, comparable and validated data (1950s to current) (Munoz, 2002). Formal quality control sensory programs (use of trained panel) were initiated in 1950s; however, awareness of their importance arose in early 1960s which resulted in the establishment of quality control sensory programs in industry.

Descriptive analysis was traditionally used as a standalone method in providing documentation and comparison of perceived sensory attributes of the current product and its competitors to the marketing teams. Sensory and consumer research then moved to focus on the relationship between product sensory attributes and consumers' overall liking responses. However, in these days of very mature and competitive markets, potential interactions of sensory attributes and other factors (e.g. emotions) have become interesting and important. The role of descriptive analysis in market research and consumer science has evolved from hedonic measures to more explicit behavioral outcome measures like purchase intentions, or even to implicit behavioral outcome measures such as 'emotional benefit' (e.g. chocolate makes me happy and will calm me), 'functional attributes' (e.g. healthy but less flavourful food is good for me). The need to understand such complex relationships between product characteristics and consumer behavior has led sensory scientists to adopt qualitative methods from other scientific disciplines, e.g. repertory grid method (Kelly, 1955), mean-ends chain (Brunsø and Grunert, 2007; Costa et al., 2007) and conjoint analysis (Enneking et al., 2007). However, little data is available to understand the relationship between sensory attributes and consumers conceptualisations (emotion, abstract, functional).

1.4 Experimental approach

The main aim of this research was to investigate the effect of sensory attributes and packaging cues on consumers' liking and conceptualisations (emotional/abstract/functional) using commercial squashes as vehicle. The research was divided into several key objectives which are listed below:

1. To select a range of commercial blackcurrant squashes products to represent the range of sensory and packaging properties observed in the UK market. This is discussed in ***chapter 2***.

2. To investigate the benefits of a sequential approach of QDA and TDS techniques in characterising sensory attributes of the commercial blackcurrant squashes. A secondary objective was to explore the impact of sample composition on taste and flavour perception in commercial blackcurrant squashes. This is discussed in ***chapter 3***.

3. To apply a published quantitative EsSense Profile method to measure consumer liking and emotional response (n=100) to the commercial blackcurrant squashes under three conditions: (i) blind (*to study the impact of sensory attributes),* (ii) pack (*to study the effect of packaging-only cues*), (iii) informed (*to study the combined effect of sensory and packaging cues*). This is discussed in ***chapter 4***.

4. To derive a conceptual lexicon (emotional, abstract, functional) for commercial blackcurrant squash using a one-to-one modified Repertory Grid interview (Kelly, 1955) with 29 articulate subjects (described in ***chapter 2***). A second key objective was to apply a method developed as part of this PhD project: consumer self defined conceptual lexicon Check-All-That-Apply method (CD-CATA) to measure consumers' liking and conceptual responses under blind, pack and informed conditions (n=100). This is discussed in ***chapter 5***.

5. To compare the use of the consumer self defined emotion lexicon of CD-CATA with the published emotion lexicon of EsSense Profile, and to evaluate the effectiveness of the CATA approach of CD-CATA compared to the intensity scaling of EsSense Profile. A secondary, but pertinent, objective was to determine whether emotional measurement goes beyond liking data. This is discussed in ***chapter 6***.

6. To determine the relationship between sensory attributes (as measured by QDA and TDS) and consumer responses (emotion data from EsSense Profile; conceptual data from CD-CATA methodology). Additional objectives here were (i) to determine whether TDS data could potentially be useful to understand consumer response and (ii) to explore whether additional abstract/functional conceptual data (from CD-CATA) gives additional consumer insights beyond emotion measurements. This is discussed in ***chapter 7***.

2 Materials and Methods

2.1 Introduction

Blackcurrant squash was chosen for this PhD research as it was of key relevance to the project sponsor. A reduced set of 11 UK commercial blackcurrant squashes was selected in such a way that they represented the range of sensory and packaging properties observed in the UK market segment (see section 2.2). Eleven blackcurrant squashes were evaluated using descriptive sensory techniques and this is detailed in section 2.3. In addition, these products were also evaluated by consumers using the EsSense Profile method (see section 2.4) and an approach newly developed for this PhD study: CD-CATA method (see section 2.5). The rich quantitative and qualitative, sensory and consumer datasets required the application of different statistical analysis techniques and this is described in section 2.6.

2.2 Samples

It is often impossible in a practical situation for a large group of consumers to taste all different products of interest as it is usually an expensive process (Helgesen and Nais, 1995). Therefore, a reduced set of samples needs to be selected in such a way that they span the actual space of interest as evenly as possible, and in such a way that all subregions of the sample space are represented. For this PhD project, the product selection process started with 24 blackcurrant squashes that were bought from different UK supermarkets (i.e. Tesco, Sainsbury, Marks and Spencer, Lidls, Aldi, and Waitrose). Samples were sensorially evaluated (qualitatively) by a group of trained panellists (n=11) where they grouped the products into seven different 'sensory buckets'. In addition, packaging elements of 24 blackcurrant squashes were also qualitatively evaluated using focus groups with two groups of naive blackcurrant squash consumers (n=13). Based on the qualitative data collected from sensory evaluation and consumer focus groups, 11 commercial blackcurrant squashes were selected to represent the range of sensory and packaging properties observed in the UK market segment (see Figure 2.1) for the different sizes and shapes of the products). Seven were added sugar (AS) and four were no added sugar (NAS) (or artificially sweetened) squashes (see Table 2.1; products are labeled using numbers due to confidentiality). Products were also grouped according to market segmentation: economy, standard or niche; as well as brand: retailer own or private label. Niche products were defined as those specifically sold in specialist shops as opposed to supermarkets. All products were prepared using filtered tap water according to the dilution factor found on the pack, and Table 2.2 lists product composition after dilution. All samples were served at 16±2°C.

AS products include products 2, 6, 8 and 10; NAS products include products 1, 3, 4, 5, 7, 9 and 11

Figure 2.1: The different sizes and shapes of the product packaging. From left to left product number 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and 11.

Table 2.1:Products

Product	AS/ NAS	Market segment	Brands
1	AS	Standard	Retailer own
2	NAS	Standard	Private label
3	AS	Niche	Private label
4	AS	Niche	Private label
5	AS	Standard	Retailer own
6	NAS	Standard	Retailer own
7	AS	Standard	Retailer own
8	NAS	Standard	Retailer own
9	AS	Standard	Retailer own
10	NAS	Economy	Retailer own
11	AS	Standard	Private label

Table 2.2: Product composition after dilution

Product	Dilution ratio	After dilution (per 50ml serving)			Sweeteners	Other ingredients
		BC juice [a] (%)	Sugar (g /50ml)	pH [b]		
1	1:5	2	3.7	2.8	Glucose fructose syrup	Citric acid, preservatives , flavouring, antioxidant
2	1:5	1.4	0.2	3.7	Aspartame, Acesulfame K	Citric acid, malic acid, preservatives , flavouring, antioxidant, acidity regulator, colouring, stabiliser
3	1:6	2.04	2.6	2.9	Glucose	None
4	1:7	0.41	2.3	3.1	Organic glucose	0.2% organic lemon and apple juice (after dilution per 50ml) , citric acid
5	1:5	2	2.3	3.0	Glucose	Citric acid, preservatives , flavouring
6	1:5	2	0.2	3.3	Sucralose	Citric acid, preservatives , flavouring, acidity regulator, colouring
7	1:5	0.88	2.9	2.8	Glucose	Citric acid, preservatives , flavouring, antioxidant, colouring
8	1:5	1.4	0.2	3.4	Sucralose, Acesulfame K*	Citric acid, preservatives , flavouring, antioxidant, acidity regulator, colouring, stabiliser
9	1:5	1.6	2.7	2.8	Glucose	Citric acid, preservatives , flavouring, antioxidant
10	1:11	0.43	0.4	3.7	Aspartame, Sodium Saccharin	Citric acid, preservatives , flavouring, antioxidant, acidity regulator, colouring
11	1:5	1	2.7	2.8	Glucose	Citric acid, preservatives , antioxidant, colouring

[a] ***Blackcurrant juice content taken from nutritional labelling.***

[b] ***measured when diluted, according to label instructions, using a pH211, Microprocessor pH meter, HANNA Instruments.***

2.3 Descriptive sensory methods

In order to investigate the effect of sensory attributes on emotional response, the samples needed to be characterised in terms of their sensory profile. To profile the sensory attributes of the blackcurrant squashes, this study adopted a sequential approach of QDA followed by TDS, using the same set of trained panellists (n=11).

2.3.1 Subjects and location of study

Eleven trained panellists (aged 30 to 55 years, 10 female and one male) from GSK sensory panel were invited to participate in the study. All panellists had been members of the GSK sensory panel for between five and 15 years and had extensive experience evaluating blackcurrant drinks. All sensory evaluations were carried out at GSK, Coleford, United Kingdom with sensory facilities designed to meet International Standard (ISO: 8589:1988).

2.3.2 Quantitative descriptive analysis (QDA)

The blackcurrant samples were first profiled using QDA (Stone et al., 1974). The panel had already been trained to assess blackcurrant squashes using the QDA technique for previous projects. However, to ensure reliability and accuracy of the data, the panel attended a further six two-hour training sessions to generate aroma (A), taste (Ts), flavour (F) and aftertaste (AT) attributes and to verify the use of attribute scales for the product range to be tested in this project. Panel performance was assessed based on three criteria: (1) repeatability (to be able to reproduce similar scores for the same product),

(2) accuracy (to agree closely with the 'mean' of the panel) and finally (3) discrimination (to be able to discriminate across the products) (Kemp, 2009). The attribute generation stage identified 24 attributes which were reduced through discussion to a list of 15 which discriminated across the products (Table 2.3).

Table 2.3: List of sensory attributes with agreed definition

Sensory attributes	**Modality[a] A/F/Ts/AT**	**Definition**
Acidic	Ts/AT	Basic taste of acidity as found in citric acid solution
Artificial sweetness	Ts/AT	Taste of artificial sweeteners as found in aspartame
Astringent	AT	Drying sensation in the mouth after swallowing
Bitter	Ts/AT	Basic taste of bitterness as found in caffeine solution
Catty	A/F/AT	Crushed leaves from a flowering currant bush
Confectionary BC	A/F/AT	Complex confectionery BC flavourings as found in Wine Gums, Pastilles, Jelly Babies and Boiled Sweets
Earthy	A/F/AT	Damp dirt and vegetation
Fresh BC	A/F/AT	Pureed fresh BC
Green and leafy	A/F/AT	Crushed BC leaves
Minty	A/F/AT	Indefinable peppermint as found in mouthwash
Natural processed BC	A/F/AT	Fruity BC as found in processed blackcurrants: Ribena Original Blackcurrant Concentrate (diluted to drink)
Natural sweetness	Ts/AT	Basic taste of sweetness as found in sucrose solution
Tomato ketchup	A/F/AT	Complex tomato, vinegar and spices as found in tomato ketchup
Veggie	A	Tinned vegetable water as found in Tesco Tinned Mixed Vegetables (in salt water)
Watery	F	Weak and watery flavour of an over-diluted squashes

[a]Modality: A (Aroma), F (Flavour), Ts (Taste), AT (Aftertaste)
BC: Blackcurrant

The squashes were evaluated in triplicate over three two-hour sessions according to a balanced incomplete design. All attributes were rated on unstructured line scales, anchored at the extremities with 'not at all' and 'very'. Products (50ml) were presented monadically, in sets of three, with breaks of 15 min between sets, and a minimum of one min between the products, to ensure no carry-over effects. Unsalted crackers (Carrs, UK) and filtered tap water were used as palate cleansers. All tests were conducted at room temperature (20±1°C) in an air-conditioned room, under Northern Hemisphere daylight and in individual booths. Data were collected using FIZZ software (Biosystèmes, Couternon, France).

2.3.3 Temporal dominance of sensations (TDS)

The panel had no previous experience using TDS and therefore attended six two-hour TDS training sessions. Panellists were introduced to the notion of temporality of sensations using the analogy of an orchestra playing music. A dominant sensation was defined as a sensation that triggers the most attention at a point of time (Pineau et al., 2009). Pineau et al. (2009) indicated that a maximum of 10 attributes could be evaluated using TDS. To select a range of the key discriminating sensory attributes, principal component analysis (PCA) on the panel averages was performed and a total of 12 attributes were selected based on the visual inspection of plot from PCA of the QDA data (data not shown). However, three attributes related to blackcurrant ('natural processed', 'confectionary' and 'fresh') and two related to sweetness ('natural' and 'artificial'). QDA indicated that any one product only exhibited one type of blackcurrant or sweetness attribute and hence the list of attributes for TDS was reduced to nine: 'blackcurrant', 'sweet', 'tomato ketchup', 'catty', 'minty', 'earthy', 'acidic', 'bitter' and 'astringent'. The TDS data for the blackcurrant and sweetness attributes could then be further interpreted by looking at the QDA to determine the nature of the blackcurrant and sweetness character.

The panellists were then trained to use a computerised TDS data capture system (FIZZ, Biosystèmes, Couternon, France) and to evaluate the products following the protocol described below (Pineau et al., 2009). The nine attributes were presented simultaneously on the computer screen with their corresponding unstructured line scale anchored at the extremities with 'not at all intense' and 'very intense' as for QDA. Panellists were instructed to put the product in mouth and click on the 'start' button to begin the evaluation. At 15s, panellists were cued on screen to swallow the product and continue their evaluation until no sensation was perceived, at which point they were instructed to click the 'stop' button unless data acquisition had automatically stopped after the agreed 60s. Panellists were asked to identify and rate the intensity of sensation they perceived as dominant while performing the tasting protocol. They were informed that they did not have to use all the attributes in the list and were allowed to choose the same attribute several times throughout the evaluation or conversely to never select an attribute as dominant. Attribute order presentation was different for each panellist to avoid order effects, but attribute order was maintained within each panellist to facilitate scoring, as the effort to refamiliarise themselves with a new attribute order and search for the right attribute would be too distracting.

The 11 blackcurrant squashes were evaluated in triplicate over three two-hour sessions according to a balanced design. Products (50ml) were presented monadically, in sets of two with breaks of 15 min between sets and a minimum of one minute was allowed between the products to ensure no carry-over effects. TDS data were collected using FIZZ software (Biosystèmes, Coutenon, France).

2.4 EsSense Profile

A group of consumers (n=100) were asked to assess their overall liking and emotional responses to 11 blackcurrant squashes using the EsSense Profile (King and Meiselman, 2010), under three conditions:

- Blind condition (consumers to taste the debranded product; to study the impact of sensory attributes on consumer response)
- Pack condition (consumers to view just the packaging; to study the effect of package-only characteristics on consumer response)
- Informed condition (consumers to taste the product and view the packaging concurrently; to study the combined effect of sensory and packaging characteristics on consumer response)

2.4.1 Consumer sample and site of the study

All subjects were recruited from the university campus to participate in the study. They were the primary shopper for their households and consumed fruit squash drinks at least once a month. Consumer tests were carried out at the Sensory Science Centre (SSC) of the University of Nottingham (UoN), UK, with sensory facilities designed to meet an International Standard (ISO: 8589:1988).

2.4.2 Consumer evaluation

The EsSense Profile method includes a list of 39 terms (see Table 2.4) classified by King and Meiselman (2010) as 'positive', 'negative' or 'unclassified', wherein terms had been labelled 'unclassified' if more than 50% of the participants in their study had rated them as neither 'positive' nor 'negative'.

Evaluation of the 11 products took place over two 30 min sessions, with a 10 min break in between (one block of five and one block of six products). Consequently, subjects were invited to attend a total of six short sessions. Consumers were asked to score their overall liking for each of the products using a nine-point hedonic scale, before rating their emotional responses using the EsSense Profile emotion lexicon on five-point scale anchored from 'not at all' to 'extremely'. The emotions were presented in alphabetical order as proposed by King and Meiselman (2010).

Table 2.4: Emotion lexicon for EsSense Profile

Emotions		
Positive	**Negative**	**Unclassified**
Active	Bored	Aggressive
Adventurous	Disgusted	Daring
Affectionate	Worried	Eager
Calm		Guilty
Energetic		Mild
Enthusiastic		Polite
Free		Quiet
Friendly		Steady
Glad		Tame
Good		Understanding
Good-natured		Wild
Happy		
Interested		
Joyful		
Loving		
Merry		
Nostalgic		
Peaceful		
Pleasant		
Pleased		
Satisfied		
Secure		
Tender		
Warm		
Whole		

Products were presented under the three different test conditions, i.e. blind, pack and informed. In the blind condition, debranded products, which were labeled with random three digit codes, were presented monadically in each of the condition following a balanced incomplete design. Unsalted crackers (Rakusen's, UK) and mineral water (Evian, France) were provided as palate cleansers during both blind and informed tasting sessions. All tests were conducted at room temperature in an air-conditioned room, under Northern Hemisphere daylight, in individual booths and data were collected using FIZZ software (Biosystèmes, Couternon, France).

2.5 Consumer self defined CATA (CD-CATA)

In order to develop an alternative conceptual lexicon using consumer language, a one-to-one modified Repertory Grid interview was conducted with 29 subjects evaluating the 11 blackcurrant squashes. A different set of consumers (n=100) were then asked to assess their conceptual response to the squashes under the three experimental conditions: blind, pack and informed as outlined in section 2.4.

2.5.1 Consumer sample and site of the study

All subjects who took part in this study were recruited from the UoN campus to participate in the study. They were the primary shopper for their households and consumed fruit squash drinks at least once a month. Subjects who took part in the one-to-one interviews were screened for their ability to express and describe their feelings and it was ensured that English was their first language. Subjects recruited for the lexicon development process were aged from 18 to 60, 60% of them were female and 50% were NAS squash drinkers. Consumer tests were carried out at the SSC of the UoN with sensory facilities designed to meet International Standard (ISO: 8589:1988).

2.5.2 Development of conceptualisation lexicon

This study sought to develop a conceptual lexicon that was evoked by sensory attributes and packaging cues of the 11 blackcurrant squashes following a modified Repertory Grid technique (Kelly, 1955). The Repertory Grid method was originally developed to identify the constructs that people use to structure their perceptions of the social world, however, the idea of applying this method to food acceptability was proposed by Olson (1981). It has been successfully used to investigate consumer perception of foods (Russell and Cox, 2004; Thomson and McEwan, 1988) as respondents reported that they found it very much easier to describe contrasts amongst a number of stimuli than to describe characteristics of a single stimulus (Green, 1992).

The 29 subjects attended a total of six sessions. Each session lasted about 60 min, with one 15 min break. At the beginning of the first session, a warm up exercise was conducted with a number of pictures (approx. 30) to encourage subjects to express and describe their feelings about pictures they had chosen. Subjects were asked to select as many or as few pictures that they found interesting to talk about (or pictures that meant something to them). The subjects were then presented with a number of prompt emotion word cards; they were asked to group the words according to categories of 'positive', 'negative' or even 'unclassified,' if they struggled to decide between 'positive' and 'negative'. At the end of the warm up session, subjects were asked to use words to describe their feelings towards the pictures they had chosen at the beginning. The warm up exercise was conducted to ensure subjects understood the task of describing their conceptual response to the samples presented in the subsequent interviews. During the next two sessions, subjects were presented with triads of debranded products which they were asked to taste and then describe *'in what way two products were similar but different from the third in terms of their conceptual response'*. This procedure was repeated until all of the products were included in triads; four triads of debranded products in total were presented to each subject in a randomised design. Through this process, individuals generated their own list of conceptual terms relevant to blackcurrant squashes, resulting in a total of 289 conceptual terms (an average of 46 terms for each subject). In the third session, subjects tasted and rated all 11 blackcurrant samples individually with respect to their own list of conceptual terms using a CATA approach. Unsalted crackers (Rakusen's, UK) and mineral water (Evian, France) were provided as palate cleansers during the tastings sessions. The process was then repeated over the final three sessions but this time only presenting the product packaging, which resulted in a total of 505 conceptual terms (an average of 75 terms for each subject).

Terms perceived to have obvious similar meaning (e.g. 'trust', 'confidence' and 'reassurance') were combined, and subsequently terms were selected for the final lexicon if they were checked by ≥ 5 subjects. As a result, a total of 54 and 87 conceptual terms were selected for the final CATA lexicon for the blind and pack condition, respectively (see Table 2.5). For the informed condition the lexicons were combined, resulting in a total of 101 terms.

Table 2.5: Terms included in consumer self defined conceptual lexicon for blind[B], pack [P]and informed[I] conditions

Emotion			Abstract	Functional
Positive	Negative	Unclassified		
Adventurous [P,I]	Angry [B,I]	Guilty pleasure [B,I]	Artificial [B,P,I]	Adult drink [P,I]
Amused [P,I]	Annoyed [B,P,I]		Attractive [P,I]	Affordable [P,I]
Approval [B,P,I]	Bored [B,P,I]		Childish [P,I]	Bad for your teeth [B,P,I]
At ease [B,P,I]	Cautious [B,P,I]		Colourful [P,I]	Basic [P,I]
Attentive [B,I]	Confused [B,P,I]		Different [P,I]	Cheap [B,P,I]
Care free [P,I]	Disappointment [B,P,I]		Ethical [P,I]	Convenient [P,I]
Comforted [B,P,I]	Disapproval [P,I]		Familiar [B,P,I]	Easy to read [P,I]
Curious [B,P,I]	Discontent [B,P,I]		Fun [P,I]	Environmentally friendly [P,I]
Desire [B,P,I]	Disgusted [B,I]		Generic [P,I]	Everyday drink [B,P,I]
Excitement [P,I]	Displeasure [B,I]		Honest [P,I]	Expensive [B,P,I]
Good [B,P,I]	Disrespect [P,I]		Imitation [P,I]	Family drink [P,I]
Happy [B,P,I]	Not excited [P,I]		Modern [P,I]	Fresh [B,P,I]
Inspired [P,I]	Not interested [P,I]		Natural [B,P,I]	Good for your teeth [P,I]
Interested [B,P,I]	Overwhelmed [P,I]		Old fashioned [P,I]	Good quality [B,P,I]
Love [P,I]	Regret [B,I]		Pointless [P,I]	Hard to read [P,I]
Patriotic [P,I]	Resentment [B,I]		Pretentious [P,I]	Healthy [B,P,I]
Pleasant surprise [B,I]	Sceptical [B,P,I]		Strange [B,I]	Helps to control my weight [P,I]
Pleased [B,P,I]	Shocked [B,I]		Traditional [P,I]	Like real fruits [B,I]
Reminiscence [B,P,I]	Sickly [B,I]		Unappealing [B,P,I]	Low in calories [P,I]
Respect [P,I]	Uncomfortable [B,P,I]		Unfamiliar [B,P,I]	Mixed messages [P,I]
Responsible [P,I]	Unhappy [B,I]			Nasty [P,I]
Satisfaction [B,P,I]	Unpleasant surprise [B,I]			Not refreshed [B,I]
Special [P,I]	Worried [B,P,I]			Not thirst quenching [B,I]
Supportive [P,I]				Occasional drink [P,I]
Trust [B,P,I]				Poor quality [B,P,I]
Warm [B,P,I]				Refreshed [B,P,I]
				Treat [B,P,I]
				Unhealthy [B,P,I]
				Vague claim [P,I]
				Value for money [P,I]
				Wrong colour [P,I]

For this study, conceptualisation terms were categorised into three broad categories, as suggested by Thomson (2010); emotional, abstract and functional. It can be difficult to distinguish the difference between 'abstract feelings' and 'functional connotation'. For example, one can argue that conceptual term 'fresh' is an 'abstract feeling' rather than 'functional connotation'. However, although we have attempted to categorise terms as 'abstract' or 'functional', for the purpose of data analysis they are combined together as one group. As over twice the number of abstract and functional conceptual terms was generated by the packaging evaluation interview compared to blind tasting interview, it was hypothesised that abstract/functional conceptualisations are more driven by packaging cues. Therefore, to facilitate examination of this hypothesis, emotional terms were separated from abstract/functional conceptual terms for the data analysis. This resulted in 33 emotional and 20 abstract/functional conceptual terms related to the blind condition; 38 emotions and 45 abstract/functional conceptual terms related to the pack condition; and finally 50 emotions and 50 abstract/functional conceptual terms for assessment in the informed condition (Table 2.5). Emotion terms were further classified as 'positive', 'negative' or 'unclassified' after reviewing the emotion classifications conducted by other scholars (King and Meiselman, 2010; Laros and Steenkamp, 2005).

2.5.3 Consumer evaluation

A larger group of consumers (n=100) were invited to attend a total of three short sessions, each representing a different test condition: blind, pack and informed (as outlined in section 2.4). Each session lasted 60 min, with a 15 min break in between an initial block of five products and a second block of six products. Subjects were first asked to rate their overall liking for each product, using a nine-point hedonic scale, and then rating their conceptual responses using a CATA approach of the relevant consumer defined conceptual lexicon (Table 2.5). Conceptual terms were presented in a randomised order according to previous authors (Ares et al., 2010; Dooley et al., 2010; Perrin et al., 2008), but emotion terms were always presented before abstract and functional conceptual terms, as it was felt that the latter might bias the consumer emotional response. For example, consumers might feel obliged to only check negative emotions if they had already scored negative conceptual terms like 'bad for your teeth'. Products were presented monadically in each of the condition following a balanced incomplete block design. Debranded products in the blind condition were labeled with random three digit codes. Unsalted crackers (Rakusen's, UK) and mineral water (Evian, France) were provided as palate cleansers during the tasting sessions. All tests were conducted at room temperature in an air-conditioned room, under Northern Hemisphere daylight, in individual booths and data were collected using FIZZ software (Biosystèmes, Couternon, France).

2.6 Data analysis

2.6.1 QDA

Two-way (product and panellist) fixed model ANOVA with interaction, was carried out to determine which attributes discriminated between products and subsequently, if this was related to product composition. Where appropriate, Tukey's Honestly Significant Different (HSD) multiple comparison tests were used to determine which products differed from each other (α=0.05) (FIZZ, Biosystèmes, Couternon, France). PCA was performed on the QDA mean panel data (XLSTAT Version 2009.6.03, Addinsoft, USA) to provide further multivariate graphical representation of the product space.

2.6.2 TDS

For each attribute, a TDS score and dominance rate at each time point was calculated. The TDS score is the mean intensity of an attribute (weighted by duration), as defined according to Equation 1.

Equation 1: TDS score: ($\sum$ Intensity x Duration)/ ($\sum$Duration)

The dominance rate is the percentage number of times an attribute is scored as dominant at a particular time point. The higher the dominance rate, the better the agreement among panellists. TDS curves, whereby dominance rates are plotted against standardised time, were created for each attribute (Pineau et al., 2009). Each panellist's time data was standardised to a score between 0 and 100, 0 representing when they clicked start and 100 when they clicked Stop or after 60s when recording stopped automatically. Spline based smoothing (fitting a smooth curve to a set of noisy observations) was applied on each curve.

Two-way (product and panellists) fixed model analysis of variance (ANOVA), with interaction, was computed on TDS scores to determine which attribute discriminated between products and if this was related to product composition. Attributes not selected during TDS were considered to have an intensity and duration of zero. Tukey's HSD multiple comparison tests were performed to determine which products significantly differed from one another (α=0.05). PCA was carried out on TDS score mean panel data to identify the key sensory attributes contributing the most variation in products within the product space (XLSTAT Version 2009.6.03, Addinsoft, USA).

2.6.3 Comparison of QDA panel mean data and TDS score

The relationship between the mean panel data on the 11 products for both QDA and TDS scores was analysed by the relative variance (RV) coefficient with Système Portable d'Analyse des Données Numériques (SPAD.N) software package (version 5.0, Centre International de Statistique et d'Informatique Appliquées, France). The RV coefficient provides a measure of correlation between the two datasets allowing the similarity of the product configurations in the sensory profiling space and in the TDS space to be evaluated. The closer the RV is to 1, the more similar the data matrices (Robert and Escoufier, 1976).

2.6.4 Overall liking data

Two-way (product and subject) mixed model ANOVA and Tukey's HSD multiple comparison tests were applied to determine which products differed from each other in terms of liking responses (α=0. 05) using XLSTAT software (Version 2009.6.03, Addinsoft, USA) in both experiments: EsSense Profile and CD-CATA methodology.

To assess the relationship between liking and emotional responses, Pearson correlation coefficients (r) were determined between mean liking scores and mean emotion scores collected from EsSense Profile; and between mean liking scores and emotion frequency counts obtained from CD-CATA methodology.

In order to understand the effect of packaging on consumers' liking's scores, liking mean scores for each product were compared in the blind condition (B), in the pack condition; also referred to as expected liking (E) and in the informed condition (I) (Villages at al., 2008). To do this, expected minus blind liking scores (E-B) and informed minus blind liking scores (I-B) were calculated and a Student's t-test was carried out to test significant differences (α=0.05) between the mean ratings of the conditions for each sample. Informed minus expected liking scores (I-E) were then calculated for 'assimilated' products. Assimilation is when actual liking moves in the direction of expected liking and contrast is when actual liking moves in the opposite direction from expectation. To determine this, (I-B) is divided by (E-B); when the value is above zero, then an assimilation effect is revealed; and when the value is below zero, then a contrast effect is revealed. For further discussion, see section 4.2.1 and 5.2.1.

2.6.5 EsSense Profile: Emotion Data

Two way (product and subjects) mixed model ANOVA was carried out on emotion scores to determine which emotion terms discriminated between products across blind, pack and informed conditions. Where appropriate, Tukey's HSD multiple comparison tests were used to determine which products differed from each other (α=0.05) (XLSTAT Version 2009.6.03, Addinsoft, USA).

In order to understand the effect of packaging on consumer emotion scores, Student's t tests (α=0.05) were carried out to compare the difference between informed and blind emotion scores (I^E-B^E); pack and blind emotion scores (P^E-B^E); and informed and pack emotion scores (I^E-P^E) (Villages at al., 2008).

In order to examine the similarities and differences between the multivariate products configuration across the three different conditions: blind, pack and informed, multiple factor analysis (MFA) was conducted on the mean liking and emotion scores for each product (XLSTAT Version 2009.6.03, Addinsoft, USA). MFA is a useful statistical technique to compare multiple data sets simultaneously by providing a map of several tables of data on the same samples from different sources and with different number of variables (Lê et al., 2008; Morand and Pagès, 2005; Nestrud and Lawless, 2008).

2.6.6 CD-CATA: Conceptual (emotion, abstract, functional) data

Frequency counts were determined for each of the conceptual term for each product. Chi-square tests of independence were carried out on total frequency counts for the conceptual terms across the 11 products across blind, pack and informed conditions (XLSTAT Version 221 2009.6.03, Addinsoft, USA) (Hair et al., 2006). A test of significance for each cell was also computed as part of chi-square analysis to determine which products were significantly different (> or <) from the expected count. This could then be interpreted in terms of which conceptual terms significantly discriminated between products (α=0.05).

Finally, MFA was performed on the mean liking scores and total frequency counts of conceptualisations for each product in order to compare product configurations across the three different conditions: blind, pack and informed.

2.6.7 Comparison of EsSense Profile and CD-CATA (emotion data)

Comparison of EsSense Profile and CD-CATA methodology was made based on the liking and emotion data collected from blind condition. Abstract/functional conceptual data obtained from CD-CATA methodology were excluded from data analysis as these measures are not obtained from the EsSense Profile.

In order to provide further multivariate graphical representation of the emotional product spaces obtained from EsSense Profile and CD-CATA, PCA was performed on the quantitative data obtained from EsSense Profile, whereas correspondence analysis (CA) and multiple correspondence analysis (MCA) were performed on the qualitative emotion data collected from CD-CATA methodology (XLSTAT Version 2009.6.03, Addinsoft, USA).

PCA is a useful method to identify patterns in the data, expressing the data in such a way to highlight their similarities and differences (Hair et al., 2006). PCA was performed on the mean data of significant discriminating emotion terms from EsSense Profile, with consumer liking scores considered as a supplementary variable.

CA is conceptually similar to PCA, but applies to categorical rather than continuous data. It can be used to visualise tabular data, usually frequency count data from cross tabulation of two categorical variables and this in case, product versus conceptual terms. In similar manner to PCA, it provides a means of displaying a set of data in two-dimensional graphical form (Hair et al., 2006). CA was performed on the total frequency count of conceptual terms for each product in order to identify relationship between the emotions and products, considering consumer overall liking scores as a supplementary variable.

Unlike CA which only takes account of total frequency counts, MCA allows the individual data from respondents to be taken into account. MCA is conceptually similar to PCA but instead of applying to quantitative variables, it applied to qualitative variables and it is a method that allows the study of the association between two or more qualitative variables, in two-dimensional graphical form (Hair et al., 2006). MCA was also performed on the individual consumer data but only on the emotion data, considering products as supplementary variable categories (Hair et al., 2006). For the latter, consumer responses were divided into two categories: either 'emotion was checked' (1) or 'emotion was not checked' (0) to construct a contingency table whereby rows represented each consumer assessing each of the 11 products across the 36 emotions (columns).

Since the EsSense Profile ratings and CD-CATA were scaled differently, the two data sets were standardised across products to minimise differences inherent to the scaling as described by Dooley et al. (2010). The data matrix placed products in columns and attributes in rows, and the data were standardised to a mean of zero and variance of one (Version 2009.6.03, Addinsoft, USA). MFA was conducted on the standardised dataset in order to examine the similarities and differences between the multivariate product configurations obtained from EsSense Profile and CD-CATA methodology.

2.6.8 Relationship between sensory attributes and consumer response

Pearson correlation coefficients (r) were calculated, together with the associated significant levels, in order to determine the relationship between sensory attributes of blackcurrant squashes (as measured by QDA and TDS) and consumer response (emotional data from EsSense Profile and conceptual data from CD-CATA methodology).

QDA provided the mean intensity score of every sensory attribute (aroma, flavour, taste and aftertaste). However, as TDS provided dominance rates of sensory attributes at every time point (standardised 0 to 100%); TDS time points were broken down into two segments (before and after swallowing) in order to reduce number of data points to those more relevant. A reduced set of time points was then selected to be representative of the two time segments: before swallow - Time (T) 6, 8, 10, 12, 14, 18, 25, and: after swallow – T28, 35, 45, 50, 60, 65, 75, 80, 85, 95, 100. The selection of the reduced set of time points was done using Structuration des Tableaux A Trois Indices de la Statistique (STATIS) method (Lavit et al., 1994) (SPAD.N software package, version 5.0, Centre International de Statistique et d'Informatique Appliquées, France). STATIS method allows several data matrices to be analysed simultaneously, where each matrix consists of the data recorded by time-intensity profiling at a given time (Chaya et al., 2004b). The STATIS method is applicable to matrices of centre variables that describe a time-dependent phenomenon, with the variables measured over time across a set of individuals or objectives (Lavit et al., 1994). Only dominance rates of significant dominant sensory attributes were selected for data analysis. This was done based on visual inspection of TDS curves; attributes which were above the 'significant lines' were selected for data analysis (see section 7.2.1 illustrates how this can be achieved). Table 2.6 lists the significantly dominant sensory attributes for selected time points. However, due the large datasets, the dominance rates for these attributes (at selected time points) are not shown in this thesis.

Table 2.6: List of dominant sensory attributes for selected time points

Dominant sensory attributes	Selection of time points	
	Before swallow	After swallow
Acidic	T6-25	T28-100
Artificial sweetness	T6-25	T28-100
Astringent	n/a	T100
Catty	T18	T45,60
Confectionary blackcurrant	T6-25	T28-100
Fresh blackcurrant	T6-25	T28-100
Natural processed blackcurrant	T6-25	T28-100
Natural sweetness	T6-25	T28-100
Minty	n/a	T28, T95
Tomato Ketchup	T6-25	T28-100

Before swallow – T6-25 (T6, 8, 10, 12, 14, 18, 25); After swallow – T28 (T28, 35, 45, 50, 60, 65, 75, 80, 85, 95, 100)

In order to provide further multivariate graphical representation of the product configuration in relation to the EsSense emotional product space, PCA was performed on the mean data of significant EsSense emotion terms, considering sensory data from QDA as a supplementary variable (XLSTAT Version 2009.6.03, Addinsoft, USA). In addition, another PCA was also performed on the same set of the mean data of significant EsSense emotion terms, but this time with dominance rates of dominant emotions at specific time points (as listed in Table 2.6) as a supplementary variable.

Finally, the same data analyses as outlined above (including the Pearson correlation with associated significant level and PCA) were performed on the total frequency counts of the conceptual terms from the CD-CATA methodology, considering either QDA or TDS sensory data as supplementary data. PCAs provide further multivariate graphical representation of the product configuration in relation to the CD-CATA conceptual product space.

3 Sensory evaluation using sequential approach of QDA and TDS

3.1 Introduction

This chapter focuses on the results of the sensory profiling of the blackcurrant squashes using a sequential QDA and TDS approach. QDA is used to describe the nature and the intensity of sensory attributes from a single evaluation of a product, whereas TDS is primarily used to identify dominant sensory attributes over time.

As it is possible to measure the intensity of dominant sensations with TDS, some scholars have attempted to relate TDS data with conventional QDA profiling. For example, Labbe et al. (2009) compared the description of gels containing different levels of odorants, citric acid, cooling agent and xanthan gum obtained with TDS and QDA methodologies. They concluded that TDS provided information on the dynamics of perception after product consumption that was not available using conventional sensory profiling, which may be important in understanding complex perceptions such as 'refreshing'. In addition, Meillon et al. (2009) showed that TDS differentiated between partially dealcholised red wines on twice as many attributes as conventional sensory methods. TDS illustrated temporal differences between wines that did not appear with the conventional sensory profile. Both these studies underlined a drawback of conventional sensory profiling methods in estimating the qualitative changes of dominance of the sensations during and after food consumption.

Furthermore, Labbe et al. (2009) used separate panels for their comparative research, and, although Meillon et al (2009) used the same panel, their investigation was performed on a model system. The study reported in this chapter compared both QDA and TDS techniques using commercially available products, using the same panellists and additional replication. We aimed to add to the literature in terms of the robustness of the data and the general discussion comparing the relative merits of TDS and QDA, in particular, TDS's relevance within a commercial product category.

The main objective of this study was primarily to investigate the benefits of using a sequential approach of QDA and TDS in characterising sensory attributes of the commercial blackcurrant squashes. In addition, the impact of sample composition on taste and flavour perceptions in blackcurrant squashes was explored.

3.2 Results

3.2.1 Products differences ascertained by QDA

Table 3.1 to Table 3.5 list the mean sensory attribute scores for aroma (A), flavour (F), taste (Ts) and aftertaste (AT) for each of the 11 products, respectively. ANOVA revealed that for all 15 attributes, significant product differences were observed ($p < 0.05$). The product groupings indicated by the Tukey's HSD multiple comparison test are also shown in Table 3.1 to Table 3.5.

Table 3.1: QDA mean panel data (& stdev) and Tukey's HSD test groupings for aroma intensity of 11 blackcurrant samples

	Aroma								
Product	Veggie	Natural processed blackcurrant	Confectionary blackcurrant	Fresh blackcurrant	Tomato ketchup	Catty	Green and leafy	Earthy	Minty
1	1.9 $_{6.1}^{B}$	39.5 $_{12.8}^{A}$	7.8 $_{12.6}^{B}$	0 $_{0.2}^{B}$	0 $_{0}^{B}$	0.6 $_{3.1}^{B}$	13.2 $_{12.2}^{ABCD}$	11.6 $_{12.9}^{AB}$	4.3 $_{9.5}^{AB}$
2	16.8 $_{16.6}^{A}$	35.5 $_{17.0}^{A}$	11.1 $_{17.7}^{B}$	0 $_{0}^{B}$	0 $_{0.2}^{B}$	0 $_{0}^{B}$	9.6 $_{12.9}^{BCD}$	9.9 $_{12.9}^{AB}$	12.8 $_{18.5}^{A}$
3	0.5 $_{2.3}^{B}$	8.5 $_{11.7}^{B}$	0 $_{0}^{B}$	46.8 $_{11}^{A}$	0 $_{0}^{B}$	4 $_{13.6}^{B}$	25.2 $_{9.8}^{A}$	20.9 $_{13.6}^{A}$	0 $_{0.2}^{B}$
4	9.5 $_{10.8}^{AB}$	5.9 $_{10.6}^{B}$	1.5 $_{4.6}^{B}$	0.1 $_{0.2}^{B}$	44 $_{8.5}^{A}$	0 $_{0}^{B}$	0 $_{0}^{D}$	0.9 $_{2.9}^{B}$	0 $_{0}^{B}$
5	5.8 $_{12.6}^{AB}$	35.9 $_{16.9}^{A}$	2.6 $_{7.2}^{B}$	3.2 $_{8.1}^{B}$	0 $_{0}^{B}$	2.8 $_{7.8}^{B}$	18.2 $_{15.9}^{ABC}$	6.5 $_{9.5}^{B}$	0.8 $_{3.2}^{B}$
6	4.8 $_{11.3}^{AB}$	35.6 $_{17.1}^{A}$	10.1 $_{13.9}^{B}$	2.3 $_{10}^{B}$	0 $_{0.2}^{B}$	5.4 $_{11.9}^{B}$	16.3 $_{17.3}^{ABC}$	9.3 $_{11.2}^{B}$	2.7 $_{6.6}^{AB}$
7	9.0 $_{15.9}^{AB}$	36.6 $_{7.6}^{A}$	2.5 $_{6.1}^{B}$	0 $_{0.2}^{B}$	0 $_{0.2}^{B}$	0.7 $_{4.2}^{B}$	14.5 $_{12.7}^{ABC}$	3.8 $_{7.9}^{B}$	2 $_{6.3}^{B}$
8	6.4 $_{12.4}^{AB}$	38.8 $_{10.2}^{A}$	5.7 $_{8.5}^{B}$	0 $_{0.2}^{B}$	0 $_{0}^{B}$	2.1 $_{6.8}^{B}$	15 $_{15.3}^{ABC}$	2.9 $_{6.6}^{B}$	0 $_{0.2}^{B}$
9	3.5 $_{8.2}^{B}$	40.0 $_{10.5}^{A}$	6.6 $_{10.7}^{B}$	0 $_{0}^{B}$	0 $_{0}^{B}$	1.9 $_{5.5}^{B}$	20.4 $_{12.6}^{AB}$	5.6 $_{9.4}^{B}$	3.1 $_{6.8}^{AB}$
10	0 $_{0.2}^{B}$	9.0 $_{15.7}^{B}$	42.5 $_{18.3}^{A}$	0 $_{0}^{B}$	0 $_{0}^{B}$	18.9 $_{17.4}^{A}$	4.9 $_{11.2}^{CD}$	4 $_{9.9}^{B}$	8.3 $_{11}^{AB}$
11	2.4 $_{5.8}^{B}$	36.5 $_{10.4}^{A}$	2.9 $_{9.59}^{B}$	0 $_{0}^{B}$	0 $_{0.2}^{B}$	1.6 $_{6.3}^{B}$	17.3 $_{13.2}^{ABC}$	4.1 $_{7.6}^{B}$	1.9 $_{5.4}^{B}$

^{ABCD}*Samples with the same letter within a column, are not significantly different from each other ($p < 0.05$)*

Table 3.2: QDA mean panel data (& stdev) and Tukey's HSD test groupings for flavour intensity of 11 blackcurrant samples

Product	Flavour								
	Watery	Natural processed blackcurrant	Confectionary blackcurrant	Fresh blackcurrant	Tomato ketchup	Catty	Green and leafy	Earthy	Minty
1	1.2 $_{4.6}^{C}$	45.5 $_{11.9}^{A}$	13.7 $_{17.1}^{B}$	0 $_{0}^{B}$	0 $_{0.2}^{B}$	0 $_{0.2}^{B}$	14.4 $_{14.5}^{ABCDE}$	7.8 $_{11.2}^{B}$	8.9 $_{11.1}^{ABC}$
2	4.6 $_{13.6}^{BC}$	39.2 $_{15.2}^{A}$	10.4 $_{16.1}^{BC}$	0 $_{0}^{B}$	0 $_{0}^{B}$	0 $_{0.2}^{B}$	5.5 $_{10.4}^{CDE}$	8.5 $_{12}^{B}$	13.8 $_{13.8}^{A}$
3	17.3 $_{16.4}^{AB}$	8.3 $_{11.9}^{B}$	0 $_{0.2}^{C}$	45.8 $_{9.5}^{A}$	0 $_{0}^{B}$	2.2 $_{7}^{B}$	24 $_{10.2}^{A}$	19.3 $_{13.2}^{A}$	2.3 $_{5.2}^{BC}$
4	27.5 $_{13.6}^{A}$	6.5 $_{11.6}^{B}$	1.5 $_{4.8}^{BC}$	0 $_{0}^{B}$	40.2 $_{11.6}^{A}$	0 $_{0}^{B}$	2.5 $_{8}^{E}$	0.7 $_{2.4}^{B}$	0 $_{0}^{C}$
5	3 $_{8.4}^{C}$	38.4 $_{18}^{A}$	2.6 $_{7.5}^{BC}$	6.2 $_{14.}^{B}$	0 $_{0.2}^{B}$	2 $_{6.3}^{B}$	17.2 $_{14.1}^{ABC}$	5.8 $_{9.5}^{B}$	3.8 $_{7.2}^{BC}$
6	10.6 $_{16.7}^{BC}$	37.8 $_{15.7}^{A}$	11.1 $_{13.2}^{BC}$	0.8 $_{4.4}^{B}$	0 $_{0}^{B}$	5.1 $_{11.3}^{B}$	10.2 $_{11.5}^{BCDE}$	7.2 $_{9.9}^{B}$	10.7 $_{11.5}^{AB}$
7	8.9 $_{15.7}^{BC}$	42.7 $_{8.8}^{A}$	5.1 $_{9.3}^{BC}$	0 $_{0}^{B}$	0 $_{0.2}^{B}$	0.1 $_{0.2}^{B}$	11.6 $_{11}^{BCDE}$	4.2 $_{8.7}^{B}$	5.5 $_{8.7}^{ABC}$
8	7.9 $_{14.6}^{BC}$	43.1 $_{12.7}^{A}$	6.3 $_{8.8}^{BC}$	0 $_{0.2}^{B}$	0 $_{0}^{B}$	0.3 $_{1.9}^{B}$	13.2 $_{13.3}^{ABCDE}$	3.2 $_{7.7}^{B}$	7.6 $_{12.4}^{ABC}$
9	6.1 $_{13.1}^{BC}$	43.2 $_{12.9}^{A}$	6 $_{9.9}^{BC}$	0 $_{0}^{B}$	0 $_{0}^{B}$	1.7 $_{4.6}^{B}$	20.3 $_{12.6}^{AB}$	6.5 $_{9.7}^{B}$	9.2 $_{9.7}^{ABC}$
10	11.7 $_{16.9}^{BC}$	8.6 $_{15.2}^{B}$	43.6 $_{15.2}^{A}$	0 $_{0.2}^{B}$	0 $_{0}^{B}$	19.4 $_{17.8}^{A}$	4.8 $_{9.9}^{DE}$	3.6 $_{9.2}^{B}$	9.9 $_{11.1}^{AB}$
11	10.6 $_{16.4}^{BC}$	40.2 $_{12.1}^{A}$	2.1 $_{7.4}^{BC}$	0 $_{0.2}^{B}$	0 $_{0.2}^{B}$	0.5 $_{2.4}^{B}$	16.6 $_{12}^{ABCD}$	6.5 $_{9.2}^{B}$	6.1 $_{8.1}^{ABC}$

^{ABCD} *Samples with the same letter within a column, are not significantly different from each other ($p < 0.05$)*

Table 3.3: QDA mean panel data (& stdev) and Tukey's HSD test groupings for taste intensity of 11 blackcurrant samples

Product	Taste			
	Natural sweets	Artificial sweet	Acidic	Bitter
1	40.2 $_{27.4}^{AB}$	0 $_{0}^{C}$	45.7 $_{10.7}^{AB}$	32.2 $_{14.1}^{BC}$
2	3.1 $_{12.4}^{D}$	29.4 $_{27.1}^{AB}$	46.3 $_{9.3}^{AB}$	42.6 $_{14}^{A}$
3	35.9 $_{17}^{AB}$	0.1 $_{0.2}^{C}$	50.6 $_{16.9}^{A}$	42.4 $_{19}^{A}$
4	29 $_{24.1}^{ABC}$	0 $_{0.2}^{C}$	39.6 $_{10.3}^{BC}$	30.2 $_{12.5}^{C}$
5	37.9 $_{20.5}^{AB}$	0.1 $_{0.4}^{C}$	50.9 $_{14.2}^{A}$	37.1 $_{15.3}^{ABC}$
6	18.8 $_{20.4}^{BCD}$	10.2 $_{18.8}^{BC}$	47.5 $_{13.2}^{A}$	37.5 $_{15.6}^{ABC}$
7	41.1 $_{23.5}^{A}$	1.7 $_{9.4}^{C}$	43.9 $_{11.7}^{ABC}$	31 $_{14.1}^{C}$
8	13.2 $_{20.6}^{CD}$	26.6 $_{28.4}^{AB}$	46.9 $_{10.1}^{AB}$	40.6 $_{15.3}^{AB}$
9	39.6 $_{23.2}^{AB}$	1.3 $_{7.1}^{C}$	49.6 $_{12.7}^{A}$	37.3 $_{15.3}^{ABC}$
10	1.6 $_{8.9}^{D}$	42.7 $_{24.8}^{A}$	43.6 $_{11}^{ABC}$	39 $_{11.6}^{ABC}$
11	40 $_{21.6}^{AB}$	0 $_{0}^{C}$	44.3 $_{14}^{ABC}$	31.4 $_{17.4}^{BC}$

[ABCD] *Samples with the same letter within a column, are not significantly different from each other ($p < 0.05$)*

Table 3.4: QDA mean panel data (&stdev) and Tukey's HSD test groupings for aftertaste (flavour) intensity of 11 blackcurrant samples

	Aftertaste (Flavour)							
Product	Natural processed blackcurrant	Confectionary blackcurrant	Fresh blackcurrant	Tomato Ketchup	Catty	Green and Leafy	Earthy	Minty
1	29.1 $_{6.7}^{A}$	9.4 $_{12.5}^{B}$	0 $_{0}^{B}$	0 $_{0}^{B}$	0 $_{0}^{B}$	9.3 $_{11}^{ABCD}$	6.6 $_{9.7}^{B}$	7.3 $_{9.6}^{AB}$
2	26 $_{9.8}^{A}$	7.9 $_{12.3}^{B}$	0 $_{0}^{B}$	0 $_{0}^{B}$	0.1 $_{0.3}^{B}$	4.6 $_{9.2}^{BCD}$	6.1 $_{9.6}^{B}$	11.5 $_{12.3}^{A}$
3	7.3 $_{9.9}^{B}$	0 $_{0.2}^{B}$	29.4 $_{8.7}^{A}$	0 $_{0}^{B}$	1.1 $_{4.5}^{B}$	18.6 $_{7.2}^{A}$	16.5 $_{11.1}^{A}$	2.2 $_{5}^{B}$
4	4.1 $_{9.3}^{B}$	1.4 $_{4.3}^{B}$	0.1 $_{0.4}^{B}$	28.6 $_{8.5}^{A}$	0 $_{0}^{B}$	2.6 $_{8.4}^{D}$	0.8 $_{2.9}^{B}$	0 $_{0.2}^{B}$
5	26.7 $_{11.3}^{A}$	2.4 $_{6.6}^{B}$	1.6 $_{5.4}^{B}$	0.1 $_{0.2}^{B}$	0.6 $_{2.6}^{B}$	13.2 $_{11.5}^{ABC}$	4.8 $_{7.9}^{B}$	3.3 $_{6.1}^{AB}$
6	24.3 $_{10}^{A}$	9.4 $_{10.9}^{B}$	0.4 $_{2.4}^{B}$	0.1 $_{0.2}^{B}$	2.9 $_{7.1}^{B}$	9.6 $_{10.1}^{BCD}$	5.9 $_{7.6}^{B}$	9.1 $_{10.3}^{AB}$
7	27.3 $_{7.4}^{A}$	3.6 $_{7.3}^{B}$	0 $_{0}^{B}$	0 $_{0.2}^{B}$	0 $_{0.2}^{B}$	9.4 $_{8.8}^{ABCD}$	3.8 $_{7.6}^{B}$	5.4 $_{8.5}^{AB}$
8	26.7 $_{7.8}^{A}$	7.2 $_{9.9}^{B}$	0 $_{0}^{B}$	0 $_{0.2}^{B}$	0 $_{0}^{B}$	10.7 $_{11.4}^{ABCD}$	1.1 $_{3.7}^{B}$	6.2 $_{9.4}^{B}$
9	28.3 $_{8.7}^{A}$	6.3 $_{9.8}^{B}$	0 $_{0.2}^{B}$	0 $_{0.2}^{B}$	0.8 $_{3.2}^{B}$	13.9 $_{12.2}^{AB}$	4.8 $_{8.7}^{B}$	7.3 $_{8.6}^{AB}$
10	7.1 $_{12.1}^{B}$	29.5 $_{9.8}^{A}$	0.1 $_{0.2}^{B}$	0.1 $_{0.2}^{B}$	15.3 $_{13.4}^{A}$	4.5 $_{9.5}^{BCD}$	2.7 $_{6.3}^{B}$	8.4 $_{9.1}^{B}$
11	26.9 $_{7.6}^{A}$	1.8 $_{5.7}^{B}$	0 $_{0}^{B}$	0 $_{0}^{B}$	0.1 $_{0.3}^{B}$	13.8 $_{11}^{AB}$	3.9 $_{7.5}^{B}$	4.2 $_{7.3}^{AB}$

^{ABCD} Samples with the same letter within a column, are not significantly different from each other ($p < 0.05$)

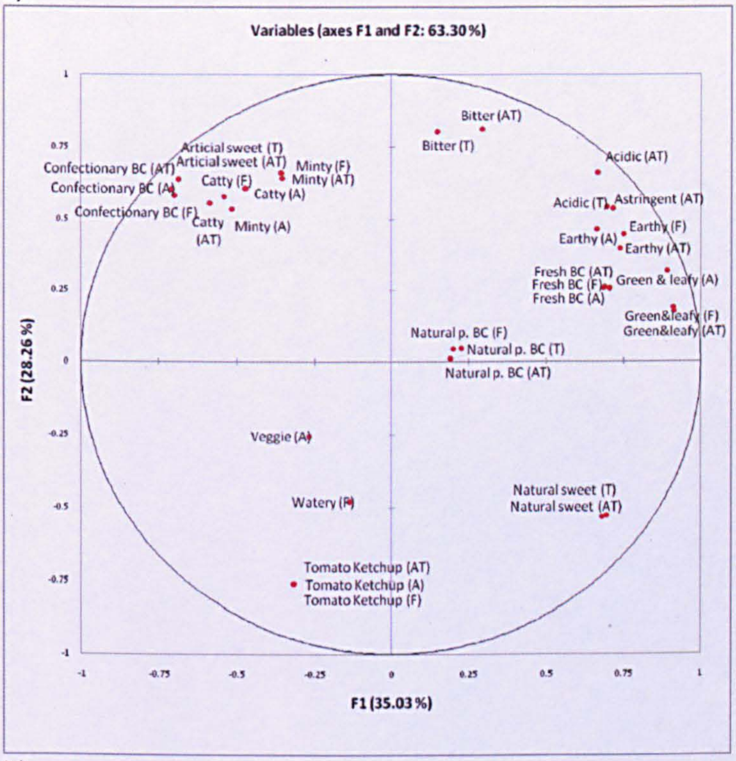
Table 3.5: QDA mean panel data (& stdev) and Tukey's HSD test groupings for aftertaste (taste) intensity of 11 blackcurrant samples

	Aftertaste (Taste)				
Product	Natural sweet	Artificial sweet	Acidic	Bitter	Astringent
1	30.6 $_{22.8}^{AB}$	0 $_{0}^{C}$	41.7 $_{13.2}^{ABC}$	29.2 $_{12.1}^{BCD}$	50.5 $_{10.6}^{BCD}$
2	2 $_{8}^{C}$	26.1 $_{25.5}^{A}$	42.2 $_{13.6}^{ABC}$	35.4 $_{11.4}^{ABC}$	52 $_{10.7}^{ABCD}$
3	29.7 $_{16.5}^{AB}$	0 $_{0}^{C}$	46.5 $_{16.7}^{A}$	39.6 $_{15.3}^{A}$	56.7 $_{16.3}^{A}$
4	23.3 $_{22.8}^{AB}$	0.1 $_{0.3}^{C}$	36.3 $_{13.3}^{CD}$	25.6 $_{14.2}^{D}$	47.9 $_{9.1}^{D}$
5	29.9 $_{19.3}^{AB}$	0 $_{0.2}^{C}$	44.6 $_{14.7}^{AB}$	31.9 $_{12.6}^{ABCD}$	54.9 $_{13.3}^{AB}$
6	16.5 $_{17.1}^{ABC}$	7.3 $_{14.9}^{BC}$	43 $_{12.9}^{AB}$	31.8 $_{11.3}^{ABCD}$	50.8 $_{11.9}^{ABCD}$
7	32.9 $_{21.4}^{A}$	1.6 $_{9.2}^{C}$	40.3 $_{14}^{ABCD}$	28.6 $_{13.5}^{BCD}$	49.3 $_{8.7}^{BCD}$
8	11.2 $_{17.7}^{BC}$	21.5 $_{24.4}^{AB}$	42.7 $_{13.8}^{AB}$	35.9 $_{13.3}^{AB}$	51.5 $_{11.2}^{ABCD}$
9	32.7 $_{21.5}^{A}$	1.2 $_{6.8}^{C}$	43.4 $_{14.8}^{AB}$	31.8 $_{13.4}^{ABCD}$	54.5 $_{14.5}^{ABC}$
10	1.2 $_{5.8}^{C}$	35.6 $_{22.4}^{A}$	40.6 $_{13.8}^{ABCD}$	34.4 $_{12.9}^{ABC}$	51 $_{10.2}^{ABCD}$
11	33.4 $_{20.9}^{A}$	0 $_{0}^{C}$	39 $_{13.8}^{BCD}$	27.9 $_{13.9}^{CD}$	50.5 $_{12.4}^{BCD}$

^{ABCD} *Samples with the same letter within a column, are not significantly different from each other ($p < 0.05$)*

The first three principal components (PCs) of the QDA PCA accounted for 84% of the variance in the data. Figure 3.1 illustrates the correlation circle for PC1 versus PC2 and PC1 versus PC3. PC1 (35%) was positively correlated with 'fresh blackcurrant' (A, F, AT), 'green and leafy' (A, F, AT), 'earthy' (A, F, AT), 'natural sweetness' (Ts, AT), 'acidic' (Ts, AT) and negatively correlated with 'confectionary blackcurrant' (A, F, AT) and 'artificial sweetness' (Ts, AT). PC2 (28.3%) was positively correlated with 'bitter' (Ts, AT), 'minty' (F, AT), 'catty' (A, F, AT) and negatively correlated with 'tomato ketchup' (A, F, AT). PC3 (20.7%) was positively correlated with 'natural processed blackcurrant' (A, F, AT) and negatively correlated with 'watery' (F).

Products 3, 4 and 10 are clearly distinct from each other as well as being notably different from the remaining products. PC1 from the QDA PCA (Figure 3.2a) clearly differentiated between products 10 and 3, especially in terms of the nature of the blackcurrant flavour. Product 10 was characterised by 'confectionary blackcurrant' (A, F, AT) whereas the flavour of product 3 was described as 'fresh blackcurrant' (A, F, AT) and was also accompanied by other complex flavours such as 'green and leafy' (A, F, AT), and 'earthy' (A, F, AT) which were all significantly lacking in product 10. PC1 was also strongly related to the attribute sweetness; AS squashes, i.e. products 1, 3, 4, 5, 7, 9 and 11 were associated with high positive values for 'natural sweetness' (Ts, AT) whereas NAS squashes, i.e. products 2, 6, 8 and 10 were associated with 'artificial sweetness' (Ts, AT). PC2 clearly differentiated between products 4 and 10 on several sensory attributes. Product 4 was significantly different *a)*



b)

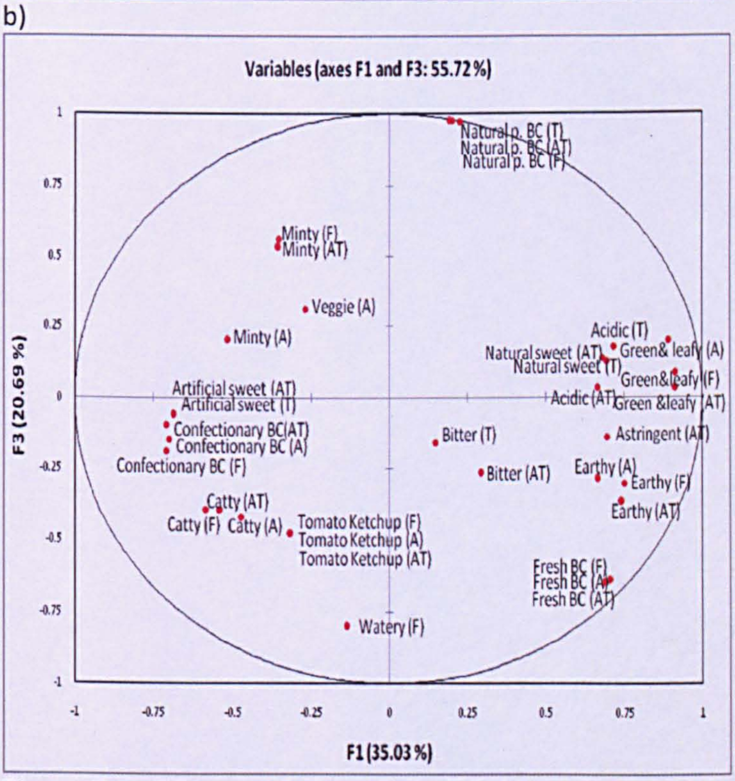


Figure 3.1: PCA correlation circle (a) PC1 versus PC2 and (b) PC1 versus PC3 from mean QDA panel data

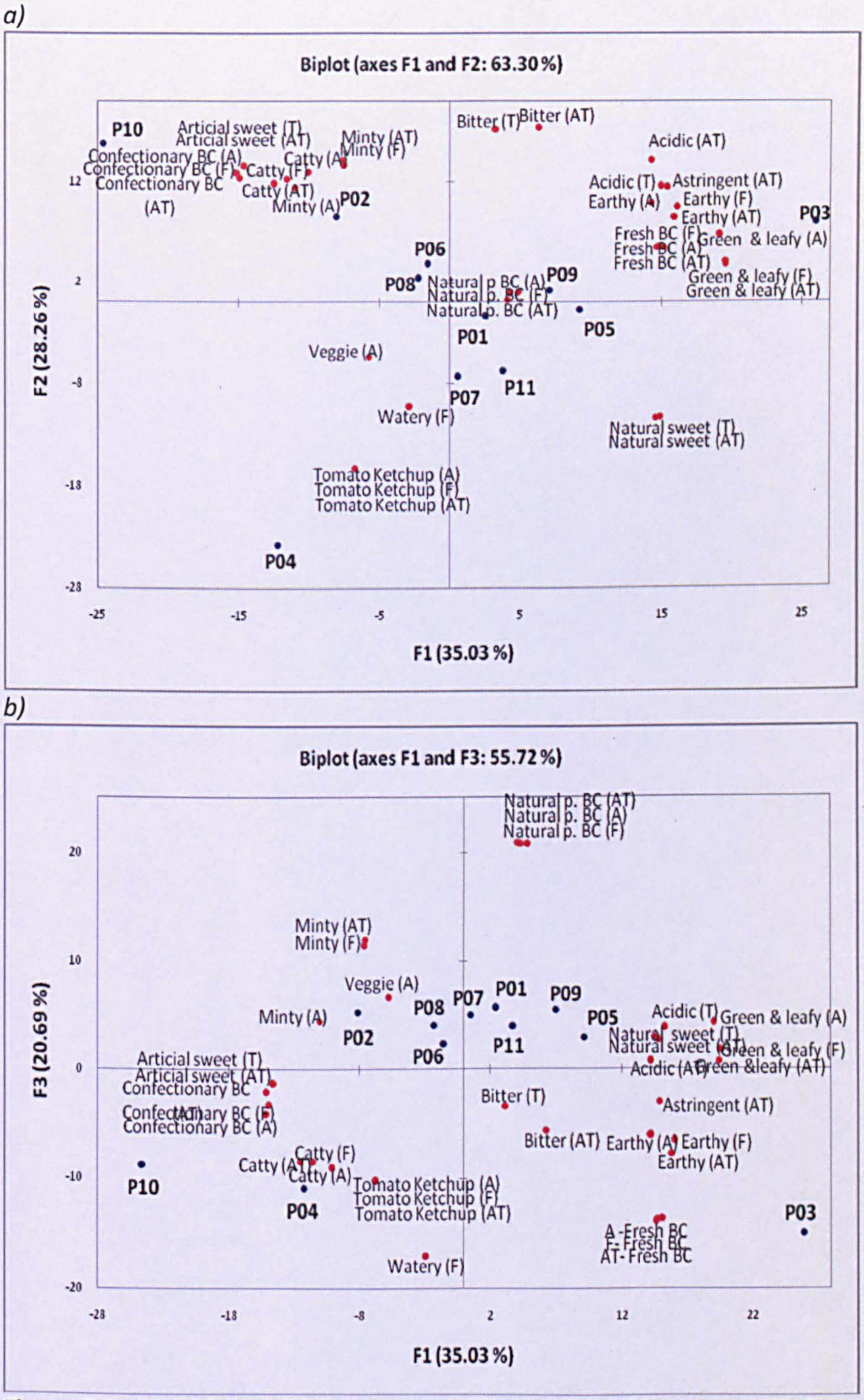


Figure 3.2: PCA biplots (a) PC1 versus PC2 and (b) PC1 versus PC3, from mean QDA panel data

from other products in terms of 'tomato ketchup' (A, F, AT) whereas product 10 was characterised as 'bitter' (Ts, AT) and 'catty' (A, F, AT). The positioning of the 'watery' attribute in Figure 3.2b indicated that PC3 was associated with the level of dilution, together with 'natural processed blackcurrant' attribute. Eight products placed in the middle of the bi-plot (i.e. products 1, 2, 5, 6, 7, 8, 9 and 11) were all characterised by a similar intensity of 'natural processed blackcurrant' (A, F, AT).

3.2.2 Use of QDA to select TDS attribute list

As described in section 2.3.3, the attribute list for TDS was built based on QDA data. The TDS data for the blackcurrant and sweetness attributes were then further interpreted by looking at the QDA to determine the nature of the blackcurrant and sweetness for respective products, e.g. the flavour of product 3 was characterised by 'fresh blackcurrant' and 'natural sweetness' whereas product 6 was characterised by 'natural processed blackcurrant' and 'artificial sweetness'. Table 3.6 lists the mean TDS score for all 12 attributes for each of the 11 products, respectively. ANOVA revealed that for all attributes, significant ($p < 0.05$) product differences were observed. The product groupings indicated by the Tukey's HSD multiple comparison test are also shown in Table 3.6.

Table 3.6: TDS score (& stdev) and Tukey's HSD test groupings for flavour intensity of eleven blackcurrant samples

Product	Flavour					Taste			
	Blackcurrant	Catty	Tomato Ketchup	Earthy	Minty	Sweet	Acidic	Bitter	Astringent
1	$41.5_{8.5}^{AB}$	0_{0}^{C}	0_{0}^{B}	0_{0}^{B}	$6.7_{13.7}^{ABC}$	46.5_{9}^{AB}	$36.6_{17.6}^{ABCD}$	$13.9_{15.3}^{AB}$	$11.3_{22.2}^{BC}$
2	$31.8_{11.7}^{C}$	0_{0}^{C}	0_{0}^{B}	$2.2_{7.3}^{B}$	$11.9_{16.7}^{A}$	$47.7_{12.8}^{A}$	$26_{17.5}^{DEF}$	$17.0_{15.6}^{AB}$	11.9_{22}^{BC}
3	$44.6_{13.4}^{A}$	0_{0}^{C}	0_{0}^{B}	$13.5_{16.3}^{A}$	$0.4_{1.8}^{D}$	21.9_{20}^{D}	$47_{14.9}^{A}$	$23.0_{18.3}^{A}$	$16.9_{24.8}^{A}$
4	$3_{6.8}^{D}$	0_{0}^{C}	$43.6_{10.5}^{A}$	0_{0}^{B}	0_{0}^{D}	$37.8_{18.6}^{C}$	$18.9_{19.8}^{F}$	$12.2_{13.7}^{B}$	$9.6_{19.2}^{C}$
5	$34.2_{8.7}^{C}$	$4.2_{12.7}^{B}$	0_{0}^{B}	$0.7_{3.2}^{B}$	$3.3_{9.3}^{CD}$	$39.9_{9.4}^{BC}$	$40.5_{17.8}^{AB}$	$17.3_{16.2}^{AB}$	$11.5_{22.7}^{BC}$
6	$34.6_{8.4}^{C}$	$4.4_{11.7}^{B}$	0_{0}^{B}	$1.5_{4.8}^{B}$	$5.8_{12.5}^{ABCD}$	$40.2_{11.3}^{BC}$	$38.2_{16.3}^{ABC}$	$18.0_{16.8}^{AB}$	$14.8_{24.1}^{AB}$
7	$32.6_{7.6}^{C}$	0_{0}^{C}	0_{0}^{B}	0_{0}^{B}	$3.7_{8.4}^{CD}$	$45.2_{11.1}^{AB}$	33.3_{19}^{BCDE}	$15.8_{15.0}^{AB}$	$10.9_{21.6}^{C}$
8	$33.6_{12.7}^{C}$	0_{0}^{C}	0_{0}^{B}	0_{0}^{B}	$10.9_{19.7}^{AB}$	$49.6_{13.3}^{A}$	26.8_{18}^{CDEF}	$22.3_{16.3}^{A}$	$11.9_{23.2}^{BC}$
9	$36.5_{6.6}^{BC}$	0_{0}^{C}	0_{0}^{B}	$1.4_{6.9}^{B}$	$9.2_{12.8}^{ABC}$	$43.8_{11.2}^{ABC}$	37.3_{19}^{ABCD}	$16.0_{15.0}^{AB}$	$11.9_{23.4}^{BC}$
10	$30.4_{13.2}^{C}$	$23.7_{17.9}^{A}$	0_{0}^{B}	0_{0}^{B}	5.5_{10}^{BCD}	$44.8_{11.3}^{AB}$	$24_{20.6}^{EF}$	$20.3_{18.1}^{AB}$	$10.8_{21.8}^{C}$
11	$30.8_{8.5}^{C}$	0_{0}^{C}	0_{0}^{B}	0_{0}^{B}	$9.3_{11.9}^{ABC}$	47.9_{11}^{A}	33.9_{16}^{BCDE}	$12.2_{13.9}^{B}$	$11.6_{22.6}^{BC}$

[ABCD] ***Samples with the same letter within a column, are not significantly different from each other ($p < 0.05$)***

The first three PCs of the TDS PCA accounted for 84.3% of the variance in the TDS Score. Figure 3.3 illustrates the correlation circle for PC1 versus PC2 and PC1 versus PC3. PC1 (33.6%) was positively correlated with 'fresh blackcurrant', 'earthy', 'astringent', 'acidic' and 'bitter'. PC2 (29.5%) was positively correlated with 'artificial sweetness', 'catty' and 'confectionary blackcurrant' and negatively correlated with 'natural sweetness'. PC3 (21.2%) was positively correlated with 'natural sweetness'. PC3 (21.2%) was positively correlated with 'natural processed blackcurrant' and 'minty' and negatively correlated with 'tomato ketchup'. The biplot of PC1 versus PC2 (Figure 3.4) separated groups of products into each quadrant, with products 3 and 10 clearly distinct from the others. The biplot of PC3 with PC1 further separated product 4 from the large group of remaining products.

3.2.3 Comparison of QDA an TDS score results

A visual inspection of both bi-plots for TDS and QDA (Figure 3.2 and Figure 3.4) indicated that product positioning is similar for both methods. Products 3, 4 and 10 are separated from the rest of the products on each PCA in terms of the differing nature of the blackcurrant flavour: product 3 was described as 'fresh blackcurrant' whereas product 10 as 'confectionary blackcurrant'; and/or additional flavours: 'earthy' (product 3), 'tomato ketchup' (product 4) and 'catty' (product 10). Product 2, 6 and 8 are also positioned together on both plots. The remaining products, i.e. products 1, 5, 7, 9 and 11, tend to congregate together in the middle part of both plots. This similarity is confirmed by a high RV coefficient of 0.8 between the two data matrices.

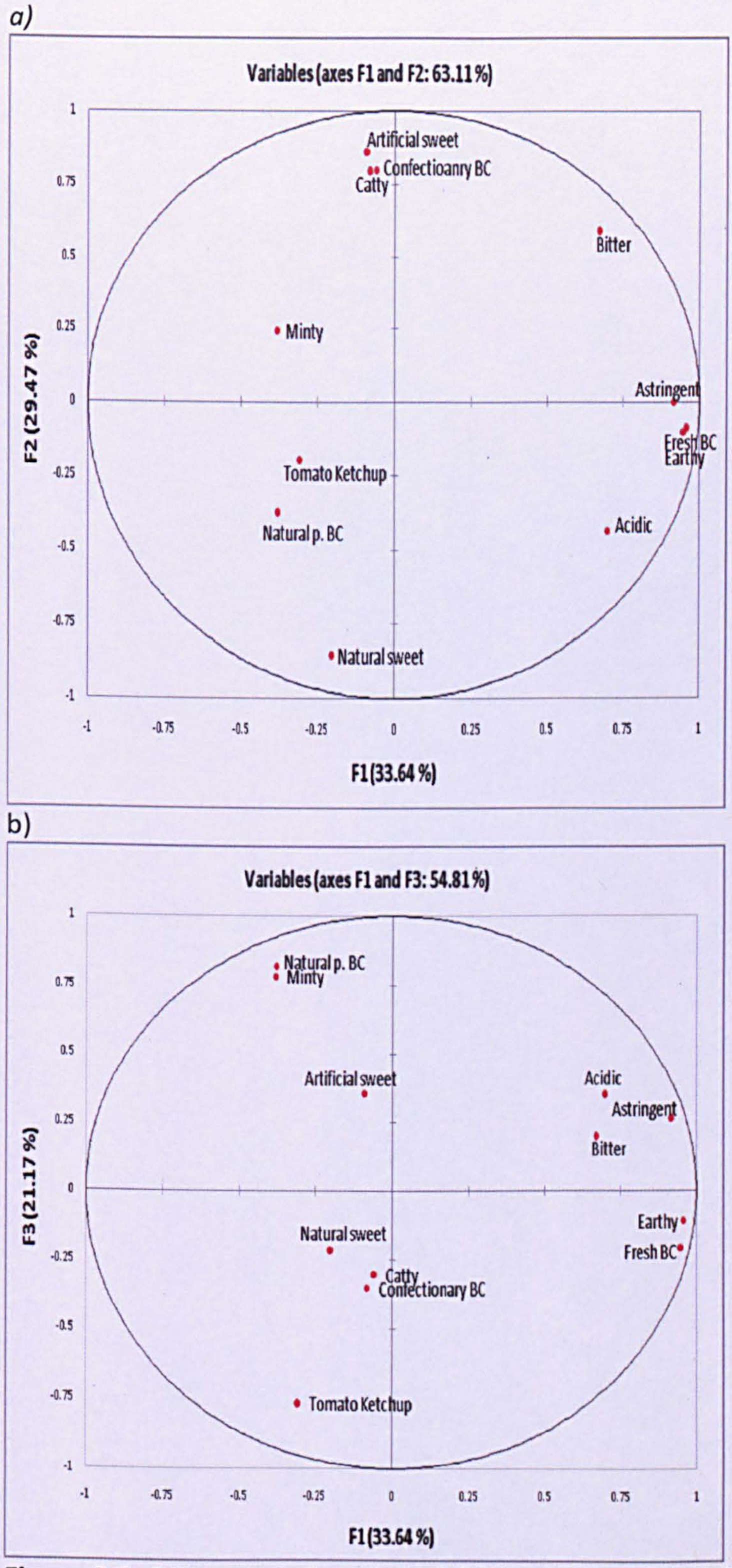
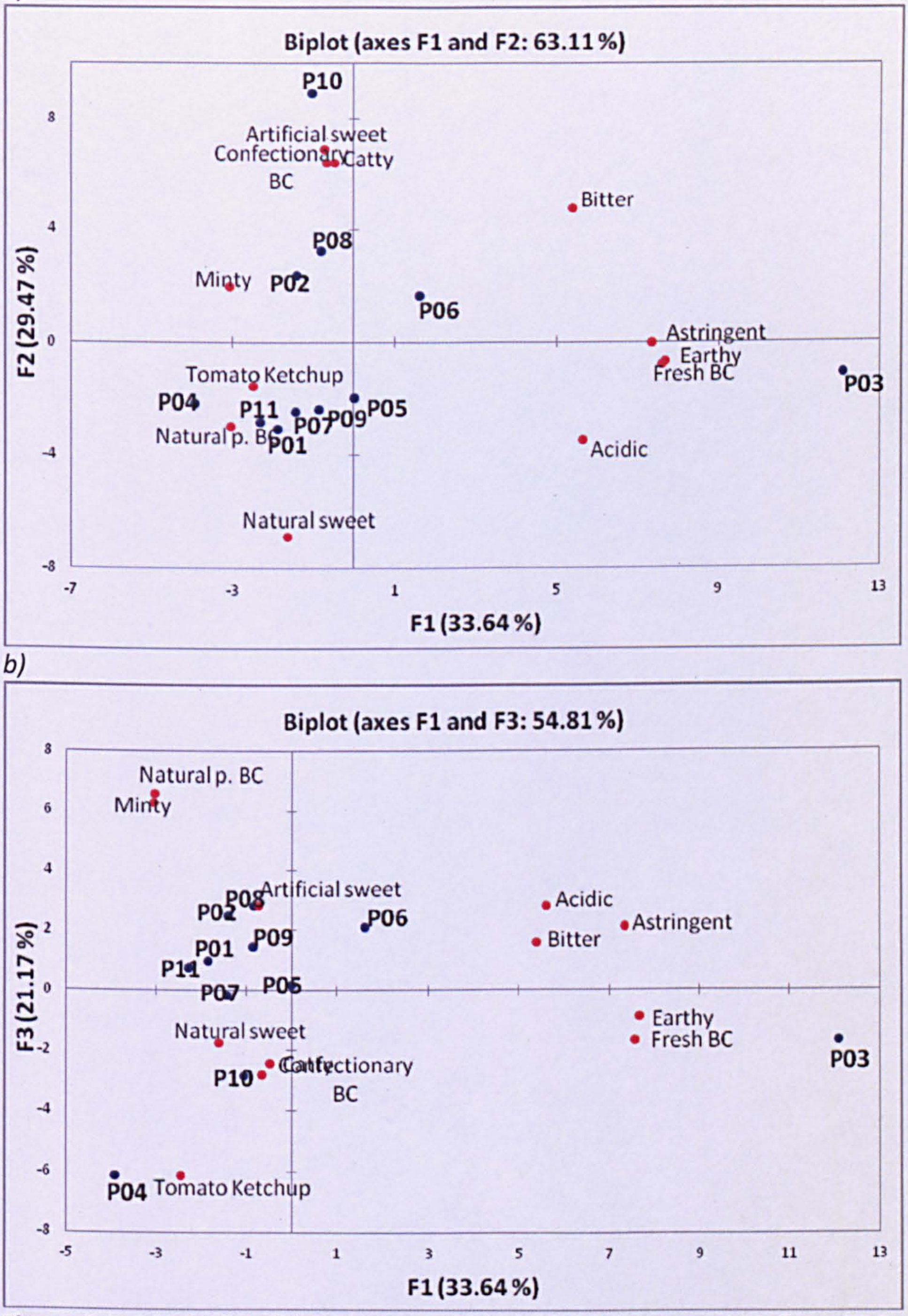


Figure 3.3: PCA correlation circle (a) PC1 versus PC2 and (b) PC1 versus PC3 from mean TDS score data

a)



b)

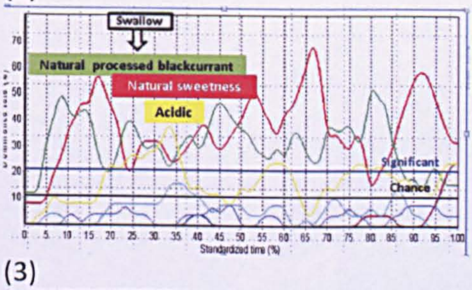
Figure 3.4: PCA biplots (a) PC1 versus PC2 and (b) PC1 versus PC3, from TDS score data

3.2.4 Additional temporal information obtained by TDS

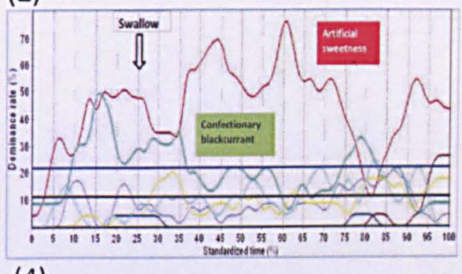
Unlike QDA, TDS provided dominance curves which are used to illustrate the temporal changes of dominant attributes during and after the drinking process. Figure 3.5 illustrates the standardised TDS dominance curves for each product. Each curve represents the evolution of the dominance rate of an attribute over standardised time (%). Data need to be standardised as the duration can vary between products, assessors and replications, which can imply a different number of time points for each evaluation (Meyners and Pineau, 2010). In order to facilitate the interpretation of TDS curves, two other additional lines (chance and significance) are displayed on each TDS graph. The 'chance line' represents the dominance rate that an attribute can be obtained by chance; its value P_0 is equal to 1/p, where p being the number of attributes (Pineau et al., 2009). The 'significance line' represents the minimum value this proportion should equal to be considered as significantly higher than P_0. According to Pineau et al (2009), the value is calculated using the confidence interval of a binomial proportion based on a normal approximation (Equation 2):

Equation 2: $$P_s = P_0 + 1.645\sqrt{\frac{P_0(1-P_0)}{n}}$$

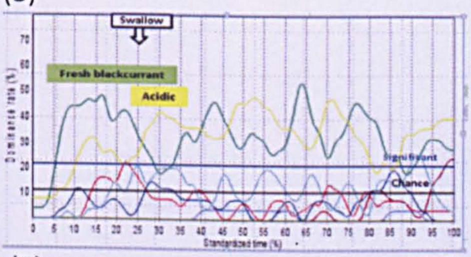
(1)



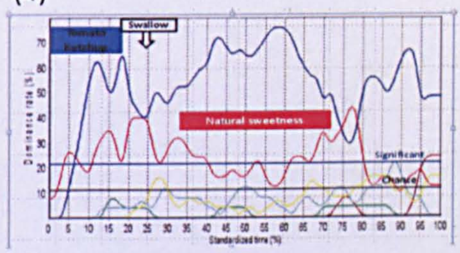
(2)



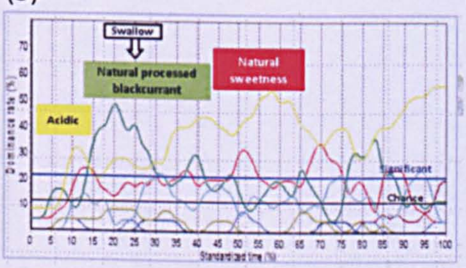
(3)



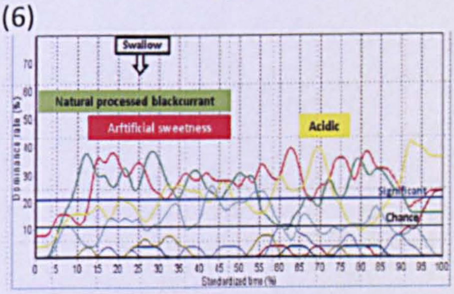
(4)



(5)



(6)



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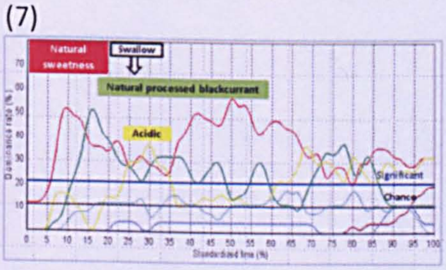

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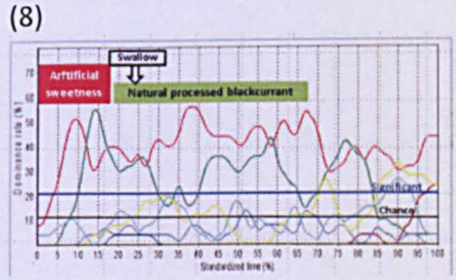
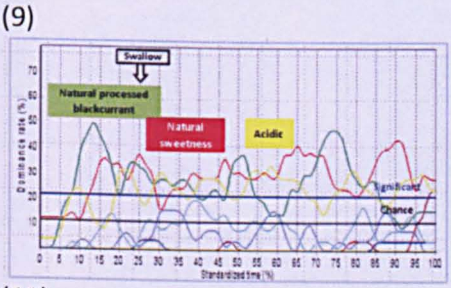
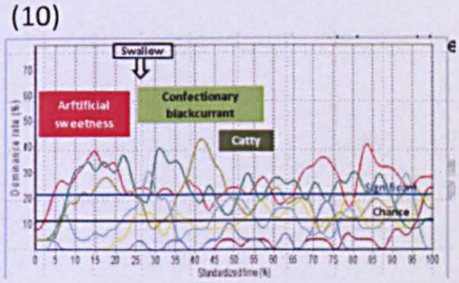


(9)



(10)



(11)

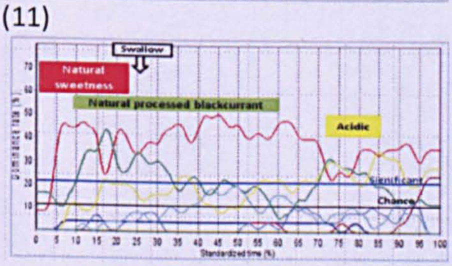


Figure 3.5 Standardised TDS curves of dominance rate (i.e. proportion of subjects scoring each attribute) versus standardised time (%) for products 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and 11

The following gives an example of how TDS curves can be interpreted. For product 1, 'natural processed blackcurrant' was perceived as being the first dominant sensation (for 50% of the panel) at 8% of standardised time (Stdtime), and this is whilst panellists were still holding the product in their mouths. This dominance rate is higher than the 'significance level', so there is a significant consensus of the panel in perceiving 'natural processed blackcurrant' as the first dominant sensation at the beginning of the product evaluation. However, it is important to note that more than one attribute could be considered dominant at a particular time point. The sequence of dominant sensations for product 1 were then subsequently 'natural sweetness' (from 15% to 20% of Stdtime, with maximum dominance rate of about 58% at 18% of Stdtime), then 'natural processed blackcurrant' (at 25% Stdtime when the panellists were swallowing the products, with a dominance rate of about 40%). After swallowing the product, the first perceived dominant sensation was 'acidic' (at 34% of Stdtime, with a dominance rate of about 38%), followed by 'natural processed blackcurrant' (at 45% of Stdtime, with a dominance rate of about 45%), 'natural sweetness' (from 50% to 70% of Stdtime, with a maximum dominance rate of about 70% at 65% of Stdtime), 'natural processed blackcurrant' (from 70% to 85% of Stdtime, with a maximum dominance rate of about 50% at 80% of Stdtime) and finally 'natural sweetness' (from 85% to 100% of Stdtime, with maximum dominance rate of about 60% at 92% of Stdtime). It is important to note that TDS dominance curves are not related to intensity but to the number of times an attribute has been cited as being a dominant sensation at a given time. The

TDS curves (Figure 3.5) highlight differences in the sequence of dominant sensations. For example, product 1 was dominated by 'natural processed blackcurrant', then 'natural sweetness' and then 'acidic'. However, product 7 was dominated initially by 'natural sweetness' followed by 'natural processed blackcurrant'. Product 4 was continuously dominated by 'tomato ketchup' with 'natural sweetness' also dominating towards the beginning and end of the assessment.

TDS dominance curves highlighted that 'fresh blackcurrant' and 'acidic' sensations were equally dominant for product 3 (Figure 3.5) whereas 'tomato ketchup' sensation was dominant throughout the whole drinking process for product 4 (Figure 3.5). On the other hand, products which contained more ingredients (see Table 2.2) were equally dominated by sensations related to blackcurrant and sweetness. For example, 'natural processed blackcurrant' was found as dominant as 'natural sweetness' for AS squashes, i.e. products 1, 7, 8 and 11 except for product 5 which was mainly dominated by 'acidic' sensation in aftertaste (Figure 3.5). NAS squashes, i.e. products 6 and 8, were equally dominated by 'natural processed blackcurrant' and 'artificial sweetness' whereas product 10 was equally dominated by 'confectionary blackcurrant' and 'artificial' sensations. Product 2, however, was mainly dominated by 'artificial sweetness', especially in the aftertaste.

3.3 Discussion

3.3.1 Sensory properties (QDA) of blackcurrant squash in relation to product composition

It is important to note that as this study assessed commercial products (not model system), we can only draw upon a few factors that might affect sensory attributes of blackcurrant squashes based on the results that were obtained. The flavour profile of blackcurrant squash was primarily influenced by the level of dilution, product composition, or the complexity of composition, although other factors like blackcurrant varieties could also be responsible. Complex products, with a mid range of blackcurrant juice content made up using a dilution ratio of 1:5 (see Table 2.2 for product composition after dilution) were characterised by 'natural processed blackcurrant'. However, when complex composition was combined with low blackcurrant juice (0.4% per 50ml serving), the flavour profile was more 'confectionary blackcurrant'. Products with a higher level of blackcurrant juice were generally perceived as more 'bitter' and 'astringent' as well as 'acidic'. Phenolic compounds remain in berry skin-rich press residue and are thought to contribute to astringency and bitter taste (Sandell et al., 2009). When high blackcurrant juice was combined with a simple ingredient composition other flavours such as 'fresh blackcurrant', 'green and leafy' and 'earthy' became apparent; and this was observed in product 3.

Baldwin and Korschgen (1979) reported that aspartame sweetened products had a significantly higher fruit-flavour intensity than equally sweet products sweetened with sucrose. However, this study shows no significant difference between AS and NAS squashes in terms of flavour suggesting a consistent enhancement of fruitiness by both sugars and artificial sweeteners in a complex beverage. However, artificial sweeteners in NAS squashes were found to modify the quality of sweetness and could also contribute to bitter notes. Even though some bitterness may come from artificial sweeteners (Wiet and Beyts, 1992), bitter components in the blackcurrant will also contribute to this attribute and may account for the observed overlap, suggesting that the type of sweetener modified the nature of the sweetness, and potentially blackcurrant, in the beverage. Although products containing a high juice to sugar ratio received high scores for acidity, there were no notable differences in acidity perception across the products and no correlation between pH and acidity score. In other words, perception of acidity was dependent on the ratio of blackcurrant juice and sugar content instead of pH level.

3.3.2 Developing the TDS attribute list

As TDS only enables a limited number of attributes to be assessed, it is crucial to select attributes that are salient for the product of interest. Meillon et al. (2009) selected attributes based on the number of citations made by the panel during discussion for TDS evaluation, but the present study has proposed an alternative way based on data obtained from previous QDA studies.

Selecting attributes for TDS using the initial QDA profile enabled meaningful product descriptions to be obtained from TDS data. Furthermore, QDA data enabled additional differentiation of some attributes on the TDS list, e.g. sweetness and blackcurrant flavour, without having to extend it to an unmanageable length. The number of attributes included for TDS could still be seen as a limitation, although only a small number of attributes can be mentally computed during the time available, probably no more than 10. In this study, some attributes had to be deleted and in this case it was those attributes that appeared least discriminating in the QDA, and which the panel did not originally feel were important temporally. Different blackcurrant and sweetness attributes were reduced to single attributes, thus loosing the added information on the nature of the attributes gained from QDA (also see section 2.3.3).

QDA enabled attributes to be separated according to different stages, e.g. attributes before, during and after consumption. Although not used in this study, it is suggested that for TDS to accomplish this, adjustments could be made to the data collection process. It could be split into stages e.g. before consumption, in mouth and aftertaste, each with its own separate and relevant TDS attribute list. In this study, TDS started with the product in mouth and so appearance and aroma attributes were ignored. Consequently, and not unexpectedly, the sensory characterisation of the products provided by TDS was not as detailed and comprehensive as QDA. For example, TDS did not include aroma and separate aftertaste characteristics and it was unable to record additional attributes, e.g. 'green and leafy', which discriminated between the products using QDA. A split stage approach could have included a pre consumption and/or aftertaste TDS assessment.

3.3.3 Comparing results (mean intensities) from QDA and TDS

The TDS score is a measure of attribute intensity that can be compared to that obtained for the same attribute from QDA studies. Interestingly, TDS scores were more discriminating for some attributes, for example, TDS pulled out products 5, 6 and 10 as being significantly more 'catty' (Table 3.6), whereas QDA only discriminated product 10 from the rest (Table 3.2). However, QDA discriminated products 2 and 3 from the remainder regarding earthiness, whereas TDS only picked out product 3. It is possible that where an attribute has particular temporal dominance, TDS is more able to show differences in that attribute intensity but additional research would be required to test this further. This study shows that neither method is more discriminating, QDA simply allows for more attributes to be investigated.

The RV coefficient comparing the QDA and TDS data matrices for PCA indicated considerable agreement and, in both, the first 3 PCs accounted for around 84% of variation (Figure 3.1 and Figure 3.3). Clearly fewer attributes were available to the TDS PCA, and looking closely at the principal components some other differences were evident. For QDA, PC1 was correlated with 'fresh blackcurrant', 'earthy', and 'acidic' and opposing sweetness attributes (Figure 3.1a). For TDS, PC1 still correlated with 'fresh blackcurrant', 'earthy' and 'acidic', but also with 'astringent' and 'bitter'. The sweetness attributes moved to PC2 (Figure 3.3a). Although interpretation of the bi-plots yielded slightly different observations, each provided very similar findings in terms of product groupings. This suggests quite strongly that TDS measures of dominant attribute intensity reflect those provided by QDA, as was also concluded by Labbe et al. (2009).

3.3.4 Relating TDS data to product composition

In time-intensity studies, aspartame sweetened beverages have been found to have longer sweetness and fruitiness durations than sucrose samples (Larsonpowers and Pangborn, 1978; Matysiak and Noble, 1991). This study showed no significant difference in durations of sweetness and fruitiness between AS and NAS products. QDA data showed no correlation between sweetness and fruitiness (blackcurrant) (r=0.3) and confirmed that the two attributes were independent. Temporal changes of dominance related to sweetness and fruitiness seemed to be affected by the complexity of ingredient composition combined with blackcurrant juice content rather than the type of sweetener. Samples with complex sample composition were dominated by sweetness, and for longer, whereas samples with less complex composition were dominated by fruit flavour, suggesting that fruit flavour became more dominant when ingredients such as flavourings, acid and preservatives were removed.

Some scholars reported no observed difference in the temporal perception of acidity between aspartame and sucrose sweetened products at any acid level (Bonnans and Noble, 1993). However, this study showed that temporal perception of acidity was more dominant, and longer, for AS squashes than NAS squashes at similar blackcurrant juice content. The ratio of blackcurrant juice content and sugar also seemed to affect the dominance of acidity in AS squashes (naturally sweetened products). Acidity was mainly found as a dominant sensation in products with high juice and low sugar content as illustrated by products 3 and 5 (Figure 3.5). In addition, TDS dominance curves also showed that when acidity became dominant, sweetness became less dominant, providing evidence that sweetness and sourness were mutually suppressive in this product set and this has also been shown in many other studies (Schifferstein and Frijters, 1990; Schifferstein and Frijters, 1991).

3.3.5 Relative merits of QDA and TDS

An obvious merit of TDS was the temporal information it provided differentiating products which shared similar sensory attributes. For example, whilst QDA grouped products 1, 2, 5, 6, 7, 8, 9, 11 together, TDS was able to highlight that products 1, 6 & 9 started with a dominance of blackcurrant, then sweetness, whereas products 7, 8 & 11 started with a dominance of sweetness, then blackcurrant (data before swallowing). This study supports previous findings (Labbe et al., 2009; Meillon et al., 2009) underlining the drawback of QDA in estimating the qualitative changes of dominant sensations during and after product consumption. For example, AS squashes, i.e. products 1, 7, 9 and 11 were scored higher in intensity for acidity than sweetness with QDA but such scales are not comparable in terms of intensity and as such it would not be possible to determine which attribute was dominant. TDS clearly identified that sweetness dominated, not acidity.

TDS dominance curves identified when attributes became dominant and how long they were dominant for. For example, product 10 was characterised by its unique 'catty' note in QDA, but TDS showed catty only became dominant as an aftertaste (Figure 3.5). In addition, AS squashes, i.e. products 1, 7, 9 and 11 scored high in acidity intensity, but were found to be dominated by sweetness rather than acidity with TDS. This illustrates that the concept of dominance is independent of the concept of intensity, which is in line with previous studies ((Labbe et al., 2009; Meillon et al., 2009).

One aspect of originality in this work was basing attribute selection for TDS on QDA data. TDS cannot replace QDA completely since a QDA study, or similar, has to be done prior to TDS. Unlike TDS, QDA allowed more attributes to be investigated. For example, whilst TDS highlighted that product 3 was mainly dominated by 'fresh blackcurrant' and 'acidic', QDA identified other complex flavours such as 'veggie' 'green and leafy' and 'earthy', which may contribute to product acceptability and differentiation and TDS did not capture this.

Panellists need to be highly motivated and focused for TDS measurement as it requires the panellist to concentrate constantly over the given timescale and select and rate attributes simultaneously. If the panel are not familiar with the product category, considerable time will still need investing in defining attributes and training the panel to rate them. However, once a panel is trained on the attributes through QDA, TDS methodology was quickly learned and adapted; it was also relatively quick to perform and provided data with added value.

Although QDA and TDS methodologies were shown to provide both qualitative and quantitative information, they are designed to satisfy different needs. QDA aims to describe and quantify the intensity of a larger number of attributes, whereas TDS illustrates the temporal sequence of dominant sensations. As QDA allows more attributes to be investigated, it remains important in the product development context. TDS should not be viewed as a potential equivalent or replacer to QDA, but a method dedicated to meet other objectives such as understanding temporal pattern of dominant attribute which then be used to relate to certain food experience or emotion (e.g. thirst quenching, refreshing or happy etc). In fact, if QDA and TDS are used together as complementary techniques, they can provide a more rounded sensory profile.

3.4 Conclusion

Using QDA and TDS in tandem was shown to be more beneficial than each method on its own. For example, mean intensities provided by QDA could not be used to predict the dominant sensations as well as their temporal changes. Nevertheless, TDS only enabled the evaluation of a limited number of attributes and so cannot replace QDA completely as subtle, less dominant, attributes may also contribute to product differentiation. The study indicates that combining the two methods in a sequential approach can be used in a commercial context and, more importantly, enables a fuller profile of the product category to be obtained.

4 Emotion (and liking) measurement using EsSense Profile

4.1 Introduction

This chapter turns to emotion research and discusses the application of the EsSense Profile method (King and Meiselman, 2010) in measuring consumers' liking and emotional responses. As discussed in chapter 1, some scholars have highlighted that hedonic measurement alone is no longer adequate to measure and understand consumer affective product experience (Desmet and Schifferstein, 2008a; King and Meiselman, 2010; Koster, 2009), therefore different methods have been proposed to measure emotions in the sensory and consumer science arena (see section 1.2.3). EsSense Profile was a method recently developed by King and Meiselman (2010) that incorporated both overall acceptability and emotion measures. EsSense Profile was validated using different food categories for its discriminating power, but little data is available in the current literature to understand its application in a commercial context within a single product category.

Schifferstein et al. (2013) have proposed that during various stages of user-product interactions (from choosing a product on a supermarket shelf to consuming food), different sensory modalities may be important and different emotional responses may be elicited. For example, vision was the most important sensory modality at the buying stage; smell was important at the cooking stage; and finally taste was important at consumption stage. Many factors might have affected emotions; some are intrinsic sensory attributes, e.g. flavour, aroma or texture, whilst others are extrinsic product characteristics, e.g. packaging material, information on brand name or price. In addition, the level of expectations and concerns held at the moment of product packaging appraisal also contribute to the formation of emotions (Lundahl, 2012). Extrinsic packaging cues such as the packaging itself, nutritional information, price, and labeling generate consumer expectation (Dransfield et al., 1998; Guinard and Marty, 1997; Guinard et al., 2001; Tuorila et al., 1998), and if these expectations are not subsequently met by the sensory delivery of the product, consumer disconfirmation may occur (Deliza and MacFie, 1996; Murray and Delahunty, 2000). Disconfirmation of expectations is defined as '*any mismatch between the expected and the actual product performance*' (Deliza et al., 1996). Post-trial product performance can be perceived as better (positive disconfirmation) or worse (negative disconfirmation) than expected (Deliza et al., 1996). Disconfirmation of expectations may influence product quality perception through four mechanisms, namely: (a) assimilation (ratings move towards expectations); (b) contrast (ratings move away from expectations); (c) generalised negativity (ratings diminished under any and all conditions of disconfirmation), and (d) assimilation-contrast (when the level of disconfirmation is low, an assimilation effect occurs; and when there is a high disconfirmation, a contrast effect occurs) (Deliza and MacFie, 1996). If a consumer's expectation is confirmed by his or her expected sensory attributes, the consumer would likely to repeat product purchase, otherwise the consumer will probably not buy the product again (Deliza and MacFie, 1996). Therefore, it is important for manufacturers to design packaging that not only attracts consumers to purchase the product, but also ably conveys sensory and hedonic expectations, as well as emotions, that are derived from brand and packaging.

Up until now, however, little data is available to understand how product sensory attributes or packaging cues affect consumers' emotional responses; and how that in turn affects their expectations and overall liking responses. The main objectives of this study were to: (i) apply EsSense Profile to measure liking and emotion on commercial products within the blackcurrant squash category, (ii) measure how liking and emotional responses change across blind, pack and informed conditions; and (iii) explore whether packaging influence the informed condition liking and emotion mean scores through comparison with those from the blind condition.

4.2 Results

4.2.1 Blind, expected (from package) and informed liking mean scores

Significant differences were observed in consumers' overall liking scores for the products across all conditions, i.e. blind, pack and informed ($p < 0.005$) (Table 4.1). However, more overlapping product groupings were observed in informed condition than in the other two (i.e. blind and pack). In general, when tastings were involved, whether it was in the blind or informed condition, the 'liked' products corresponded to standard AS squashes, all scoring for above 'six' ('like slightly') whereas the 'disliked' products were generally corresponded to niche AS products and all NAS products, all scoring

Table 4.1: EsSense Profile: Blind (B), expected (E) and informed (I) mean liking scores of products evaluated under blind, pack and informed conditions by consumers, together with differences (M) and corresponding probabilities (*P*) between mean ratings tested through Student's t-tests (n=100)

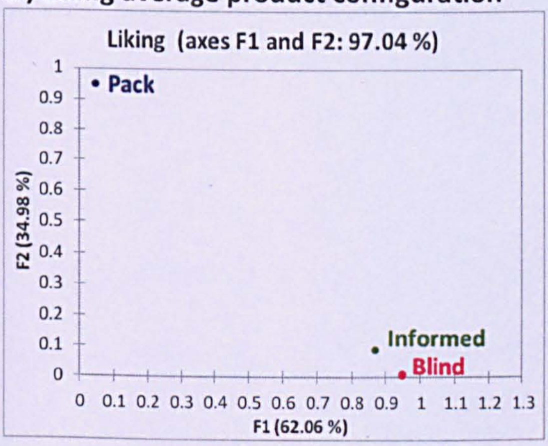
				E-B		I-B		I-E	
	B	E	I	M	*P*	M	*P*	M	P
P1	6.3^{ABC}	5.3^{CD}	6.2^{BC}	- 1	0.001	-0.1	0.785	0.9	0.001
P2	6.0^{ABCD}	7.0^{B}	5.5^{CDEFG}	1	0	-0.5	0.052	-	-
P3	4.3^{FG}	7.9^{A}	5.3^{DEFG}	3.6	< 0.0001	1	0	-2.6	<0.0001
P4	4.1^{G}	7.0^{B}	4.6^{G}	2.9	< 0.0001	0.5	0.059	-2.4	<0.0001
P5	5.9^{BCD}	5.7^{C}	5.7^{BCDE}	- 0.2	0.365	-0.2	0.299	-	-
P6	5.5^{CDE}	5.5^{C}	5.0^{EFG}	0	1	-0.5	0.082	-	-
P7	6.7^{AB}	5.2^{CD}	6.1^{BCD}	- 1.5	< 0.0001	-0.6	0.012	0.9	0.001
P8	5.3^{DE}	5.3^{CD}	5.5^{BCDEF}	0	0.862	0.2	0.453	-	-
P9	6.5^{AB}	5.4^{C}	6.4^{AB}	- 1.1	< 0.0001	-0.1	0.714	1	<0.0001
P10	5.0^{EF}	4.7^{D}	4.7^{FG}	- 0.3	0.316	-0.3	0.418	-	-
P11	6.8^{A}	7.4^{AB}	7.1^{A}	0.6	0.011	0.3	0.212	- 0.3	0.177

I-B denotes Informed minus blind liking scores; E-B denotes expected minus blind liking scores; I-E denotes informed minus expected liking scores
Student t-tests (p < 0.05) for I-E scores were only calculated for assimilated products (I-B)/(E-B) > 0.
[ABCDEFG] Products with the same letter code, within a column, are not significantly different (p < 0.005)

'five' ('neither like nor dislike') or below (also see Table 2.1 for product description). On the other hand, as illustrated in Table 4.1, products were ranked differently in the pack condition compared to blind and informed conditions; the 'liked' products corresponded to private label products (products 2, 3, 4, and 11) which all scored expected liking scores above 'seven' ('like moderately'). This includes those from the niche market (products 3 and 4) that scored low for liking during blind and informed conditions.

In addition, as mentioned in section 2.6.4, Student's t-tests were performed to compare expected and blind liking scores (E-B) (Table 4.1) (Villegas et al., 2008). Significant t-tests revealed that a disconfirmation occurred in all products except for products 5, 6, 8 and 10 ($p < 0.05$). Student t-tests were also performed to compare liking scores between Informed and conditions (I-B) for each product. Significant differences revealed a significant effect of packaging on informed liking scores in products 7 ($p \leq 0.05$). A contrast effect is revealed when (I-B)/(E-B) below zero and an assimilation effect revealed when (I-B)/(E-B) above zero. When assimilation was detected, student t-tests were performed to compare informed and expected liking scores (I-E); significant differences were observed for products 1, 3, 4, 7 and 9, but not product 11. No significant difference indicated the assimilation effect was *complete* for product 11 whereas significant difference indicated that the assimilation effect was not *complete* for products 1, 3, 4, 7 and 9 (where the informed liking score was located between the blind liking score and the expected liking score). In other words, both sensory attributes and packaging cues had impact on the informed liking scores for these products. Nevertheless, the informed liking scores for these products were generally closer to their blind liking scores than expected liking scores, suggesting that the sensory attributes played a more important role than packaging cues. Indeed, the average product configuration of the 11 product determined by sensory attributes of the products (blind condition) was closely aligned with the average product configuration determined by the informed condition (Figure 4.1a). This can also be confirmed by a high RV coefficient of 0.7.

a.) Liking average product configuration



b.) Emotional average product configuration

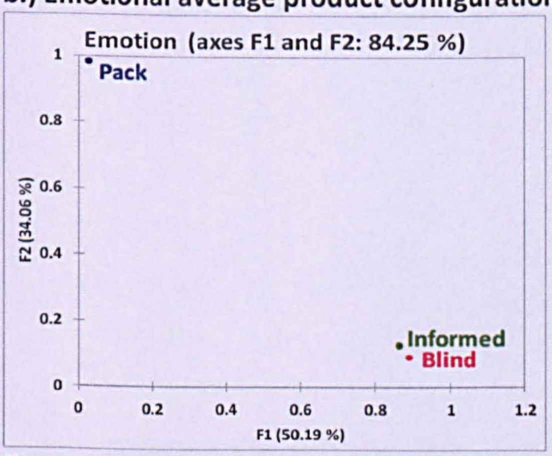


Figure 4.1: EsSense Profile: Representation of average product configuration of 11 products under three conditions considered in the first two dimensions for: a.) liking and b.) emotional (n=100)

4.2.2 Blind, pack and informed emotion mean scores

ANOVA revealed that of the 39 emotions (also see Table 2.4 for the full emotion list), significant product differences were observed for 33, 35 and 31 emotions in blind, pack and informed conditions respectively ($p \leq 0.05$). Table 4.2, Table 4.3 and Table 4.4 list the mean scores for each product for the discriminating emotion terms for blind, pack and informed conditions, respectively. Product groupings are also indicated by the Tukey's HSD multiple comparison tests. Some emotion terms did not appear to discriminate products under any of the three conditions and this included 'aggressive', 'guilty' and 'mild'. Other non-discriminating emotion terms, however included: 'nostalgic', 'quiet' and 'wild' in blind condition; and 'tame' in pack condition; 'calm', 'quiet', 'tame', 'tender', and 'wild' in informed condition. The product groupings indicated by the Tukey's HSD multiple comparison tests showed that particular emotions were very discriminating across blind, pack and informed conditions, e.g. 'adventurous', 'disgusted', 'eager', 'enthusiastic', 'good', 'interested', 'joyful', 'pleasant', and 'satisfied'; all had several distinct subgroups of products.

Table 4.2: EsSense Profile: Mean scores (Tukey's HSD multiple comparison tests) for discriminating positive^{+}, negative^{-}, unclassified^{u} emotions across products in blind condition (n=100)

	Products										
Emotions	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11
Active^{+}	2.6^{CD}	2.3^{BCD}	1.9^{A}	1.8^{A}	2.4^{BCD}	2.2^{AB}	2.6^{D}	2.4^{BCD}	2.7^{D}	2.2^{ABC}	2.6^{CD}
Adventurous^{+}	2.3^{BCD}	2.1^{ABC}	1.9^{A}	1.8^{A}	2.2^{ABCD}	2.0^{AB}	2.2^{ABCD}	2.2^{ABCD}	2.5^{D}	1.9^{AB}	2.4^{CD}
Affectionate^{+}	2.4^{D}	2.1^{ABCD}	1.7^{A}	1.7^{A}	2.0^{ABC}	1.9^{AB}	2.2^{BCD}	2.1^{ABCD}	2.3^{CD}	1.9^{AB}	2.3^{CD}
Bored^{-}	1.6^{AB}	1.6^{AB}	1.8^{BC}	2.0^{C}	1.7^{ABC}	1.8^{ABC}	1.5^{AB}	1.5^{AB}	1.5^{AB}	1.8^{BC}	1.4^{A}
Calm^{+}	2.3^{AB}	2.4^{B}	2.0^{A}	2.1^{AB}	2.2^{AB}	2.3^{AB}	2.4^{AB}	2.1^{AB}	2.2^{AB}	2.2^{AB}	2.4^{B}
Daring^{u}	1.0^{AB}	1.7^{A}	1.7^{A}	1.7^{AB}	1.7^{AB}	1.8^{AB}	1.9^{AB}	2.0^{AB}	2.0^{AB}	1.8^{AB}	2.0^{B}
Disgusted^{-}	1.5^{ABC}	1.5^{ABC}	2.2^{DE}	2.3^{E}	1.4^{ABC}	1.7^{BC}	1.3^{AB}	1.8^{CD}	1.4^{ABC}	1.8^{CD}	1.3^{A}
Eager^{u}	2.3^{BCD}	2.2^{BCD}	1.8^{A}	1.8^{A}	$2.^{ABCD}$	2.0^{AB}	2.3^{CD}	2.0^{ABC}	2.3^{BCD}	2.0^{AB}	2.4^{D}
Energetic^{+}	2.6^{C}	2.4^{BC}	1.9^{A}	1.8^{A}	2.3^{BC}	2.3^{BC}	2.6^{C}	2.3^{BC}	2.6^{C}	2.1^{AB}	2.7^{C}
Enthusiastic^{+}	2.7^{EF}	2.4^{CDE}	1.9^{AB}	1.9^{A}	2.3^{ABCD}	2.4^{CDEF}	2.6^{DEF}	2.3^{CDE}	2.6^{DEF}	2.1^{ABC}	2.8^{F}
Free^{+}	2.4^{BC}	2.4^{BC}	1.9^{A}	2.0^{A}	2.2^{AB}	2.1^{AB}	2.4^{BC}	2.2^{AB}	2.4^{BC}	2.1^{AB}	2.6^{C}
Friendly^{+}	2.8^{D}	2.6^{ABC}	2.0^{A}	2.3^{AB}	2.4^{ABC}	2.4^{ABC}	2.8^{D}	2.4^{AB}	2.6^{ABC}	2.4^{ABC}	2.8^{CD}
Glad^{+}	2.6^{CD}	2.4^{BCD}	1.8^{A}	1.9^{A}	2.3^{BC}	2.2^{AB}	2.7^{CD}	2.1^{AB}	2.7^{CD}	2.1^{AB}	2.7^{D}
Good- natured^{+}	2.7^{EF}	2.5^{CDE}	1.9^{A}	2.1^{AB}	2.3^{ABCD}	2.4^{ABCD}	2.7^{F}	2.3^{ABC}	2.7^{CDE}	2.3^{ABC}	2.7^{CDE}
Good^{+}	2.9^{D}	2.6^{BCD}	1.9^{A}	2.0^{AB}	2.4^{AB}	2.4^{AB}	2.8^{CD}	2.4^{AB}	2.9^{D}	2.3^{AB}	2.9^{D}
Happy^{+}	2.9^{F}	2.7^{CDEF}	1.9^{A}	2.2^{AB}	2.5^{CDEF}	2.4^{BCD}	2.9^{EF}	2.4^{BCD}	2.8^{DEF}	2.4^{AB}	2.8^{DEF}
Interested^{+}	2.8^{C}	2.4^{ABC}	2.1^{A}	2.1^{A}	2.3^{AB}	2.4^{ABC}	2.8^{C}	2.3^{AB}	2.6^{BC}	2.3^{AB}	2.6^{BC}
Joyful^{+}	2.6^{E}	2.4^{CDE}	1.7^{A}	1.9^{AB}	2.2^{BCD}	2.2^{BCD}	2.6^{DE}	2.1^{ABC}	2.6^{DE}	2.1^{ABC}	2.5^{DE}
Loving^{+}	2.3^{CDE}	2.2^{BCDE}	1.7^{A}	1.8^{AB}	2.1^{BCDE}	2.0^{ABCDE}	2.3^{CDE}	2.0^{ABCD}	2.3^{DE}	1.9^{ABC}	2.4^{E}
Merry^{+}	2.5^{E}	2.2^{BCDE}	1.7^{A}	1.8^{A}	2.0^{ABCD}	2.0^{ABC}	2.3^{CDE}	2.0^{ABCD}	2.4^{DE}	1.9^{AB}	2.4^{DE}
Peaceful^{+}	2.3^{BC}	2.3^{BC}	1.8^{A}	2.1^{AB}	2.3^{BC}	2.1^{ABC}	2.5^{C}	2.1^{ABC}	2.3^{BC}	2.1^{AB}	2.4^{BC}
Pleasant^{+}	2.8^{EF}	2.6^{CDEF}	1.9^{A}	2.0^{AB}	2.4^{BCDE}	2.3^{BCD}	3.0^{F}	2.2^{ABC}	2.7^{DEF}	2.2^{ABC}	2.7^{DEF}
Pleased^{+}	2.7^{D}	2.6^{CD}	1.9^{A}	1.9^{A}	2.4^{BCD}	2.2^{AB}	2.7^{D}	2.2^{ABC}	2.7^{D}	2.1^{AB}	2.7^{D}
Polite^{u}	2.2^{AB}	2.2^{AB}	1.9^{A}	2.1^{AB}	2.2^{B}	2.1^{AB}	2.3^{B}	2.1^{AB}	2.3^{B}	2.2^{AB}	2.5^{B}
Satisfied^{+}	2.8^{E}	2.6^{CDE}	1.9^{A}	1.9^{A}	2.4^{BCD}	2.3^{ABC}	2.8^{E}	2.2^{ABC}	2.7^{DE}	2.1^{AB}	2.8^{DE}
Secure^{+}	2.4^{B}	2.3^{AB}	2.0^{A}	2.0^{AB}	2.1^{AB}	2.2^{AB}	2.4^{B}	2.0^{AB}	2.4^{B}	2.1^{AB}	2.4^{B}
Steady^{u}	2.3^{B}	2.3^{B}	1.8^{A}	2.1^{AB}	2.0^{AB}	2.2^{B}	2.3^{B}	2.1^{AB}	2.2^{B}	2.1^{AB}	2.3^{B}
Tame^{u}	1.9^{ABC}	1.9^{ABC}	1.7^{A}	2.2^{C}	1.9^{ABC}	1.9^{ABC}	1.8^{ABC}	1.7^{AB}	2.0^{ABC}	2.0^{BC}	1.9^{ABC}
Tender^{+}	1.9^{AB}	1.9^{AB}	1.7^{A}	1.8^{AB}	1.9^{AB}	1.9^{AB}	1.9^{AB}	1.8^{AB}	2.0^{B}	1.8^{AB}	2.1^{B}
Understanding^{u}	2.2^{ABC}	2.3^{BC}	1.9^{A}	2.0^{AB}	2.3^{ABC}	2.1^{AB}	2.3^{BC}	2.1^{ABC}	2.3^{BC}	2.1^{ABC}	2.4^{C}
Warm^{+}	2.4^{E}	2.3^{BCE}	1.8^{A}	1.9^{AB}	2.1^{ABCDE}	2.1^{ABCDE}	2.3^{CDE}	2.0^{ABC}	2.4^{DE}	2.0^{ABCD}	2.4^{E}
Whole^{+}	2.3^{C}	2.2^{BC}	1.8^{A}	1.9^{AB}	2.1^{ABC}	2.1^{ABC}	2.3^{C}	2.0^{ABC}	2.3^{BC}	2.0^{ABC}	2.3^{C}
Worried^{-}	1.5^{AB}	1.5^{AB}	1.9^{C}	1.8^{BC}	1.4^{A}	1.6^{ABC}	1.5^{AB}	1.6^{ABC}	1.4^{A}	1.6^{ABC}	1.5^{AB}

^{ABCDEF}Products with the same letter code, within a row, are not significantly different ($p < 0.05$)

Table 4.3: EsSense Profile: Mean scores (Tukey's HSD multiple comparison tests) for discriminating positive^{+}, negative^{-}, unclassified^{u} emotions across products in pack condition (n=100)

	Products										
Emotions	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11
Active^{+}	2.1^{A}	2.7^{B}	2.8^{B}	3.0^{B}	2.1^{A}	2.1^{A}	2.0^{A}	2.1^{A}	2.2^{A}	2.0^{A}	2.9^{B}
Adventurous^{+}	2.0^{A}	2.6^{B}	3.1^{BC}	3.1^{C}	1.9^{A}	1.9^{A}	1.9^{A}	2.1^{A}	2.1^{A}	1.8^{A}	2.7^{BC}
Affectionate^{+}	1.9^{A}	2.6^{B}	3.0^{B}	2.6^{B}	1.9^{A}	1.9^{A}	1.8^{A}	1.9^{A}	2.0^{A}	1.7^{A}	2.8^{B}
Bored^{-}	1.9^{BC}	1.5^{AB}	1.1^{A}	1.3^{A}	2.0^{C}	2.2^{C}	2.2^{C}	2.0^{C}	2.0^{C}	2.3^{C}	1.4^{A}
Calm^{+}	2.0^{AB}	2.3^{B}	2.3^{B}	1.8^{A}	2.1^{AB}	2.2^{AB}	2.1^{AB}	2.0^{AB}	2.1^{AB}	2.0^{AB}	2.2^{AB}
Daring^{u}	1.8^{ABC}	2.1^{CD}	2.4^{D}	2.3^{D}	1.6^{AB}	1.6^{A}	1.6^{A}	1.7^{AB}	1.7^{AB}	1.6^{A}	2.1^{BCD}
Disgusted^{-}	1.7^{CDE}	1.3^{ABC}	1.1^{A}	1.3^{ABC}	1.6^{CDE}	1.6^{BCD}	1.6^{BCD}	1.7^{DE}	1.6^{BCD}	2.0^{E}	1.2^{AB}
Eager^{u}	2.0^{AB}	2.5^{CD}	2.9^{D}	2.5^{CD}	1.9^{A}	1.8^{A}	2.0^{AB}	1.8^{A}	1.9^{A}	1.8^{A}	2.4^{BC}
Energetic^{+}	2.0^{A}	2.7^{B}	2.8^{B}	2.9^{B}	1.9^{A}	1.9^{A}	2.0^{A}	2.1^{A}	2.0^{A}	1.9^{A}	2.7^{B}
Enthusiastic^{+}	2.1^{A}	2.8^{B}	3.2^{B}	3.0^{B}	1.8^{A}	1.9^{A}	2.0^{A}	2.0^{A}	2.0^{A}	1.9^{A}	2.9^{B}
Free^{+}	1.9^{A}	2.6^{BC}	3.0^{C}	2.7^{C}	2.0^{A}	2.0^{A}	2.1^{AB}	2.1^{AB}	2.0^{A}	2.0^{A}	2.7^{C}
Friendly^{+}	2.1^{A}	2.9^{B}	3.2^{B}	2.9^{B}	2.2^{A}	2.2^{A}	2.3^{A}	2.3^{A}	2.2^{A}	2.1^{A}	3.0^{B}
Glad^{+}	2.2^{A}	2.8^{B}	3.1^{B}	2.8^{B}	2.1^{A}	2.1^{A}	2.0^{A}	2.2^{A}	2.1^{A}	2.0^{A}	2.9^{B}
Good^{+}	2.3^{A}	2.9^{C}	3.3^{C}	2.8^{BC}	2.2^{A}	2.3^{A}	2.2^{A}	2.3^{AB}	2.2^{A}	2.1^{A}	2.9^{C}
Good- natured^{+}	2.2^{AB}	2.8^{CD}	3.1^{D}	2.7^{BCD}	2.2^{AB}	2.2^{A}	2.1^{A}	2.4^{ABC}	2.1^{A}	2.0^{A}	2.8^{CD}
Happy^{+}	2.2^{A}	3.0^{B}	3.2^{B}	3.1^{B}	2.1^{A}	2.2^{A}	2.1^{A}	2.2^{A}	2.2^{A}	2.0^{A}	3.1^{B}
Interested^{+}	2.2^{A}	2.9^{B}	3.5^{C}	3.0^{BC}	2.1^{A}	2.2^{A}	2.1^{A}	2.2^{A}	2.1^{A}	1.9^{A}	2.9^{B}
Joyful^{+}	1.9^{A}	2.7^{B}	3.0^{B}	2.7^{B}	1.9^{A}	1.9^{A}	1.9^{A}	2.0^{A}	1.9^{A}	1.8^{A}	2.7^{B}
Loving^{+}	1.8^{A}	2.4^{B}	2.7^{B}	2.4^{B}	1.8^{A}	1.8^{A}	1.8^{A}	1.9^{A}	1.7^{A}	1.7^{A}	2.4^{B}
Merry^{+}	1.9^{AB}	2.5^{C}	2.7^{C}	2.5^{C}	1.8^{A}	1.8^{A}	1.8^{A}	1.9^{A}	1.8^{A}	1.8^{A}	2.4^{BC}
Nostalgic^{+}	1.7^{A}	2.5^{B}	1.9^{A}	1.7^{A}	1.8^{A}	1.8^{A}	1.7^{A}	1.7^{A}	1.8^{A}	1.7^{A}	2.6^{B}
Peaceful^{+}	1.9^{A}	2.5^{BC}	2.7^{C}	2.0^{A}	2.0^{A}	2.2^{AB}	2.1^{AB}	2.1^{AB}	2.1^{AB}	2.0^{A}	2.5^{BC}
Pleased^{+}	2.1^{A}	2.9^{C}	3.2^{C}	2.7^{BC}	2.1^{A}	2.2^{AB}	2.1^{A}	2.1^{A}	2.1^{A}	2.0^{A}	2.9^{C}
Pleasant^{+}	2.1^{A}	2.8^{C}	3.0^{C}	2.7^{BC}	2.2^{AB}	2.2^{A}	2.2^{A}	2.2^{AB}	2.1^{A}	2.0^{A}	2.8^{C}
Polite^{u}	2.1^{AB}	2.6^{BC}	2.7^{C}	2.3^{ABC}	2.2^{AB}	2.2^{AB}	2.1^{AB}	2.3^{ABC}	2.1^{AB}	2.0^{A}	2.4^{ABC}
Quiet^{u}	2.0^{AB}	2.2^{B}	2.1^{AB}	1.7^{A}	2.2^{B}	2.2^{B}	2.1^{AB}	2.2^{B}	2.1^{AB}	2.0^{AB}	2.0^{AB}
Satisfied^{+}	2.0^{A}	2.9^{CD}	3.2^{D}	2.5^{BC}	2.0^{A}	2.2^{AB}	2.1^{AB}	2.1^{AB}	2.0^{A}	1.9^{A}	2.9^{CD}
Secure^{+}	2.0^{A}	2.5^{BCD}	2.6^{CD}	2.1^{ABC}	2.1^{AB}	2.1^{AB}	2.1^{AB}	2.0^{A}	2.1^{AB}	1.9^{A}	2.8^{D}
Steady^{u}	2.0^{A}	2.4^{AB}	2.5^{B}	2.1^{AB}	2.1^{AB}	2.1^{AB}	2.2^{AB}	2.0^{A}	2.1^{AB}	2.0^{A}	2.4^{AB}
Tender^{+}	1.7^{AB}	2.0^{ABC}	2.2^{BC}	1.8^{ABC}	1.8^{ABC}	1.8^{ABC}	1.8^{ABC}	1.9^{ABC}	1.8^{ABC}	1.7^{A}	2.2^{C}
Understanding^{u}	2.0^{A}	2.4^{AB}	2.6^{B}	2.3^{AB}	2.1^{A}	2.2^{AB}	2.1^{A}	2.2^{AB}	2.0^{A}	2.1^{A}	2.5^{AB}
Warm^{+}	2.1^{ABC}	2.5^{BCD}	2.8^{D}	2.4^{ABCD}	2.0^{A}	1.9^{A}	2.0^{A}	2.0^{AB}	2.1^{AB}	2.0^{A}	2.6^{CD}
Whole^{+}	2.1^{A}	2.6^{B}	2.8^{B}	2.4^{AB}	2.0^{A}	2.1^{A}	2.0^{A}	2.0^{A}	2.0^{A}	2.0^{A}	2.7^{B}
Wild^{u}	1.7^{ABCD}	1.9^{ABCD}	2.1^{CD}	2.2^{D}	1.6^{AB}	1.5^{A}	1.5^{AB}	1.5^{AB}	1.6^{ABC}	1.5^{AB}	2.0^{BCD}
Worried^{-}	1.7^{AB}	1.4^{AB}	1.3^{A}	1.6^{AB}	1.6^{AB}	1.4^{AB}	1.6^{AB}	1.7^{AB}	1.6^{AB}	1.8^{B}	1.3^{A}

^{ABCDEF}Products with the same letter code, within a row, are not significantly different ($p < 0.05$)

Table 4.4: EsSense Profile: Mean scores (Tukey's HSD multiple comparison tests) for discriminating positive^{+}, negative^{-}, unclassified^{u} emotions across products in informed condition (n=100)

	Products										
Emotions	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11
Active^{+}	2.6^{BC}	2.3^{AB}	2.2^{AB}	2.2^{AB}	2.4^{AB}	2.2^{AB}	2.7^{BC}	2.5^{ABC}	2.6^{BC}	2.0^{A}	2.9^{C}
Adventurous^{+}	2.5^{BC}	2.2^{AB}	2.2^{ABC}	2.3^{ABC}	2.2^{AB}	2.1^{AB}	2.5^{BC}	2.2^{AB}	2.4^{BC}	1.9^{A}	2.7^{C}
Affectionate^{+}	2.4^{BC}	2.1^{ABC}	2.0^{AB}	1.9^{A}	1.9^{AB}	1.9^{A}	2.1^{ABC}	2.0^{AB}	2.3^{ABC}	1.9^{A}	2.6^{C}
Bored^{-}	1.5^{A}	1.8^{AB}	1.7^{AB}	1.9^{AB}	1.7^{AB}	1.9^{AB}	1.5^{A}	1.6^{AB}	1.6^{AB}	2.0^{B}	1.4^{A}
Daring^{u}	1.9^{AB}	1.8^{A}	1.9^{AB}	1.9^{AB}	1.8^{A}	1.7^{A}	1.9^{AB}	1.9^{AB}	1.8^{AB}	1.7^{A}	2.2^{B}
Disgusted^{-}	1.6^{AB}	1.8^{ABC}	1.9^{BC}	2.1^{C}	1.8^{BC}	1.8^{ABC}	1.5^{AB}	1.7^{ABC}	1.5^{AB}	2.1^{C}	1.3^{A}
Eager^{u}	2.3^{AB}	2.2^{AB}	2.2^{AB}	2.1^{AB}	2.0^{A}	1.9^{A}	2.4^{AB}	2.2^{AB}	2.2^{AB}	1.9^{A}	2.6^{B}
Energetic^{+}	2.5^{AB}	2.3^{A}	2.2^{A}	2.2^{A}	2.3^{A}	2.1^{A}	2.6^{AB}	2.3^{A}	2.5^{AB}	2.1^{A}	2.9^{B}
Enthusiastic^{+}	2.5^{BC}	2.3^{AB}	2.1^{AB}	2.2^{AB}	2.3^{AB}	2.1^{AB}	2.5^{BC}	2.3^{AB}	2.5^{BC}	2.0^{A}	3.0^{C}
Free^{+}	2.4^{AB}	2.1^{A}	2.1^{A}	2.3^{AB}	2.1^{A}	2.0^{A}	2.4^{AB}	2.2^{A}	2.4^{AB}	2.0^{A}	2.7^{B}
Friendly^{+}	2.5^{A}	2.3^{A}	2.2^{A}	2.3^{A}	2.3^{A}	2.2^{A}	2.5^{A}	2.4^{A}	2.4^{A}	2.1^{A}	3.1^{B}
Glad^{+}	2.5^{AB}	2.3^{A}	2.2^{A}	2.1^{A}	2.2^{A}	2.1^{A}	2.4^{A}	2.3^{A}	2.5^{A}	2.1^{A}	3.0^{B}
Good^{+}	2.6^{BC}	2.5^{AB}	2.2^{AB}	2.2^{AB}	2.3^{AB}	2.2^{AB}	2.5^{AB}	2.4^{AB}	2.6^{BC}	2.1^{A}	3.1^{C}
Good-natured^{+}	2.5^{AB}	2.4^{AB}	2.3^{A}	2.3^{A}	2.2^{A}	2.2^{A}	2.4^{AB}	2.3^{AB}	2.4^{AB}	2.1^{A}	2.9^{B}
Happy^{+}	2.6^{BC}	2.3^{AB}	2.3^{AB}	2.2^{AB}	2.3^{AB}	2.2^{AB}	2.5^{AB}	2.3^{AB}	2.6^{BC}	2.1^{A}	3.1^{C}
Interested^{+}	2.7^{CD}	2.4^{ABC}	2.3^{ABC}	2.3^{ABC}	2.3^{ABC}	2.1^{AB}	2.5^{ABCD}	2.2^{ABC}	2.6^{BCD}	2.0^{A}	3.0^{D}
Joyful^{+}	2.3^{BC}	2.1^{AB}	2.0^{AB}	2.1^{AB}	2.0^{AB}	1.9^{AB}	2.2^{AB}	2.1^{AB}	2.3^{ABC}	1.8^{A}	2.7^{C}
Loving^{+}	2.2^{BC}	1.9^{AB}	1.9^{AB}	1.9^{AB}	1.9^{AB}	1.8^{AB}	2.0^{ABC}	1.8^{AB}	2.0^{ABC}	1.7^{A}	2.5^{C}
Merry^{+}	2.2^{AB}	2.0^{A}	2.0^{A}	1.9^{A}	2.0^{A}	1.8^{A}	2.1^{AB}	1.9^{A}	2.1^{AB}	1.8^{A}	2.6^{B}
Nostalgic^{+}	2.0^{AB}	2.1^{B}	1.6^{A}	1.7^{AB}	1.9^{AB}	1.6^{AB}	1.9^{AB}	1.7^{AB}	1.8^{AB}	1.7^{AB}	2.6^{C}
Peaceful^{+}	2.2^{AB}	2.2^{A}	2.0^{A}	2.1^{A}	2.1^{A}	2.0^{A}	2.3^{AB}	2.1^{A}	2.1^{A}	2.0^{A}	2.7^{B}
Pleased^{+}	2.5^{B}	2.3^{AB}	2.2^{AB}	2.1^{AB}	2.2^{AB}	2.1^{AB}	2.5^{AB}	2.3^{AB}	2.4^{AB}	2.0^{A}	3.1^{C}
Pleasant^{+}	2.6^{BC}	2.3^{AB}	2.2^{AB}	2.1^{AB}	2.1^{AB}	2.1^{A}	2.4^{AB}	2.3^{AB}	2.5^{ABC}	2.1^{A}	3.0^{C}
Polite^{u}	2.3^{AB}	2.3^{AB}	2.2^{AB}	2.0^{A}	2.1^{A}	2.1^{A}	2.3^{AB}	2.2^{AB}	2.3^{AB}	2.1^{A}	2.6^{B}
Satisfied^{+}	2.5^{AB}	2.3^{AB}	2.1^{A}	2.0^{A}	2.2^{AB}	2.0^{A}	2.6^{BC}	2.2^{AB}	2.6^{BC}	2.0^{A}	3.1^{C}
Secure^{+}	2.2^{AB}	2.2^{A}	2.2^{A}	1.9^{A}	2.1^{A}	2.0^{A}	2.3^{AB}	2.1^{A}	2.2^{AB}	2.0^{A}	2.7^{B}
Steady^{u}	2.1^{AB}	2.1^{AB}	2.0^{A}	2.0^{A}	2.1^{AB}	2.0^{AB}	2.3^{AB}	2.1^{AB}	2.1^{AB}	2.0^{A}	2.5^{B}
Understanding^{u}	2.2^{AB}	2.2^{AB}	2.2^{AB}	2.0^{A}	2.1^{AB}	2.0^{AB}	2.3^{AB}	2.1^{AB}	2.2^{AB}	2.1^{AB}	2.5^{B}
Warm^{+}	2.3^{AB}	2.2^{AB}	2.0^{A}	2.0^{A}	2.0^{A}	2.0^{A}	2.3^{AB}	2.1^{A}	2.2^{AB}	1.9^{A}	2.6^{B}
Whole^{+}	2.4^{AB}	2.3^{AB}	2.1^{A}	2.0^{A}	2.1^{A}	1.9^{A}	2.2^{AB}	2.1^{A}	2.3^{AB}	2.0^{A}	2.7^{B}
Worried^{-}	1.6^{AB}	1.6^{AB}	1.7^{AB}	1.7^{AB}	1.6^{AB}	1.7^{AB}	1.5^{AB}	1.6^{AB}	1.5^{AB}	1.8^{B}	1.4^{A}

^{ABCDEF}Products with the same letter code, within a row, are not significantly different ($p < 0.05$)

In accordance with the approach applied to liking scores (see section 4.2.1), Student's t-tests were carried out to compare emotion scores between pack and blind condition (P^E-B^E) and to compare emotion scores between informed and blind condition (I^E-B^E) for each emotion term across all products. Student t-tests for P^E-B^E values revealed disconfirmation effect was found on informed emotion scores for products 1, 3, 4, 5, 7 and 11 but only for certain emotion terms ($p < 0.05$) which are listed in Table 4.5. In addition, a significant effect of packaging was also observed in these products. In order to determine whether an assimilation or contrast effect was observed in these products, (I^E-B^E)/(P^E-B^E) were calculated and their values were all above zero, indicating assimilation effect was found in these products. Hence, Student's t-tests were carried out to compare emotion scores between informed and pack condition (I^E-P^E). Significant differences were found in product 1 for 'satisfied'; in product 3 for 'eager', 'glad', 'good' and 'good-natured'; in product 4 for 'adventurous' and in product 7 for 'happy' ($p < 0.005$). This suggested that the assimilation effect was *not complete* for these products. However, their informed scores for these emotions were generally closer to their blind emotion scores, indicating that packaging of products 1, 3, 4 and 7 had a minor effect on these emotions. However, as no significant difference was found in product 7 for 'pleasant' and product 11 for 'secure' (see Table 4.5), indicating that consumers were assimilating towards the packaging for these emotions (informed emotion mean scores were closer to pack emotion mean scores).

Table 4.5: EsSense Profile: Mean emotion scores of products evaluated under blind (B), pack (P) and informed (I) conditions, together with differences (M) and corresponding probabilities (*P*) between mean ratings tested through student t-test (n=100)

					P^E-B^E		I^E-B^E		I^E-P^E	
	Emotions	**B**	**P**	**I**	**M**	**P**	**M**	**P**	**M**	**P**
P1	Satisfied	2.84	2	2.47	- 0.84	< 0.0001	- 0.37	0.03	0.47	0.003
P3	Eager	1.82	2.87	2.22	1.05	< 0.0001	0.4	0.009	- 0.65	0.000
P3	Glad	1.84	3.14	2.15	1.3	< 0.0001	0.31	0.026	- 0.99	< 0.0001
P3	Good	1.88	3.26	2.23	1.38	< 0.0001	0.35	0.026	- 1.03	< 0.0001
P3	Good-natured	1.9	3.09	2.3	1.19	< 0.0001	0.4	0.026	- 0.79	< 0.0001
P4	Adventurous	1.82	3.13	2.26	1.31	< 0.0001	0.44	0.005	- 0.87	< 0.0001
P7	Happy	2.88	2.08	2.54	- 0.8	< 0.0001	- 0.34	0.027	0.46	0.002
P7	Pleasant	2.95	2.17	2.43	- 0.78	< 0.0001	- 0.52	0.001	0.26	0.073
P11	Secure	2.37	2.77	2.71	0.4	0.019	0.34	0.048	- 0.06	0.738

I^E-B^E denotes Informed minus blind emotion scores; P^E-B^E denotes pack minus blind liking scores; I^E-P^E denotes informed minus expected liking scores

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4.2.3 Comparison of emotion profiles across blind, pack and informed conditions

Figure 4.2 shows the MFA emotion plot comparing the emotional space obtained under blind, pack and informed conditions. The first two dimensions of the MFA emotion plot accounted for 84.3% of the variance in the data and are represented at opposing ends by positive and negative terms. The latter findings are in line with previous studies which have noticed the opposed position of positive and negative emotions terms (Schifferstein et al., 2013; Watson et al., 1999). It can be observed that the first dimension of the MFA emotion plot for the blind (terms coloured in red) and informed conditions (terms coloured in green) were positively correlated with 23 positive emotion terms (i.e. 'active', 'adventurous', 'affectionate', 'energetic', 'enthusiastic', 'free', 'friendly', 'glad', 'good', 'good-natured', 'happy', 'interested', 'joyful', 'loving', 'merry', 'peaceful', 'pleasant', 'pleased', 'satisfied', 'secure', 'tender', 'warm' and 'whole') and five unclassified emotion terms (i.e. 'daring', 'eager', 'polite', 'steady', and 'understanding') but were negatively correlated with three negative emotions (i.e. 'bored', 'disgusted' and 'worried'). In addition, the first dimension of the MFA emotion plot was also positively correlated with additional emotion terms, i.e. 'calm' for the blind condition and 'nostalgic' for the informed condition.

On the other hand, the pack emotional terms (terms coloured in blue) were heavily loaded along the second dimension of the MFA emotion plot. The latter dimension was positively correlated with the same 23 positive and six emotion terms that were positively loaded on the first dimension, but with additional positive emotion 'nostalgic' and unclassified emotion 'wild'. It was also negatively correlated with three negative emotions (i.e. 'bored', 'disgusted' and 'worried').

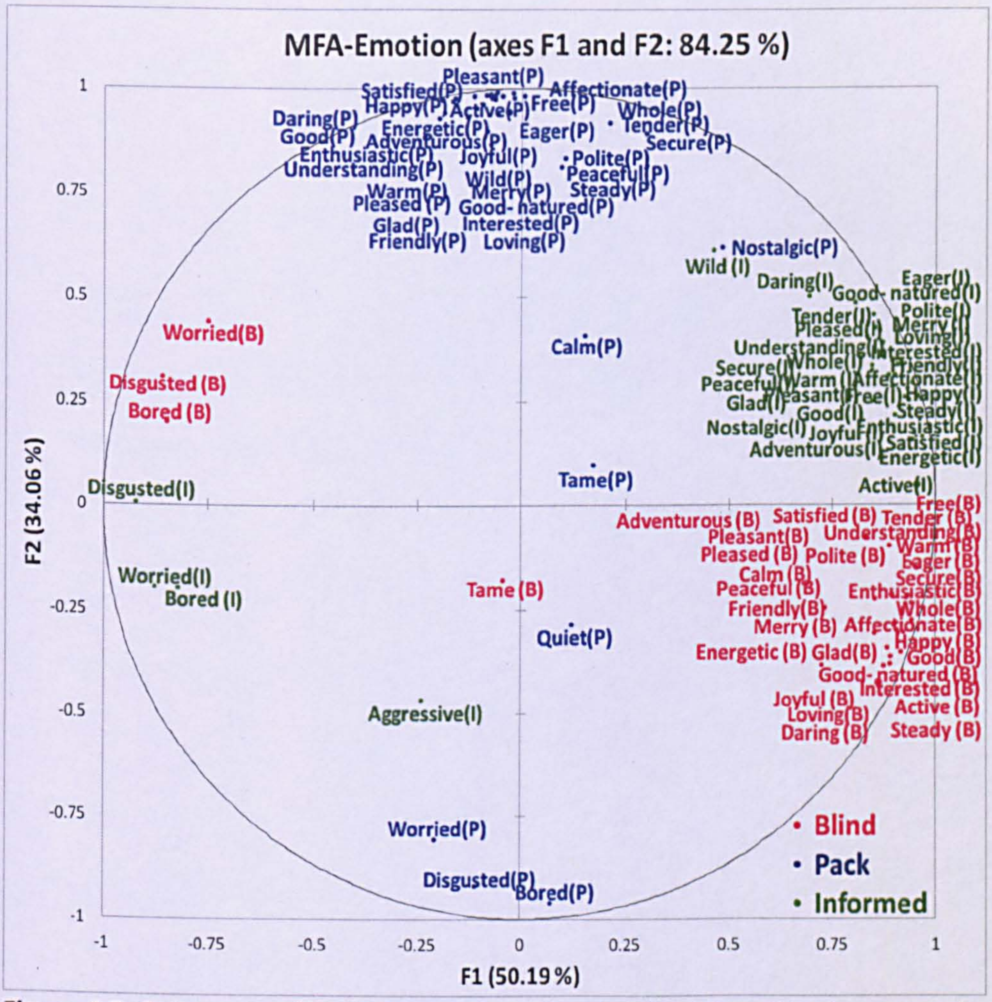
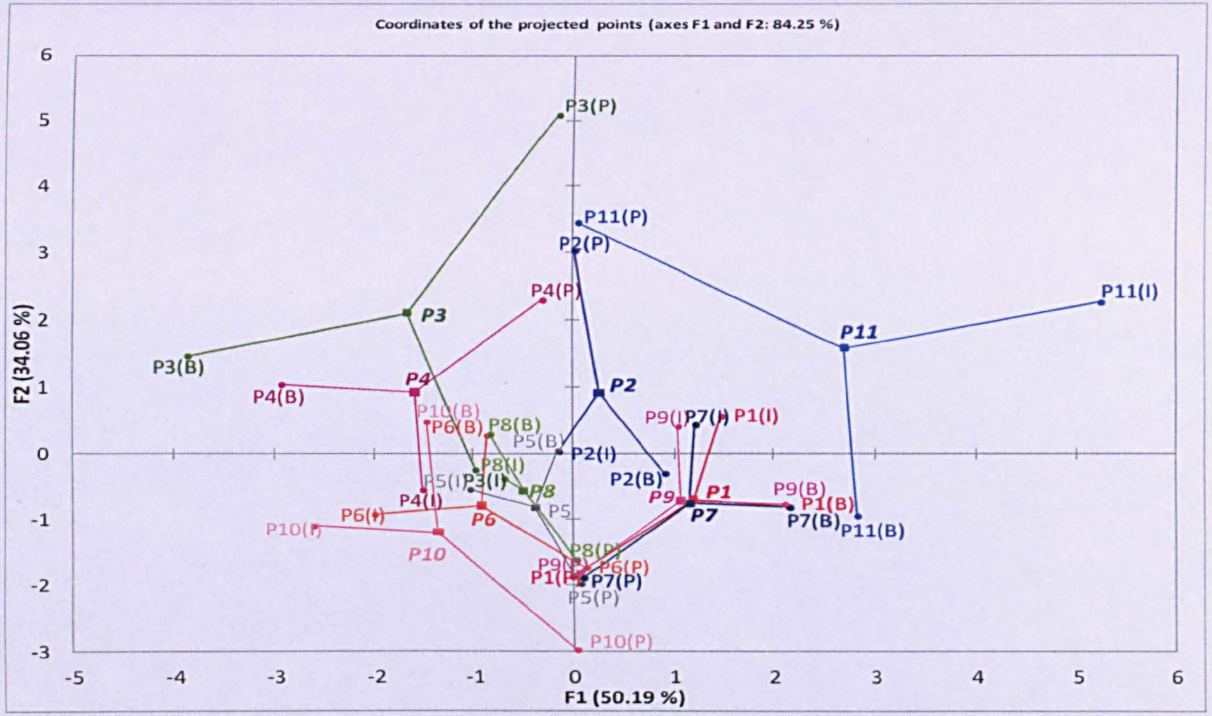


Figure 4.2: EsSense Profile: MFA emotion plot obtained from blind, pack and informed conditions (n=100)

The MFA product plot comparing the positioning of individual products in the emotional space obtained from blind, pack and informed conditions is shown in Figure 4.3. In the blind condition, standard AS squashes (products 1, 7, 9 and 11) were projected towards positive emotions on the right of the plot, whereas niche AS squashes (products 3 and 4) were projected towards negative emotions on the left of the plot. The plot also indicated that the remaining blackcurrant squashes (products 2, 5, 6, 8 and 10) were positioned more towards the middle of the plot. The product positioning observed in informed condition, however, was similar to the ones obtained in the blind condition. Indeed, the average product configuration of the 11 products determined by sensory attributes (blind condition) was closely aligned with the average product configuration determined in the informed condition (see Figure 4.1b) which can be confirmed by a relatively good RV coefficient of 0.6. As there was no particular distribution of products relating to brands or market segments under blind and informed conditions, product positioning was likely to be driven by the sensory attributes of the products. The relationship between emotional response and sensory attributes of the products will be discussed later in chapter 7. On the other hand, in the pack condition, products were distributed according to the brands, where retailer own brands from standard and economy markets (products 1, 5, 6, 7, 8, 9 and 10) were projected towards negative emotions whereas all other private labels from niche and standard markets (products 2, 3, 4 and 11) were projected towards positive emotions along the second dimension (Figure 4.3).



Each product[1] is represented using three points corresponding to each condition: blind (B), pack (P) and informed (I), and its compromise position in the middle

Figure 4.3: EsSense Profile: Superimposed representation of the products[1] in the MFA emotional space taking into account of three conditions: blind (B), pack (P) and informed (I) (n=100)

4.3 Discussion

4.3.1 Discriminative ability of emotion terms

Although the same emotion lexicon (which consists of 39 emotion terms) (see Table 2.4) was used across different conditions, not all terms presented in the EsSense Profile discriminated products, and this included 'aggressive', 'guilty' and 'mild', suggesting the latter emotions were not important for this product category. However, most of the emotion terms in the EsSense Profile lexicon can be used to discriminate within the blackcurrant squash category across blind, pack and informed conditions, although the discriminative ability of some emotion terms differed according to the product presentation condition. For example, emotions 'quiet' and 'wild' were not discriminating during blind tasting sessions but were discriminating during pack condition, suggesting that these emotions were only induced by the packaging. Interestingly, the emotion 'quiet' seemed to be evoked by the blue coloured packaging of NAS products whereas the emotion 'wild' seemed to be evoked by the vibrant fuchsia pink coloured packaging of niche AS product (see Table 4.3) (personal observation). Indeed, research has found that different colours can elicit different emotions (e.g. Ballast, 2002; Kaya and Epps, 2004; Mahnke, 1996). For example, the cool colours (e.g. blue, green, purple) are generally considered to be restful and quiet whereas the warm colours (e.g. red, yellow, orange) are seen as stimulating (Ballast, 2002). However, in this case other factors (brand information, bottle shape etc) could have overridden the effect of colour of packaging, therefore a more systematic experimental design is needed to test the latter observation.

4.3.2 How liking and emotion profiles change across blind, pack and informed conditions?

Liking. This study shows that product packaging generally generates higher (expected) liking scores than blind and informed tastings, indicating that extrinsic packaging characteristics heighten hedonic expectation. This is probably due to the high level of information processing and involvement by consumers when they actively scan packages in order to make purchase decisions. A recent study suggested that consumer overall liking perception of powdered drink was mainly influenced by brand perception rather than perceived sensory attributes (Varela, 2010). However, in this study, the average product configuration of the 11 blackcurrant squashes according to informed liking scores, was closer to blind liking scores (Figure 4.1b). The latter findings indicate that consumers' informed liking scores were driven more by the product sensory attributes than their packaging. For example, although consumers scored 'five' ('neither like nor dislike') for expected liking for retailer own brands (e.g. products 1, 7 and 9) (when consumers were only cued by their packaging), the latter products scored higher during informed tasting (above 'five'). This may be due to the sweetness associated to the natural sweeteners that were present in the products. Indeed, naturally sweetened solutions have been reported to be associated with positive emotions, e.g. happiness and surprise (Rousmans et al., 2000). Furthermore, Berridge (2003) has also looked into how the brain causes positive affective reactions to sensory pleasure by understanding which parts of the brains system cause positive affective response. It has been suggested that liking and positive affective reactions to sweet taste are caused by activity in the subcortical network. This knowledge has aided clarification of how sensory experience results in pleasure experience.

Emotions. The MFA emotion plot (Figure 4.2) indicated that there was a clear disconnection between the emotion terms obtained from the pack condition and the emotion terms obtained from the blind and informed conditions. These results clearly indicated that the emotions consumers experienced when looking at just the packaging of the products were different from the emotions they experienced when tasting the products, whether it was in the informed or blind condition (with or without packaging). This indicates that consumers' informed emotional responses were influenced more by the product sensory attributes rather than the packaging. For example, although the aesthetic packaging of niche products 3 and 4 appeared to evoke positive emotions such as 'interested' and 'adventurous' (Table 4.3), they evoked the negative emotion 'disgusted' when the packaging was presented together with the drink for consumption (informed condition; Table4.4). Indeed, the sensory attributes of product 3 and 4 (blind condition; Table 4.2) induced significantly less intense positive emotions but evoked the negative emotion 'disgusted'. Analogous to the liking profiles, the average product configuration of the 11 products determined in the informed condition for emotional profiles was closely aligned with the average product configuration determined in the blind condition (Figure 4.1b).

4.3.3 Effect of packaging on mean liking and emotions scores between blind and informed conditions

The results of this study indicated that generally packaging did not have a significant effect on the informed liking scores for products, except for product 11. An assimilation effect was *complete* for product 11 for liking, indicating that consumers were assimilated to their expected liking scores. One element that clearly distinguished product 11 from the rest of the products was that it is a long established 'well known brand' in the UK market. It could be hypothesised that a well known brand played a role in enhancing the positive affect experienced from tasting the product. Previous findings have shown that brands are more likely to elicit strong positive feelings if there is a congruency between consumer and the brand image (Louw and Kimber, 2006). Indeed, when the packaging of product 11 was presented with its drink during the informed condition, consumers felt more 'secure' about the product (Table 4.5), suggesting that the brand induced this emotion.

Although an assimilation effect was observed in products 1, 3, 4, 7 and 9, consumers did not *completely* assimilate towards the expected liking created by packaging. Sensory attributes of these products seemed more decisive than their packaging. Interestingly, standard retailer own products 1, 7 and 9 performed better than the expectation created by their packaging, whereas niche private label products 3 and 4 performed under expectation. It has been reported that consumers generally have stronger susceptibility to retail brand information (Hubert et al., 2009) and this could explain why retailer own brands generally scored low for expected liking. On the other hand, the packaging of products 3 and 4 was more aesthetic than the other products, e.g. they were bottled in glass whereas others were bottled in plastic. Indeed, packaging is claimed to attract attention when its appearance is not typical within a product class (Schoormans and Robber, 1997), which could explain why products 3 and 4 scored high for expected liking. However, the results of this study showed that the expectation created by packaging need to be met by sensory attributes in order to do well.

On the other hand, although an assimilation effect was observed for some products for a minority of emotion terms (see Table 4.5), assimilation effect was only *complete* for the emotion 'pleasant' for product 7 and 'secure' for product 11. As mentioned earlier, the brand of product 11 was suggested to evoke 'secure' in consumers. However, consumers felt less 'pleasant' when evaluating product 7 when the drink was presented with its packaging. Due to the nature of packaging tested in this study, it is difficult to identify which element in the packaging induced such positive or negative emotion. Nonetheless, it appeared that for most of the products, consumer informed liking and emotion scores were influenced more by the sensory attributes than packaging. These findings confirmed that the product's sensory attributes are an important factor in confirming liking scores, which may also determine repeat purchase (Murray and Delahunty, 2000).

4.4 Conclusion

This study provides the food industry with an insight into the application of the EsSense Profile method in a commercial context; most of the emotions on EsSense Profile can be used to discriminate products across blind, pack and informed conditions within the blackcurrant squash product category. However, the discriminative ability of emotion terms depends on product presentation condition. Emotions that were not important to this product category include 'aggressive', 'guilty' and 'mild'.

This study shows that although extrinsic packaging characteristics generally heighten hedonic expectation, both consumer liking responses and emotions were influenced more by the product's sensory attributes than the packaging, confirming previous findings that human senses are powerful elicitors of emotions (Chrea et al., 2009; Gibson, 2006; Porcherot et al., 2012; Thomson et al., 2010). However, the packaging was shown to influence certain emotion scores between blind and informed conditions in a small number of products. Therefore, before generalising these findings across all contexts, trials testing comparative effects of sensory and packaging attributes in a more systematic manner are required, across a range of different products. It would also be interesting to study more emotionally charged products such as chocolate, alcohol or even a non food product category such as perfume using EsSense Profile.

One point that emerged during the study was to question if subjects are simply evaluating the product category in general, in this case blackcurrant squash, rather than focusing on profiling individual differences across the products. The former would lead to less differentiation across the products within a category. In future studies the use of a warm up sample may increase product differentiation on emotional profiles.

What is clear is that emotional data can be used to further discriminate products with similar liking scores (which will be discussed in further detail in Chapter 6). Understanding the relationship between emotion and liking is of great benefit to industry.

5 Conceptualisation (and liking) measurement using CD-CATA method

5.1 Introduction

Chapter 4 discussed the importance of emotion research in understanding consumer affective product experience. However, Thomson et al. (2010) have argued that when consumers associate 'meanings' to product characteristics, the associations are not always 'emotions', they also associate 'functional connotations' (e.g. thirst quenching) and 'abstract feelings' (e.g. sophisticated). Therefore, this chapter taps into something more than just emotions-conceptualisation research through the use of a consumer self defined conceptual lexicon CATA methodology, a newly developed method for this PhD research.

It could be hypothesised that most abstract/functional conceptualisations may have already been formed prior to product consumption or usage, from the information gained from the product packaging or other sources (e.g. contextual, psychological, social and cultural). As consumers are unable to try the product prior to purchase, the visual appearance of package design has the ability to generate affect and create value (Creusen and Schoormans, 2005) and influence food consumption experience (Schifferstein et al., 2013). The evaluation of product packaging could induce cognitive processing, such as memory retrieval and hedonic evaluation (Schoormans and Robben, 1997), resulting, for example, in conceptualisations such as 'trustworthy' (abstract) or 'will refresh me' (functional).

Indeed, previous research has established that both our emotional and cognitive systems contribute to decision making (Damasio, 1994a). In general, the emotional system has been characterised as being more holistic, affective, concretive, and passive, while the cognitive system has been characterised as being more analytical, logical, abstract, and active (Lee et al., 2009). The mechanisms of how consumers perceive intrinsic product sensory attributes differ from how they perceive extrinsic product characteristics. Intrinsic product attributes, i.e. physiochemical and associated sensory attributes are derived through sensory and perceptual systems whereas the extrinsic factors operate mainly through cognitive and psychological mechanisms (Cardello, 2007). Such different mechanisms may result in different conceptualisation consequences. In fact, touch, smell and taste are reported to be more closely connected with emotions (Hinton and Henley, 1993) whereas vision and audition are sensory modalities that are suggested to be more closely connected to cognitive or rational thinking (Neisser, 1994). As consumers usually appraise product packaging using visual and tactile senses, abstract/ functional conceptualisations might have a stronger association with extrinsic product characteristics. Indeed, it has also been proposed that, in addition to communicating functional values which give a quality impression, product appearance also conveys aesthetic and symbolic value (Creusen and Schoormans, 2005). Aesthetic value denotes something beautiful that appeals to consumers, whereas symbolic value refers to the meaning consumers attached to a product on the basis of, among other things, advertising, country of origin etc (e.g. the product may look expensive, friendly or childish) (Creusen and Schoormans, 2005).

The level of expectations and concerns held at the moment of product appraisal might also contribute to the formation of abstract and functional conceptualisations other than just emotions. Disconfirmation of expectations may influence product quality perception through four mechanisms, namely: (a) assimilation, (b) contrast, (c) generalised negativity and (d) assimilation-contrast; this was discussed earlier in the introduction section of chapter 4 (Deliza and MacFie, 1996). To date, little data in the current sensory and science field is available to understand how intrinsic or extrinsic product characteristics affect consumer conceptualisations, and how that in turn affects their expectation and overall liking. Such capability would help companies to design and produce products that satisfy and meet consumer expectation.

The objectives of the CD-CATA study were similar to chapter 4, however in addition to emotion data; it also investigated conceptual data, i.e. abstract and functional conceptual data. Therefore, one key objective of the CD-CATA study was to develop a conceptual lexicon using 29 articulate subjects (see section 2.5.2), after which subjects (n=100) were asked to rate the conceptual lexicon using CATA approach. The objectives of this chapter were to: (i) measure how consumers' liking and conceptual responses change across blind, package and informed conditions; (ii) test the hypothesis that abstract/functional conceptualisations are more strongly associated with extrinsic product cues; and finally (iii) explore whether packaging influence the informed condition liking and conceptual total frequency count through comparison with those from the blind condition.

5.2 Results

5.2.1 Blind, expected (from package) and informed liking mean scores

Significant differences were found in consumers' overall liking scores for the products under blind, pack and informed conditions ($p < 0.005$) (Table 5.1). Less discriminating product groupings and larger value ranges were observed in the informed condition as compared to blind and pack conditions. In general, during the blind and informed tastings, the 'liked' products corresponded to standard AS squashes, except for standard NAS product 2, all scoring above 'six' ('like slightly'). The 'disliked' products, on the other hand, corresponded to niche AS products and all NAS products, all scoring 'five' ('neither like nor dislike') or below. When consumers were cued by just the packaging of the products, higher expected liking scores (above 'six'; 'like slightly') were observed for private labels of standard and niche products (products 2, 3, 4 and 11) as compared to other retailer own brands, regardless of whether the products were AS or NAS. Intriguingly, although the data were collected from a different group of consumers, results obtained from this study were very similar to the ones obtained from EsSense Profile experiment (as presented in section 4.2.1). A full comparison of EsSense Profile and CD-CATA in measuring emotions is presented in chapter 6.

Table 5.1: CD-CATA method: Blind (B), expected (E) and informed (I) mean liking scores of products evaluated under blind, pack, and informed conditions by consumers, together with differences (M) and corresponding probabilities (*P*) between mean ratings tested through student t-tests (n=100)

				E-B		I-B		I-E	
	B	**E**	**I**	**M**	**P**	**M**	**P**	**M**	**P**
P1	6.6^{D}	5.4^{A}	6.7^{EF}	- 1.2	< 0.0001	0.1	0.705	-	-
P2	5.5^{BC}	7.0^{B}	5.8^{BCDE}	1.5	< 0.0001	0.4	0.233	- 1.2	< 0.0001
P3	4.1^{A}	7.9^{C}	5.6^{BCD}	3.8	< 0.0001	1.6	<0.0001	- 2.3	< 0.0001
P4	4.6^{AB}	7.0^{B}	5.1^{ABC}	2.4	< 0.0001	0.5	0.161	- 1.9	< 0.0001
P5	6^{CD}	5.6^{A}	5.9^{CDE}	- 0.4	0.052	- 0.08	0.752	-	-
P6	4.8^{AB}	5.6^{A}	4.9^{AB}	0.8	0.009	0.05	0.872	- 0.7	0.012
P7	6.6^{D}	5.8^{A}	6.4^{DE}	- 0.8	0.001	- 0.2	0.349	0.6	0.008
P8	4.8^{AB}	5.7^{A}	4.5^{A}	0.9	0.007	- 0.3	0.329	-	-
P9	6.4^{CD}	5.5^{A}	6.4^{DE}	- 0.9	0.001	0.03	0.91	-	-
P10	4.3^{A}	5.1^{A}	4.9^{AB}	0.9	0.005	0.6	0.05	- 0.2	0.457
P11	6.6^{D}	7.6^{BC}	7.5^{F}	1.0	< 0.0001	0.9	<0.0001	- 0.2	0.420

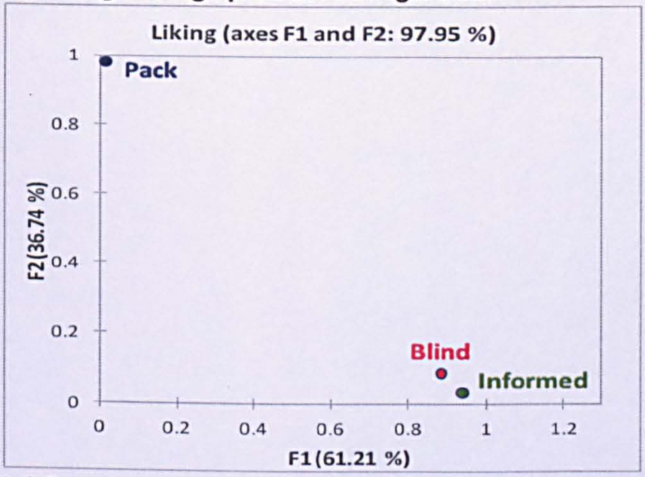
I-B denotes Informed minus blind liking scores; E-B denotes expected minus blind liking scores; I-E denotes informed minus expected liking scores

Student t-tests ($p < 0.05$) for I-E scores were only calculated for assimilated products (I-B) / (E-B) > 0.

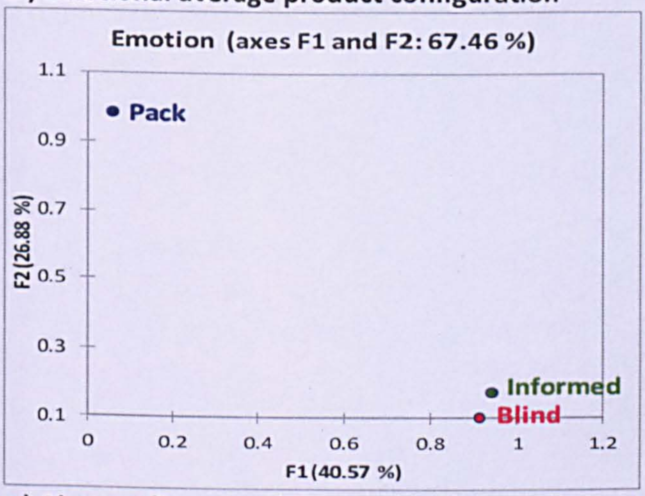
^{ABCDEFG}Products with the same letter code, within a column, are not significantly different ($p < 0.05$)

In addition, Student's t-tests were performed to compare expected and blind liking scores (E-B) (Table 5.1) (Villegas et al., 2008). Significant t-tests revealed that disconfirmation occurred in all products except for product 5 ($p \leq 0.05$). Student t-tests were also performed to compare informed and blind liking scores (I-B) and significant effects of packaging on informed liking scores were observed for products 3, 10 and 11 ($p \leq 0.05$), but not the remaining products. A contrast effect is revealed when (I-B)/(E-B) below zero and an assimilation effect is revealed when (I-B)/(E-B) above zero. An assimilation effect was detected for product 2, 3, 4, 6, 7, 10 and 11. As assimilation was detected, I-E scores for these products were calculated and a significant difference was found in product 2, 3, 4, 6 and 7, revealing that consumers did not *completely* assimilate towards their expectation (where the informed liking score was located between the blind liking score and the expected liking score). The informed liking scores were generally closer to sensory attributes, suggesting that the packaging played a secondary role when compared to the sensory attributes of the product. However, assimilation was *complete* for product 10 and 11 as informed liking scores were closer to the expected scores than the blind scores, indicating that packaging did have an effect on liking. Nonetheless, in general, the average product configurations of the 11 products determined by sensory attributes (blind condition) for liking were more closely aligned with the average product configuration determined by informed condition (see Figure 5.1a). The latter is confirmed by an RV coefficient of 0.7.

a.) Liking average product configuration



b.) Emotional average product configuration



c.) Abstract/functional average product configuration

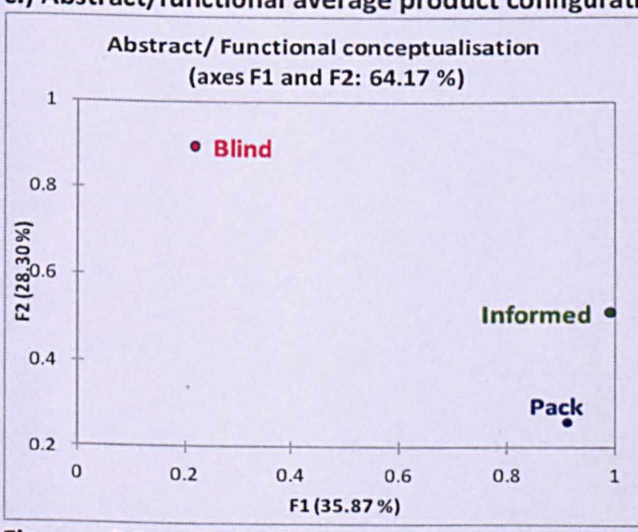


Figure 5.1: CD-CATA method: Representation of average product configuration of 11 products under three conditions considered in the first two dimensions for a.) liking, b.) emotional and c.) abstract/functional (n=100)

5.2.2 Total frequency counts for conceptualisation

In the blind condition, the total frequency counts for each emotion term ranged from 0 to 55 (Table 5.2) and for abstract/functional terms ranged from 0 to 58 (Table 5.3). In the pack condition, emotion term frequencies ranged from 0 to 76 (Table 5.4), and abstract/functional terms frequencies ranged from 0 to 89 (Table 5.5). Finally, for the informed condition, emotion term frequencies ranged from 0 to 62 (Table 5.6) and abstract/functional terms frequencies ranged from 0 to 78 (Table 5.7). In general, lower frequency counts were observed for negative emotions compared to positive emotions. These results concur with those observed in the literature that majority of emotional self reports concerning foods in published literature are positive (Desmet and Schifferstein, 2008a; Gibson, 2006).

Within a conceptual term, as presented in Table 5.2 to Table 5.7, frequencies in bold were significantly greater (>) or less than (<) expected counts under the null hypothesis of no difference (or independence). For example, as illustrated in Table 5.2, for the emotion 'happy', the sensory attributes of products 1, 7 and 11 (blind condition) induced happiness significantly more than the other products, whereas products 3, 4, 6 and 10 induced it significantly less. Using the latter approach, it was evident that some conceptual terms shared by all conditions, were very discriminating and this included emotions of 'at ease', 'good', 'happy' and 'satisfaction' and abstract/functional conceptual terms of 'good quality', 'bad for your teeth', 'familiar' and 'unappealing'. However, there were terms that were not discriminating and these included emotions of 'angry', 'cautious', and 'confused' in the blind condition, as well as emotions 'attentive', 'overwhelmed', 'responsible' and a functional term, 'easy to read', in the informed condition.

Table 5.2: CD-CATA method: Frequency count (chi square test analysis) for positive^{+}, negative^{-}, 'unclassified^{u} emotions across products in blind condition (n=100)

	Products										
Emotions	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**	**P9**	**P10**	**P11**
Annoyed^{-}	5<	16	19	15	8	17	4<	22>	6<	24>	6<
Approval^{+}	26	18	11<	14	25	14	23	14	20	6<	28>
At ease^{+}	27	33	13<	18	44>	20	35	15<	32	14<	46>
Attentive $^{+}$	13	7	12	8	11	7	14	4<	14	6	12
Bored^{-}	5<	12	12	16	17	9	9	7	8	24>	9
Comforted^{+}	28>	10	7<	10	18	8<	26>	13	17	11	20
Curious^{+}	27	21	27	28	16	24	18	20	25	10<	17
Desire^{+}	20>	6	4<	4	9	6	11	9	16>	2<	7
Disappointment^{-}	12<	27	37>	28	16	31	13<	32	17	47>	10<
Discontent^{-}	7<	22	29>	22	13	22	3<	17	8<	32>	8<
Disgusted^{-}	6<	16	25>	22	5<	21	4<	30>	9	24>	4<
Displeasure^{-}	13<	30	47>	30	18<	38	15<	43>	20	48>	12<
Good^{+}	48>	30	13<	24	37	24	48>	26	46>	13<	47>
Guilty pleasure ^{U}	20>	10	4<	4<	6	5	16	9	14	4<	11
Happy^{+}	54>	31	15<	22<	40	25	55>	28	41	15<	48>
Interested^{+}	46>	24	16<	24	35	24	37	22<	40>	14<	39
Pleasant surprise^{+}	36	14<	14<	25	28	18	35	22	42>	10<	41>
Pleased^{+}	34	28	19<	18<	37>	18<	43>	20<	31	13<	42>
Regret^{-}	7<	15	25>	17	8	13	5<	20	12	15	3<
Reminiscence^{+}	14	17	11	9	14	7	15	11	7	8	22>
Resentment^{-}	4<	8	10	8	6	13	3<	14	8	16>	5
Satisfaction^{+}	43>	26	17<	19<	37	18<	54>	24	35	13<	42>
Shocked^{-}	7	10	16>	10	2<	12	2<	14	4	9	0<
Sickly^{-}	21	25	19	15	12	30>	12<	35>	17	14	12
Trust^{+}	21>	6<	7	11	18	2<	16	13	13	6	17
Uncomfortable^{-}	12<	22	34>	23	11<	29>	12<	33>	10<	21	9<
Unhappy^{-}	4<	18	23>	22>	6<	20	7<	16	8	20	5<
Unpleasant surprise^{-}	7<	20	41>	24	12<	29>	8<	33>	12<	30>	7<
Warm^{+}	21>	10	5<	10	15	8	13	12	8	8	18
Worried^{-}	9	8	11	10	4	7	5	10	6	8	3<

Frequencies (with '>' or '<') either significantly greater (>) or less than (<) the expected counts

Table 5.3: CD-CATA method: Frequency count (chi square test analysis) for abstract^{A}/ functional^{F} terms across products in blind condition (n=100)

	Products										
Abstract/ functional	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**	**P9**	**P10**	**P11**
Artificial ^{A}	31	43	30	26<	29	54>	30	49	37	51>	25
Bad for your teeth ^{F}	43>	32	25	14<	22	30	27	39	35	17<	25
Cheap ^{A}	9<	26	20	39>	23	35	21	24	12<	58>	13<
Everyday drink ^{F}	11	18	6<	16	25>	9<	21	17	16	16	28>
Expensive ^{F}	25>	7	18>	6	7	5<	11	7	12	1<	12
Familiar ^{A}	40	35	19<	15<	39	25	43>	22<	32	18<	47>
Fresh ^{F}	30	20	17<	28	36>	19<	32	21	33	16<	35>
Good quality ^{F}	41>	27	22	19	29	19<	37>	23	24	8<	35>
Healthy ^{F}	19	9	18	20	15	7<	16	6<	16	9	18
Like real fruits ^{F}	33>	14	23	20	26	14	18	13	22	8<	14
Natural ^{A}	26	12<	23	29	27	13<	27	10<	20	9<	24
Not refreshed ^{F}	14<	22	36>	22	14<	37>	21	33	19	33	14<
Not thirst quenching ^{F}	24	26	32	18	15	28	13<	24	23	23	23
Poor quality ^{F}	8<	24	27	39>	19	29	14<	29	13<	52>	10<
Refreshed ^{F}	40	23	18<	33	36	24	39>	25	32	19<	38
Strange ^{A}	13<	23	36>	35	15<	33	17	35	23	24	18
Treat ^{F}	21>	8	9	5<	12	7	16	9	14	4<	16
Unappealing ^{A}	15<	30	47>	42	23	43	8<	37	21	52>	14<
Unfamiliar ^{A}	9<	18	32>	33>	13	31>	9<	25	20	23	8<
Unhealthy ^{F}	18	27	14	15	10<	32>	19	31>	15	21	13

Frequencies (with '>' or '<') are either significantly greater (>) or less than (<) the expected counts

Table 5.4: CD-CATA method: Frequency count (chi square test analysis) for positive^{+}, negative^{-}, 'unclassified^{u} emotions across products in pack condition (n=100)

	Products										
Emotions	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11
Adventurous^{+}	19	12<	42>	54>	4<	5	10	12	6	2<	8<
Amused^{+}	9	11	10	44>	3<	3	8	8	5	3<	7<
Annoyed^{-}	15>	7	0<	6	9	9	5	12	10	15>	3<
Approval^{+}	23<	61	63	47	27	31	25	35	22	28	62
At ease^{+}	19<	53>	26<	17<	31	29	29	34	28	32	49
Bored^{-}	26	9<	1<	4<	39>	39>	40>	32>	38>	42>	4<
Care free^{+}	8<	20	12<	22	12	9	20	17	18	21	21
Cautious^{-}	29>	7<	12<	19	15	17	16	17	20>	16	3<
Comforted^{+}	9<	45>	17	13<	13	16	14	17	7<	14	39>
Confused^{-}	26>	4<	6<	13	13	12	9	10	14	10	1<
Curious^{+}	31	11<	57>	49>	24	21	18	27	25	21	14<
Desire^{+}	15	24	50>	25	4<	4<	9	6<	6<	7<	27
Disappointment^{-}	14	7<	2<	5<	11	11	14	20>	16>	24>	3<
Disapproval^{-}	22>	13	1<	9<	17	18	17	15	22>	21>	1<
Discontent^{-}	16>	6<	1<	7<	13	10	12	13	16>	17>	2<
Disrespect^{-}	10>	2<	1<	3	4	4	4	7	4	10>	1<
Excitement^{+}	18	24	63>	63>	4<	4<	11	9<	5<	4<	30
Good^{+}	17<	56>	48	46	22	30	22	31	23	20<	57>
Happy^{+}	13<	46>	46>	45>	11<	11<	23	18	11<	12<	54>
Inspired^{+}	9	11	37>	27>	5	3<	6	8	1<	6	15
Interested^{+}	34	47	77>	77>	23	23<	31	32	29	20<	48
Love $^{+}$	4	11	18>	11	1<	0<	3	2	1<	0<	13
Not excited^{-}	22	13<	4<	7<	45>	40>	34>	28	42>	38>	13<
Not interested^{-}	29	10<	0<	9<	36>	42>	33>	31>	27	35>	8<
Overwhelmed^{+}	13>	0<	4	15>	1<	3	1<	5	4	0<	3
Patriotic^{+}	2<	27>	12	5	1<	2<	1<	0<	2<	3	25>
Pleased^{+}	18	46>	41	30	14	17	17	18	22	17	58>
Reminiscence^{+}	6	22>	7<	9	7	4<	6	3<	9	8	38>
Respect $^{+}$	10<	38	50>	22	16	17	13	9<	7<	14	51>
Responsible^{+}	4<	16	14	10	8	18>	10	12	4<	13	20
Satisfaction^{+}	11<	44>	36	20<	18	16	20	24	20	21	55>
Sceptical^{-}	29>	8<	4<	17	24>	19	23>	27>	18	15	5<
Special^{+}	6	11	45>	26>	5	1<	6	2<	1<	2<	18
Supportive^{+}	11<	37>	30	19	13	22	11	20	9<	21	35
Trust^{+}	13<	54>	32	19<	22	22	13<	10<	14	21	58>
Uncomfortable^{-}	20>	5<	0<	7	10	11	10	8	20>	14	0<
Warm^{+}	10	29	24	20	10	12	13	14	10	7<	33>
Worried^{-}	17>	6	3<	8	7	8	6	7	10	11	1<

Frequencies (with '>' or '<') are either significantly greater (>) or less than (<) the expected counts

Table 5.5: CD-CATA method: Frequency count (chi square test analysis) for abstract[A]/ functional[F] terms across products in pack condition (n=100)

	Products										
Abstract/ functional	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**	**P9**	**P10**	**P11**
Adult drink [F]	15	14	58>	15	12	12	7<	7<	13	9<	14
Affordable [F]	53	33<	6<	11<	63>	61>	61>	57	62>	56	39
Artificial [A]	34>	16<	1<	7<	20	27	31>	34>	30>	41>	3<
Attractive [A]	32	74>	83>	68>	19<	17<	30	36	29	13<	77>
Bad for your teeth [F]	51>	7<	20<	19<	39>	14<	37>	9<	48>	20	38
Basic [F]	41	17<	9<	9<	53>	62>	69>	69>	51	71>	15<
Cheap [F]	59>	9<	1<	4<	41	34	59>	67>	50>	69>	4<
Childish [A]	1<	12	0<	67>	2<	4<	12	13	4<	3<	14
Colourful [A]	35	62>	36	80>	15<	21<	29	39	31	17<	58>
Convenient [F]	23	29	9<	11<	31	37>	34	26	31	38>	28
Different [A]	29>	14<	52>	56>	14	5<	6<	5<	11	9<	13<
Easy to read [F]	38<	72	65	46<	72	72	73	75	75	67	74
Environmentally friendly [F]	20<	44	46>	49>	26	28	27	25	18<	26	40
Ethical [A]	2<	15	29>	30>	3<	2<	6	4<	1<	2<	21>
Everyday drink [F]	31	50	7<	16<	44	56>	44	58>	41	52>	40
Expensive [F]	5<	40>	89>	66>	9<	3<	1<	0<	3<	0<	48>
Familiar [A]	10<	72>	7<	6<	34	26	34	35	27	41	82>
Family drink [F]	26<	57	15<	42	41	45	43	46	42	45	54
Fresh [F]	12	37>	37>	36>	9<	7<	9<	11<	9<	7<	38>
Fun [A]	10<	42>	22	71>	6<	2<	10<	9<	5<	3<	35>
Generic [A]	17	5<	6<	2<	30>	36>	25	28	31>	36>	12<
Good for your teeth [F]	1<	31>	10	13	2<	23>	3<	24>	1<	19>	5<
Good quality [F]	20<	67>	86>	70>	22<	18<	11<	13<	17<	8<	79>
Hard to read [F]	31>	7<	8	15	10	10	9	11	9	7	9
Healthy [F]	13<	48>	40>	35	21	28	10<	24	12<	12<	27
Helps to control my weight [F]	1<	27>	5<	5<	0<	19>	1<	22>	1<	18>	3<
Honest [A]	13<	43>	54>	30	22	23	18	23	15<	15<	41>
Imitation [A]	29>	5<	3<	3<	16	23	35>	34>	34>	22	2<
Low in calories [F]	9<	63>	10<	11<	11<	51>	5<	59>	8<	54>	5<
Mixed messages [F]	18>	6<	6<	12	13	15	8	7	13	12	6
Modern [A]	16<	43	36	62>	18<	23	31	33	18<	31	29
Nasty [F]	20>	6	0<	1<	9	17>	9	15	10	18>	1<
Natural [A]	13<	45>	72>	46>	24	17<	13<	18<	18	8<	44>
Occasional drink [F]	23	20	41>	37>	25	12<	19	10<	18	8<	22
Old fashioned [A]	40>	12<	37>	11<	29>	26	17	13<	21	13<	19
Pointless [A]	18>	3<	1<	5	9	9	9	14	8	13	2<
Poor quality [F]	44>	3<	1<	6<	16	19	30>	27	24	40>	0<
Pretentious [A]	12	7	20>	15	8	4<	9	4<	11	6	4<
Refreshing [F]	9<	40>	38>	32	14	10<	14	17	14	16	45>
Traditional [A]	31	42	51>	17<	30	25	21	14<	32	12<	63>
Treat [F]	8<	15	67>	50>	6<	1<	9<	5<	7<	2<	35>
Unappealing [A]	49>	9<	0<	10<	44>	42>	36>	27	35>	42>	3<
Unfamiliar [A]	57>	1<	36>	40>	16	20	11<	20	24	14	1<
Unhealthy [F]	32>	7<	5<	9<	17	9<	22	11	31>	15	18
Vague claim [F]	30	35<	17	11<	33>	42>	49	40	41	52	25<
Value for money [F]	30	35	17<	11<	33	42	48>	40	41	52>	25<

Frequencies (with '>' or '<') are either significantly greater (>) or less than (<) the expected counts

Table 5.6: CD-CATA method: Frequency count (chi square test analysis) for positive$^+$, negative$^-$, 'unclassified^U' emotions across products in informed condition (n=100)

	Products										
Emotions	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**	**P9**	**P10**	**P11**
Adventurous$^+$	23>	3<	19>	21>	5	4<	7	4<	9	2<	10
Amused$^+$	18>	5	6	9	6	3<	6	5	12	4	11
Angry$^-$	1<	6	8	12>	2	5	2	11>	2	9	0<
Annoyed$^-$	8<	24	26	30>	8<	30>	9<	27>	11	20	3<
Approval$^+$	54>	38	28	21<	38	21<	44>	21<	52>	26	56>
At ease$^+$	32	24	24	17<	31	19	36>	21	23	21	51>
Bored$^-$	4<	16	5<	6<	16	27>	7	11	12	25>	6<
Care free$^+$	15	16	13	13	15	10	16	9<	17	18	33>
Cautious$^-$	19	13	11	30>	10	14	14	23	14	22	6<
Comforted$^+$	26	26	13	10<	24	11<	25	10<	21	11<	40>
Confused$^-$	14	20	25	26	20	20	15	11	12	16	11<
Curious$^+$	25	13	27	27	11	16	22	11<	21	16	14
Desire$^+$	14	12	16	6<	9	4<	8	6	17	6	23>
Disappointment$^-$	7<	35	35	40>	23	45>	9<	33	15<	31	13<
Disapproval$^-$	14<	25	27	30	22	32>	8<	40>	14<	34>	5<
Discontent$^-$	9<	15	20	24	13	25>	6<	33>	7<	22	6<
Disgusted$^-$	5<	15	21	21	11	21>	7	22>	7<	21>	1<
Displeasure$^-$	9<	19	35>	36	22	39>	9<	37>	17	33>	6<
Disrespect$^-$	3<	9	10	12	6	11	5	20>	1<	25>	1<
Excitement$^+$	26>	3<	20	19	10	7	11	6<	15	2<	18
Good$^+$	59	42	36	33<	48	28<	60>	30<	62>	33	72>
Guilty pleasure^U	21>	9	11	9	8	3<	14	6	16	1<	22>
Happy$^+$	44>	26	30	25	30	14<	32	15<	39	20	52>
Inspired$^+$	19>	2<	14	12	4	3<	7	4	7	4	14
Interested$^+$	50>	21<	33	32	27	17<	39>	20<	40	18<	42
Love$^+$	12	9	11	8	5	6	6	3<	11	2<	29>
Not excited$^-$	17<	52>	31	44	41	61>	31	51>	27<	51>	18<
Not interested$^-$	6<	23	9<	25	17	34>	11	30>	21	27>	6<
Patriotic$^+$	1<	23>	10	2<	0<	0<	1<	0<	4	1<	32>
Pleasant surprise$^+$	60>	17<	21<	23	33	17<	45>	20<	46>	19<	24<
Pleased$^+$	47	28	33	29	39	18<	48>	25<	41	27	61>
Regret$^-$	7	12	10	17	6	14	6	16	4<	15	3<
Reminiscence$^+$	11	20	6<	8<	13	3<	16	5<	9	11	42>
Resentment$^-$	2<	13	10	10	6	17>	6	16	8	19>	5<
Respect$^+$	20	14	19	13	15	10	14	10	13	8<	36>
Satisfaction$^+$	38	35	29	27<	37	19<	44>	18<	43	32	61>
Sceptical$^-$	10	12	11	18	11	11	12	14	18	16	5<
Shocked$^-$	21	16	25	26	17	20	14	20	15	11	8<
Sickly$^-$	20	23	15	15<	15	29	15	43>	24	28	8<
Special$^+$	12	10	23>	14	5	5	6	6	11	3<	20>
Supportive$^+$	20	21	15	12	11	14	16	10<	22	10	32>
Trust$^+$	9<	27>	17	15	14	14	9<	9<	18	11	47>
Uncomfortable$^-$	4<	14	11	20	12	22>	10	25>	8<	28>	5<
Unhappy$^-$	5<	15	18	22	10	23>	7<	37>	8<	25>	5<
Unpleasant surprise$^-$	12<	22	36>	41>	16	34>	12<	39>	10<	25	8<
Warm$^+$	17	17	14	11	10	6<	15	8<	15	10	35>
Worried$^-$	8	8	7	13	6	10	5	22>	6	14	1<

Frequencies (with '>' or '<') are either significantly greater (>) or less than (<) the expected counts

Table 5.7: CD-CATA method: Frequency count (chi square test analysis) for abstract^{A}/ functional^{F} terms across products in informed condition (n=100)

	Products										
Abstract/ functional	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**	**P9**	**P10**	**P11**
Adult drink ^{F}	16	15	59>	15	11	11	4<	9<	12	3<	21
Affordable ^{F}	17	27	28	34>	22	22	18	15	18	14<	30
Artificial ^{A}	16	47>	7<	4<	27	13<	26	13<	26	20	64>
Attractive ^{A}	28	28	8<	7<	25	25	32	34	33	30	26
Bad for your teeth ^{F}	7<	37>	28	31>	14	25	10<	21	7<	18	23
Basic ^{F}	35	30	56>	34	33	12<	24	10<	35	6<	53>
Cheap ^{F}	3<	13	17>	27>	2<	2<	2<	1<	2<	3<	10
Childish ^{A}	6	10	0<	38>	2<	1<	7	11	3<	6	13
Colourful ^{A}	21	5<	13<	25	33>	46>	24	29	24	43>	2<
Convenient ^{F}	32	11<	6<	5<	48>	50>	56>	52>	47>	72>	10<
Different ^{A}	34	39	39	35	29	18<	31	15<	27	11<	48>
Environmentally friendly ^{F}	14	16	23	24	15	23	16	28>	16	13	11<
Ethical ^{A}	1<	24>	5	6	0<	23>	2<	15	0<	19>	5
Everyday drink ^{F}	51	53	6<	13<	55	54	61>	52	52	61>	55
Expensive ^{F}	55>	6<	0<	2<	38	52>	47>	69>	41	71>	4<
Familiar ^{A}	36<	70	61	51	64	58	67	62	66	68	73
Family drink ^{F}	38	61>	10<	33<	46	40	55>	48	43	49	62>
Fresh ^{F}	12	9	9	15	7	21>	4<	26>	4<	21>	2<
Fun ^{A}	20	25	12	52>	11	8<	13	12	12	5<	33>
Generic ^{A}	21	14<	8<	4<	37>	36>	33>	29	34>	42>	7<
Good for your teeth ^{F}	32>	8<	10<	13	29>	13	24	22	28>	19	17
Good quality ^{F}	39	56>	75>	47	31	21<	26<	12<	41	11<	75>
Hard to read ^{F}	13	8	10	19>	12	14	5	8	12	6	6
Healthy ^{F}	61>	31	13<	6<	37	31	53>	35	55>	41	26<
Helps to control my weight ^{F}	3<	32>	8<	13	6<	31>	2<	26>	3<	24>	10
Honest ^{A}	9<	28	25	19	19	14	13	16	21	22	39>
Imitation ^{A}	13	6<	4<	8<	21	27>	23	34>	18	23	1<
Like real fruits ^{F}	29	35	11<	22<	26	39	34	63>	28	57>	9<
Low in calories ^{F}	53>	16<	26	21<	48>	14<	45>	18<	48>	18<	45
Mixed messages ^{F}	15	8<	5<	25	34>	32>	10	14	19	27>	3<
Modern ^{A}	13	26	21	36>	18	16	19	18	15	24	17
Nasty ^{F}	23	23	53>	38>	27	17	14<	13<	21	8<	41>
Natural ^{A}	25	10<	19	32>	18	22	12	23	14	17	2<
Not refreshed ^{F}	12<	20	21	23	19	38>	12<	39>	15	28	4<
Not thirst quenching ^{F}	7<	57>	13<	11<	9<	53>	4<	43>	2<	60>	6<
Occasional drink ^{F}	20	18	37>	30	19	16	16	8<	28	8<	27
Old fashioned ^{A}	23	13	32>	9<	18	16	6<	9<	17	11	17
Pointless ^{A}	6<	6<	11	21>	12	24>	10	19	7	20	3<
Poor quality ^{F}	21	12<	6<	23	23	34>	26	41>	15	45>	2<
Pretentious ^{A}	7	7	27>	19>	10	11	6	5	3<	3<	4<
Refreshed ^{F}	56>	39	43	41	43	25<	52	30<	52	35	65>
Strange ^{A}	15	15	21	37>	12	24	10<	28>	12	24	5<
Traditional ^{A}	34	33	34	15<	23	13<	22	10<	24	14<	51>
Treat ^{F}	18	17	50>	34>	5<	1<	10	3<	11	0<	30>
Unappealing ^{A}	17	8<	36>	38>	6<	9	7<	9	11	14	7<
Unfamiliar ^{A}	39>	7	9	11	5	10	6	5<	4<	8	8
Unhealthy ^{F}	5<	37>	81>	69>	2<	2<	0<	2<	1<	0<	43>
Vague claim ^{F}	32	48	36	62>	15<	23<	24	38	34	18<	55>
Value for money ^{F}	58>	31<	8<	5<	60>	51	68>	44	64>	55	40

Frequencies (with '>' or '<') are either significantly greater (>) or less than (<) the expected counts

5.2.3 Comparison of emotion and abstract/functional conceptualisations across blind, pack and informed conditions

Figure 5.2 shows the variable MFA emotion plot comparing emotional profiles obtained under blind, pack and informed conditions. The blind and informed emotional terms loaded heavily on the first dimension, which accounted for about 41% of the variance in the dataset. On the other hand, the pack emotional terms loaded heavily on the second dimension which accounted for about 27% of the variance in the dataset. The first two dimensions are represented at opposing ends by positive and negative emotional terms which are also in line with previous chapter EsSense Profile study (section 4.2.3). There was a slight difference in specific quality of emotions loaded on either end of the first and second dimension for the three conditions. For example, the first dimension of the MFA emotion plot for blind condition (terms coloured in red) was associated with positive emotions such as 'at ease' and negative emotions such as 'displeasure', whereas for informed condition (terms coloured in green) it was associated with positive emotions such as 'good' and negative emotion like 'resentment'. The second dimension of MFA emotion plot for pack condition (terms coloured in blue), however, moved from positive emotions like 'respect', 'approval' through to negative emotions such as 'sceptical', 'disapproval'.

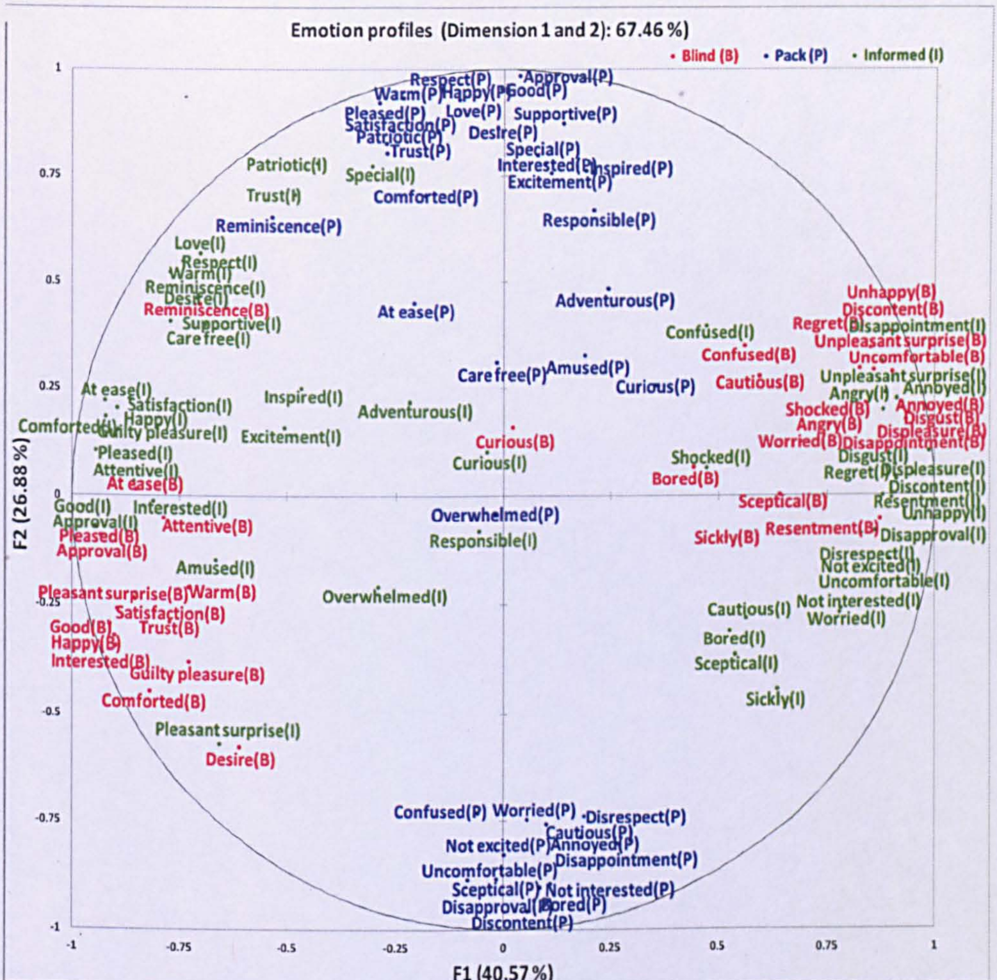
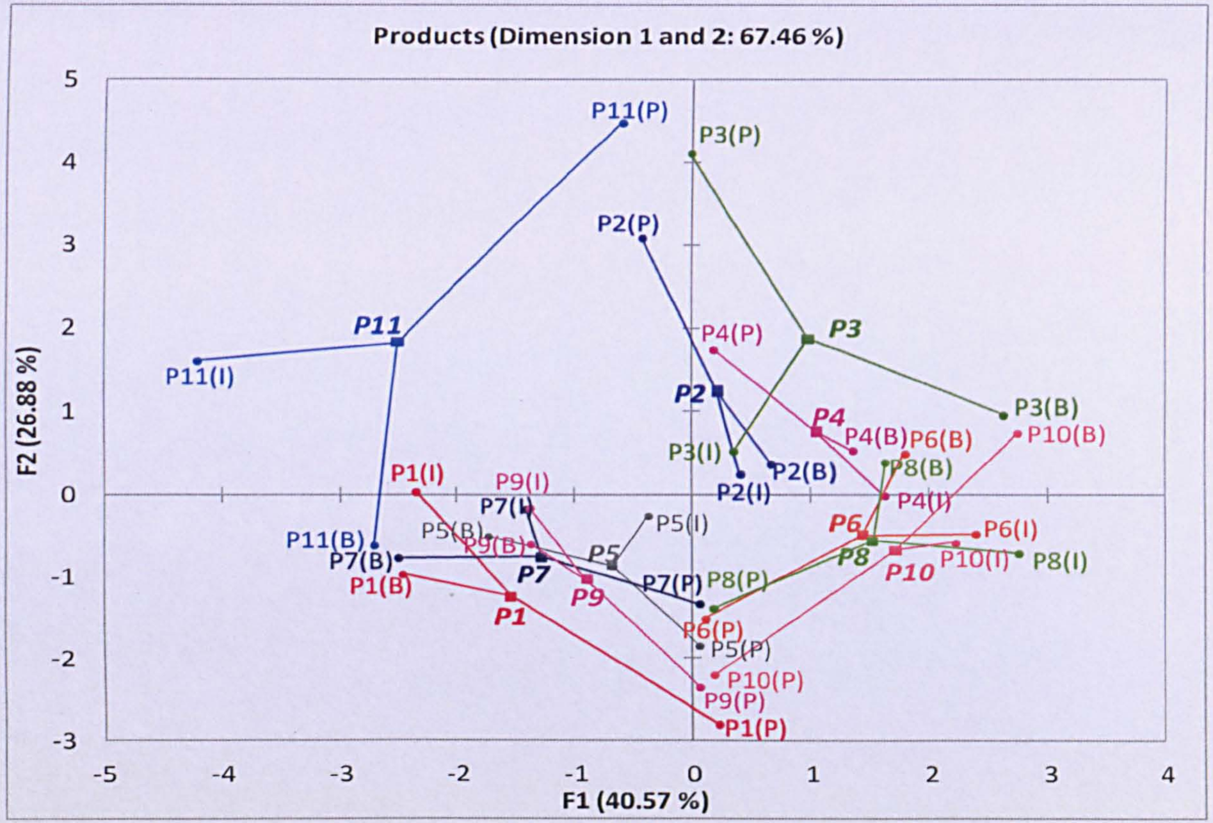


Figure 5.2: CD-CATA method: MFA emotion plots obtained from blind (B), pack (P) and informed (I) conditions (n=100)

The MFA product plot as illustrated by Figure 5.3 compared the positioning of individual products in the emotional space obtained from the blind, pack and informed conditions, respectively. Although the data were collected from another group of consumers, individual product positioning was found similar to that obtained from the previous EsSense Profile study (as discussed in section 4.2.3). In the blind condition, niche AS squashes (products 3 and 4) as well as all NAS squashes (products 2, 6, 9 and 10) were positioned with unpleasant emotions at the far right of the first dimension whereas standard



Each product[1] is represented using three points corresponding to each condition: blind (B), pack (P) and informed (I), and its compromise position in the middle

Figure 5.3: CD-CATA method: Superimposed representation of the products[1] in the MFA emotional space taking into account of three conditions: blind (B), pack (P) and informed (I) (n=100)

AS squashes (products 1, 5, 7, 9 and 11) were positioned with pleasant emotions, to the left of the first dimension. The product configuration observed in blind condition was similar to the one obtained in the informed condition. Indeed, the average product configurations of the blind and informed conditions were more closely aligned (see Figure 5.1b). The latter can be confirmed by a high RV coefficient of 0.8. There was no particular distribution of products relating to market segment or brands under the blind and informed tastings and therefore the product positioning are likely to be driven by the sensory attributes of the products (this will be discussed further in chapter 7). On the other hand, products seem to distribute according to their market segments and brands, regardless of whether they were AS or NAS products, when consumers were only cued by the packaging of the products. For example, private label squashes (products 2, 3, 4 and 11) were positioned with positive emotions on the top of the second dimension whereas retailer own brands (products 1, 2, 5, 6, 7, 8, 9 and 10) were positioned with negative emotions on the bottom of the second dimension.

5.2.4 Abstract/functional conceptualisations profiles

Figure 5.4 shows the MFA abstract/functional plot comparing abstract/functional conceptualisations obtained by the blind, pack and informed conditions. The pack abstract/functional terms were heavily loaded along the first dimension which accounted for about 36% of the variance in the dataset. On the other hand, the blind abstract/functional terms were heavily loaded on the second dimension which accounted for about 28% of

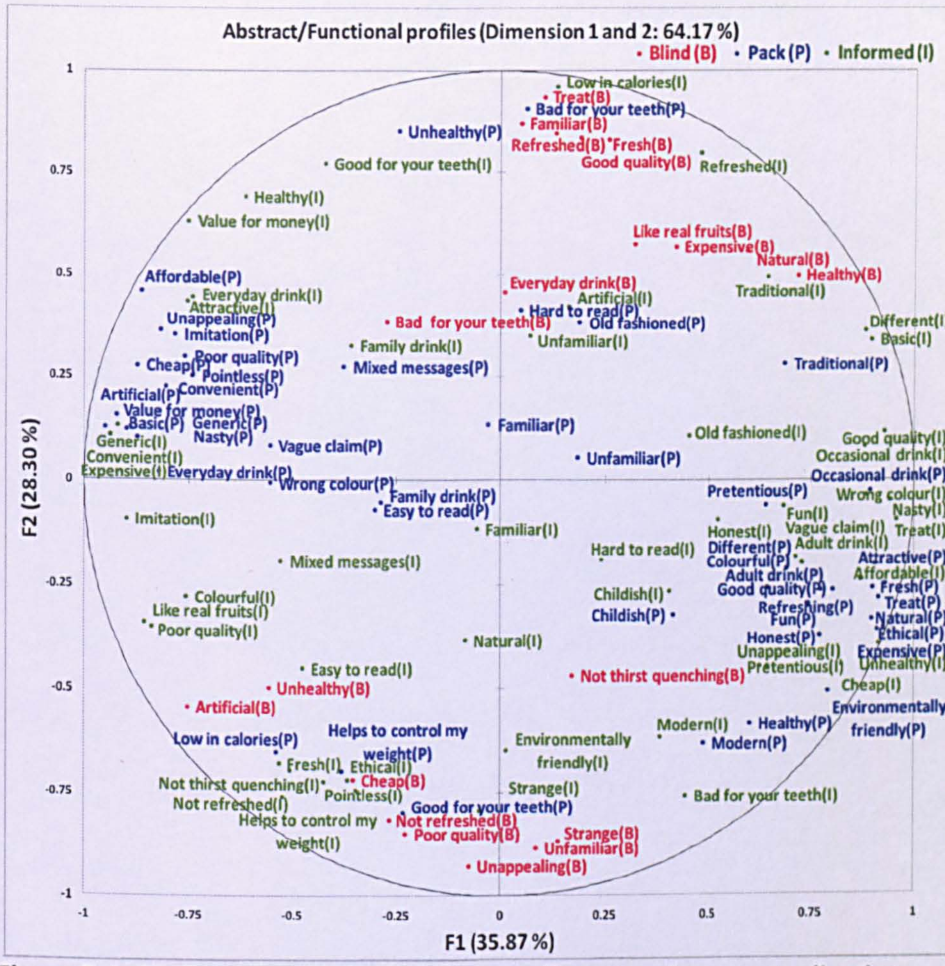
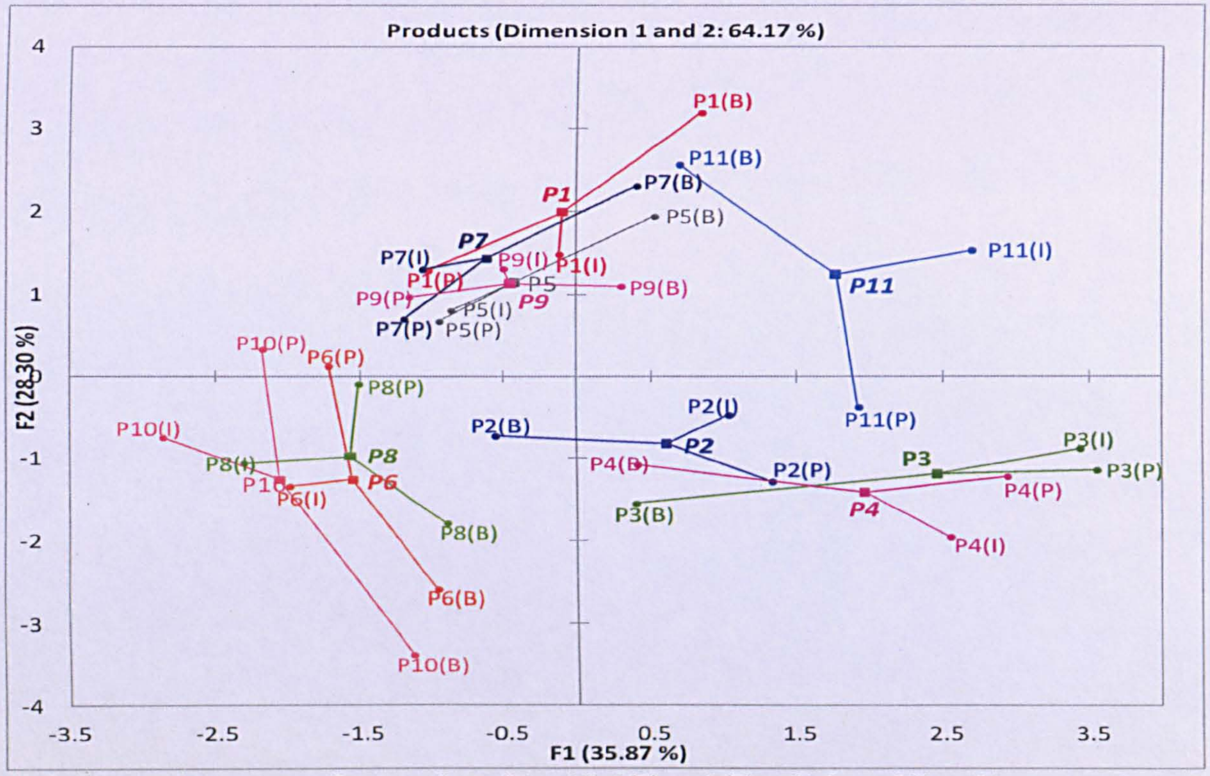


Figure 5.4: CD-CATA method: MFA abstract/functional conceptualisation plots obtained from blind (B), pack (P) and informed (I) condition (n=100)

the variance in the dataset. The informed abstract/functional terms, however, were scattered across the MFA plot (first and second dimensions) but many tended to align with pack abstract/functional terms along the first dimension. On the first dimension, pack abstract/functional terms shifted from left to right, from 'everyday drink' to 'occasional drink'; towards increased quality of product, moving from 'basic', 'value for money' to 'treat'. For the blind abstract/functional terms, the second dimension can be related to perceived familiarity and quality, moving from 'familiar', 'good quality' down to 'unfamiliar', 'poor quality'. There is no clear distribution of the informed abstract/functional terms, making it hard to interpret. For example, conflicting terms appeared close together, e.g. 'nasty' and 'treat'.

The MFA product plots (Figure 5.5) showed the positioning of individual products in the abstract/functional conceptual space obtained from blind, pack and informed conditions. In agreement with the emotion profiles, products seem to be distributed according to sensory attributes for blind tasting and according to their market segments and brands during pack assessment. For example, for the blind condition, standard AS squashes (products 1, 5, 7, 9 and 11) were positioned with positive abstract/functional terms versus niche AS squashes (products 3 and 4) and all NAS squashes (products 2, 6, 9 and 10) that were positioned with negative abstract/less functional terms along the second dimension. When consumers were cued by the packaging of the products retailer own brands of standard and economy AS and NAS squashes (products 1, 2, 5, 6, 7, 8, 9 and 10) were positioned with 'cheap', 'basic' and 'affordable' conceptualisations whereas private labels of standard and niche squashes (products 2, 3, 4 and 11) were positioned with for example 'good quality', 'treat' and 'expensive' conceptualisations, to the right of the plot. However, during the informed tasting, when consumers were also cued by packaging whilst consuming the squash, products were found to distribute according to their sensory attributes along the first dimension; standard AS squashes on the left side of the plot and niche AS and all NAS on



Each product[1] is represented using three points corresponding to each condition: blind (B), pack (P) and informed (I), and its compromise position in the middle

Figure 5.5: Superimposed representation of the products[1] in the MFA abstract/functional conceptualisations space taking into account of three conditions: blind (B), pack (P) and informed (I) (n=100)

the right side of the plot; but interestingly were distributed according to their market segments and brands along the second dimension; private labels versus retailer own brand. When comparing the average product configuration across all condition, pack and informed conditions were more closely aligned (see Table 5.1c). The latter was confirmed by a high RV coefficient of 0.9.

5.3 Discussion

5.3.1 Consumer lexicon

This study revealed that during the lexicon development stage, different product presentation conditions not only resulted in different conceptualisations but also in different numbers of conceptual terms. Indeed, over twice the number of abstract/functional terms was generated by packaging cues compared to blind product assessment. This suggests that it was easier for consumers to generate abstract/functional terms when appraising the product package than when just tasting the product blind. This supports the hypothesis that some abstract/functional conceptualisations are already formed prior to product consumption, based on the packaging of the products. A possible explanation for this is that the exposure to aspects of packaging can trigger cognitive processes like memory retrieval of previous experiences (Schoormans and Robben, 1997).

During consumer product evaluation, different conditions were also found to evoke different conceptualisations even in the same product. For example, the sensory attributes of product 3 significantly induced less 'happy' and more 'unappealing' conceptualisations, but the packaging cues of the same product significantly induced the opposite (Table 5.2 and Table 5.3 for blind condition; Table 5.4 and Table 5.5 for pack condition). In addition, although both sensory and packaging characteristics induced 37 common conceptual terms, the discriminative ability of some terms differed, depending on the presentation condition. For example, 'disappointment' and 'pleasant surprise' were more discriminating in the blind tastings (Table 5.2) whereas 'comforted' and 'trust' were more discriminating during the pack condition (Table 5.4). These findings demonstrated that the sensory attributes of the product did not affect consumers' conceptualisations in the same way as the product packaging. This is probably because the mechanism of how consumers perceive sensory attributes is different from how they perceive extrinsic packaging cues (Cardello, 2007). Schifferstein et al. (2013) have also recently claimed that the dominance of different sensory modalities in different stages of user-product interactions (e.g. vision was important at the buying stage, taste was important at consumption stage), may evoke different emotions and cognitive associations.

5.3.2 How liking and conceptualisation profiles change across blind, pack and informed conditions

Liking. This study shows that product packaging generally generates higher (expected) liking scores than blind and informed tastings, which is in line with the previous study discussed in chapter 4 which used a different group of consumers (see section 4.2.1). These results again indicate that the extrinsic product characteristics of the packaging heighten hedonic expectation. Nevertheless, the average product configuration of the 11 blackcurrant squashes, according to informed liking scores, was closer to blind liking scores (Figure 5.1a). Although packaging was suggested to heighten hedonic expectation, consumers' informed likings appeared to be influenced more by sensory attributes than any brand perception of the products gained from packaging cues. For example, AS squashes (e.g. products 1, 5, 7 and 9) moved from low expected liking scores of 'five' ('neither like nor dislike') to higher informed liking scores of 'six' ('like slightly'), probably because of the sweetness associated to the natural sweetener, an observation which was also made in relation to the EsSense Profile data (see section 4.3.2).

Emotions. Interestingly, consumer emotions were shown to follow liking patterns as the average product configuration of the 11 products determined in the informed condition was also closely aligned with the average product configuration determined in the blind condition (Figure 5.1b), which again is in line with the previous study as discussed in chapter 4 (see section 4.3.3). In addition, there was a clear disconnection between the package and blind/informed emotional terms (Figure 5.2). This clearly demonstrated that emotional response was influenced more by sensory attributes than packaging cues. For example, although the aesthetic packaging of niche products 3 and 4 evoked positive emotions such as 'interested', when these packages were presented with their corresponding products for consumption (informed condition), they evoked more negative emotions than positive emotions, e.g. 'unpleasant surprise' (see Table 5.4). Indeed, the sensory attributes of the niche products were found to evoke negative emotions, e.g. 'unhappy' (Table 5.2). This demonstrates the power of sensory attributes over the expectations built through the packaging cues in determining positive emotions and liking for most of the products (Murray and Delahunty, 2000).

Abstract/functional conceptualisation. Abstract/functional conceptual terms appeared to be influenced more by packaging cues; this is demonstrated in (Figure 5.1c) where the average product configuration of the pack and informed conditions were much more closely aligned. Although there was some synthesis between informed abstract/functional conceptualisations and those obtained from blind and pack conditions, there was more alignment between informed and pack abstract/functional conceptualisations (Figure 5.4). This has a very important implication that abstract/functional conceptualisations are more related to extrinsic packaging cues, which could potentially add invaluable insights in developing marketing strategies, for example when designing the brand and packaging. Many conceptualisations built from the packaging cues (e.g. 'old fashioned' and 'treat') were retained during the informed product assessment, demonstrating that the sensory consumption experience of the products did not change many of the abstract/functional conceptualisations. However, it is important to note there were some terms (e.g. 'natural') that were not retained during the informed tasting and some of these terms seem to be influenced by the sensory consumption experience. Not surprisingly these terms tended to link in some way to the sensory attributes, for example conceptual 'natural' may relate to the 'natural sweetness' and the nature of the flavour – blackcurrant (see chapter 3). This also explains why there was some synthesis between informed and blind abstract/functional conceptualisations in the first place.

5.3.3 Effect of product packaging on liking and total frequency of conceptual terms between blind and informed conditions

The results of this study indicated that although packaging may have resulted in an assimilation effect in product 2, 3, 4, 6, 7, 10 and 11 for liking, the effect was *not complete* for product 2, 3, 4, 6 and 7 (see Table 5.1). Assimilation effect was complete for products 10 and 11 where informed liking moved towards expectations, rather than actual blind liking assessment. Package derived positive emotions (e.g. 'good', 'happy' and 'satisfaction') of product 11 were also found to raise the total frequency counts for these positive emotions from a range value of 42 to 48 in the blind condition (Table 5.2) to a higher range value of 52 to 72 in informed condition (Table 5.6). The latter trend can also be observed in product 3, except that the total frequency counts of the above mentioned emotions in informed condition were lower than those checked in the pack condition. Although the packaging of economy product 10 induced significantly less positive emotions, 'good', 'happy' and 'satisfaction', and functional 'everyday drink' (pack condition; see Table 5.4 and Table 5.5), over twice the number of consumers checked the latter conceptualisations when tasting the product in the presence of the packing (informed condition; see Table 5.6 and Table 5.7) compared to the blind condition. Interestingly, the packaging of products 3 and 11 scored higher for some conceptualisations like 'expensive', 'fresh', 'healthy' and 'natural' (Table 5.6), however, it appeared that this only translated into an effect of 'good quality' in the informed condition (Table 5.7). This also suggests that raising conceptualisation of quality has increased the liking score in product 3 and 11. However, it should be noted that for most products liking scores did not change from the blind to the informed condition indicating that the packaging cues did not influence liking response.

5.3.4 Making sense of the relationship between conceptualisation and liking: an example

It is important to note that as this study assessed commercial products (not model system), we have attempted to relate the conceptualisation data to liking data based on the results that were obtained. However, this study shows that conceptualisation research may provide different insights in understanding certain food emotions and preferences and the following gives an example of how this can be achieved. Although the packaging of niche products 3 and 4 was conceptualised as 'unfamiliar' (Table 5.5), they scored high for expected liking ('seven' - 'like moderately') (Table 5.1). This could be due to the aesthetic packaging of niche products. One element that clearly differentiated them was that they were bottled in glass, whereas others were bottled in plastic. They were conceptualised as more in terms of 'good quality' and more 'expensive', demonstrating an association between weight and quality (Piqueras-Fiszman and Spence, 2012; Spence and Gallace, 2011). In addition, their packaging were also conceptualised as being 'different' from other products. This aligned with prior studies that showed that products that differed slightly from the prototype were evaluated more positively than products that were either very typical or atypical (Meyers-Levy and Tybout, 1989; Schoormans and Robben, 1997). It was proposed by Mandler (1982) that moderate atypical products stimulated enjoyment of product novelty and as a result consumers would evaluate the novel product more positively than one that is typical. This is known as the 'moderate incongruity effect' (Mandler, 1982). Interestingly, abstract conceptualisation has been suggested to be analogous to stepping stones that eventually lead to functional and/or emotional conceptualisation (Thomson et al., 2010). If this were true, the 'different' conceptualisation of niche private labelled products might have resulted in anticipatory activated emotions like 'adventurous', 'curious', 'excitement', 'inspired' and 'interested' (Table 5.4). It could be hypothesised that these heightened consumer hedonic expectation. In addition, the 'natural' conceptualisation could have led to functional 'fresh', 'good quality' and 'healthy' concepts in product 3 and 4 (Table 5.6). However, when sensory attributes of product 3 and 4 failed to deliver the conceptualisation gained from the extrinsic product packaging, consumers were 'unpleasantly surprised' by the products during informed tasting (Table 5.6) and ultimately disliked the products - their informed liking scores were lower than expected liking scores (Table 5.1).

5.4 Conclusion

To the author's knowledge, this is the first study to show that sensory attributes do not influence consumer liking and conceptualisations in the same way as product packaging. Extrinsic product characteristics such as brand, packaging and other information appear to have influenced abstract/functional conceptualisations more than the sensory attributes of the commercial blackcurrant squashes. The sensory consumption experience was, however, shown to deliver emotional impact, which is in line with findings obtained from the EsSense Profile study (chapter 4) as well as previous research (e.g. Gibson 2006; Chrea et al. 2009; Thomson et al. 2010; Porcherot, Delplanque et al. 2012). In addition, the results of the study also showed how package derived conceptualisations influenced the liking score, and conceptualisations frequencies between blind and informed conditions in a small number of products.

Before generalizing these findings across all contexts, trials testing the comparative effects of sensory attributes and packaging cues on conceptualisations in a more systematic manner are required, for example, through conjoint studies varying sensory attributes and aspects of packaging design. However, Meiselman (personal communication) has raised an interesting point that the relative roles of sensory attributes and packaging cues will have different strengths in different product categories, e.g. chocolate confection as compared with snack chips. Therefore, trials testing different food categories would also be needed to further investigate the hypotheses that follow the results obtained in the study.

Nevertheless, it is clear that additional abstract and functional conceptual data provide notable consumer insights that were not available via emotion measurement. Therefore, conceptualisation research will provide industry with a much better understanding of consumer choice behavior than emotion research and hence the opportunity for competitive advantage. The relationship between consumer conceptual response and sensory perceptions will be discussed later in chapter 7.

For now, the next chapter compares the measurement of emotion using EsSense Profile and CD-CATA methodologies and discusses how emotion measurement provides data beyond liking.

6 Beyond liking: comparing the measurement of emotions using EsSense Profile and CD-CATA methodologies

6.1 Introduction

Chapter 4 covered the application of EsSense Profile in measuring consumer emotions whereas chapter 5 discussed the application of a new method developed for this PhD study, CD-CATA, in measuring consumer conceptualisations. This chapter only focuses on the emotional data collected from CD-CATA and compares the effectiveness of the CD-CATA method and EsSense Profile in measuring consumers' emotional responses. In addition, for the purpose of this PhD, the comparison of EsSense Profile and CD-CATA method is made solely based on the liking and emotion data collected from blind condition (where consumers tasted the debranded products). It is beyond the scope of this thesis to discuss the data collected from pack and informed condition, however the data will be available for future studies.

To date, verbal self report techniques have been used most often in the sensory and consumer science arena and the lexicons used were generally drawn from published literature and generally not product specific (see section 1.2.4). In addition to selecting a lexicon, using verbal self report also raises the challenge of choosing an appropriate scale to rate emotions. Richins (1997) recommended four to six-point scale for measuring consumer emotions, however, she also suggested that this should be used as a starting point for further development. Indeed, quantitative measures have been widely used to measure emotions (Chrea et al., 2009; Ferdenzi et al., 2011a;

Ferrarini et al., 2010; King and Meiselman, 2010; Porcherot et al., 2012; Porcherot et al., 2010) but, asking consumers to rate a long list of emotion adjectives on Likert (or intensity) scales could be a source of bias as they involve an inevitable amount of cognitive processing which may distort the original emotional reaction, e.g. just thinking about rating emotions may change one's initial response. Nevertheless, they do provide the opportuntity for wider statistical analysis methodologies. CATA questions, on the other hand, allow respondents to simply check (or select) attributes that are relevant to them without having to be forced to rate all attributes on a scale. They have been reported to be more intuitive, more consumer friendly and to have minimal impact on consumers' perceptions of the product and hence minimise cognitive processing (Adams et al., 2007). Previous studies have demonstrated the effectiveness of the CATA approach in assessing consumers' sensory perceptions of a food product (Ares et al., 2010; Dooley et al., 2010; Perrin et al., 2008), but few studies have used them to assess emotions.

The main objectives of this chapter were to (i) compare the use of consumer generated emotion terminology (CD-CATA method) with a predetermined emotion lexicon of published EsSense Profile; and (ii) evaluate the effectiveness of CATA approach compared to intensity scaling used in EsSense Profile. In addition, a secondary but pertinent objective of this chapter was to determine whether emotional data collected from quantitative EsSense

Profile and qualitative CD-CATA methodology would provide additional data beyond liking within a commercial product category.

6.2 Results and discussion

6.2.1 Experiment 1: Quantitative EsSense Profile

6.2.1.1 Overall liking scores

Significant differences were found in consumers' overall liking for the products in blind conditions ($p < 0.005$) and product groupings indicated by the Tukey's HSD multiple comparison tests showed considerable overlap, but picked out a subgroup of three squashes (products 3, 4 and 10) with low liking scores (below 'five' neither like nor dislike) and a group with higher liking scores (products 1, 2, 7, 9, and 11) all scoring above 'six' ('like slightly') on the nine-point hedonic scale (Table 4.1). The 'liked' products corresponded to AS squashes from the standard market segment, with the exception of product 2, a NAS squash from the standard market segment. The three low scoring products were the niche market AS squashes (products 3 and 4) and the NAS economy squash (product 10). The correlation circle and product configuration biplot from the emotion PCA plot (Figure 6.1 and Figure 6.2, respectively) indicated that the average direction of liking was correlated with positive emotions, in a direction towards standard AS products and away from the niche AS products, as well as both standard and economy NAS squashes.

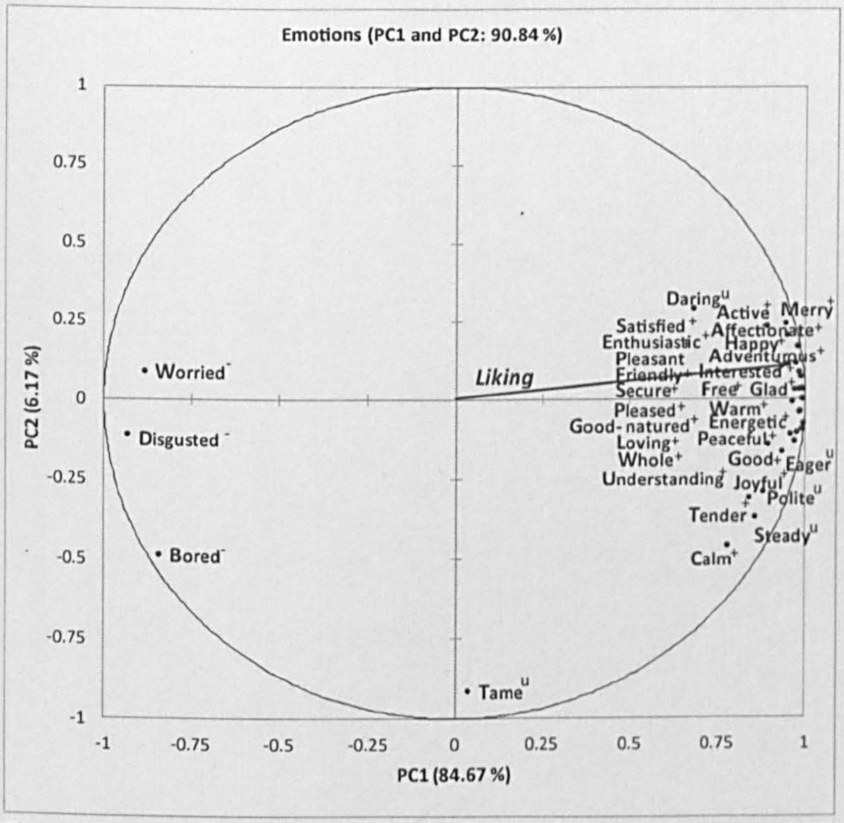


Figure 6.1: PCA correlation circles of the emotions (PC1 vs. PC2) obtained from EsSense Profile (n=100)

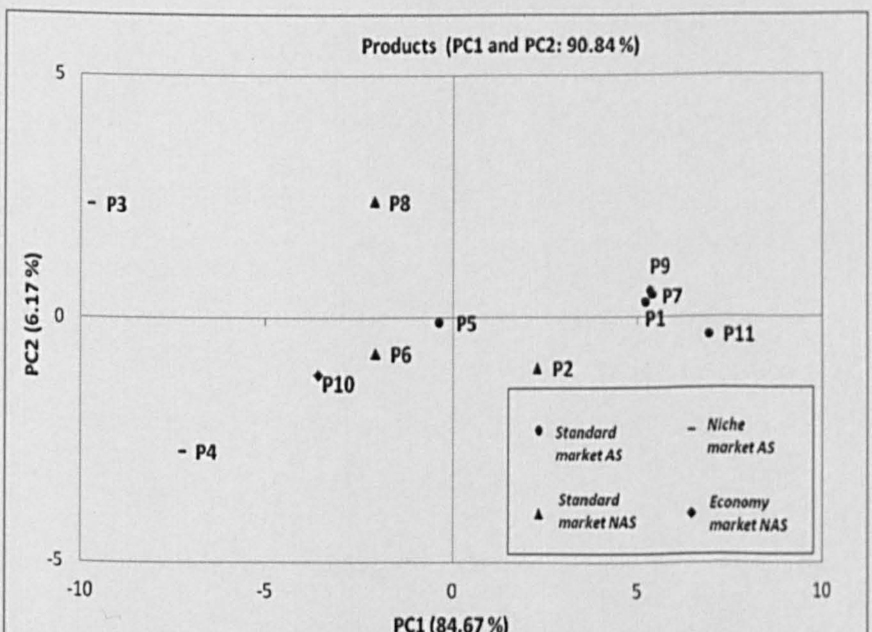


Figure 6.2: PCA analysis product plot (PC1 vs. PC2) obtained from EsSense Profile (n=100)

6.2.1.2 Emotional response from EsSense Profile

As discussed earlier in chapter 4, significant product differences were observed for 33/39 emotions for blind condition ($p < 0.05$); the product groupings indicated by the Tukey's HSD multiple comparison tests (Table 4.2) showed that some emotions were very discriminating, e.g. 'active', 'disgust', 'energetic', 'friendly', 'good', 'good-natured', 'happy', 'joyful', 'merry', 'pleased', 'pleasant', 'satisfied' and 'warm', all had several distinct subgroups of products. Results obtained Tukey's HSD multiple comparison tests (Table 4.2) were used to help interpret PCA emotion plot.

The first two PCs of the PCA emotion plot accounted for 90.8% of the variance in the data. Figure 6.1 shows the correlation circle for PC1 versus PC2. PC1 (84.7%) was positively correlated with 24 positive emotions (i.e. 'active', 'adventurous', 'affectionate', 'calm', energetic', 'enthusiastic', 'free', 'friendly', 'glad', 'good', 'good-natured', 'happy', 'interested', 'joyful', 'loving', 'merry', 'peaceful', 'pleasant', 'pleased', 'satisfied', 'secure', 'tender', 'warm' and 'whole') and six unclassified emotions (i.e. 'daring', 'eager', 'polite', 'steady', 'tame' and 'understanding') and negatively correlated with three negative emotions (i.e. 'worried', 'bored', 'disgusted'). PC2 was negatively correlated with 'tame', an unclassified emotion. Interestingly, most of unclassified terms, with the exception of 'tame', were highly correlated with positive emotion terms in this study suggesting, that for blackcurrant squashes, most unclassified terms in the EsSense Profile would be deemed more positive than negative.

The PCA product plot of PC1 versus PC2 (Figure 6.2) shows that the standard AS squashes (products 1, 7, 9 and 11) were projected towards positive emotions on the right of the plot, whereas niche AS squashes (products 3 and 4) were projected towards negative emotions on the left of the plot. Product 4 was negatively associated with PC2 and therefore related with 'tame' whereas products 3 and 8 were positively associated with this component. The plot also indicated that the remaining squashes (products 2, 5, 6, 8 and 10) were positioned more towards the middle of the plot, with NAS product 2 going slightly against the trend of other standard NAS products. Product 5 was also somewhat separated from other standard AS products. These differences could be attributed to the different temporal sensory properties observed in these products in the sensory study (see chapter 3). For example, unlike other standard AS products which were mainly dominated by sweetness and blackcurrant flavour, product 5 was mainly dominated by an acidic sensation (see Figure 3.5).

6.2.1.3 *Does EsSense Profile go beyond liking?*

A high correlation between liking scores and positive and unclassified emotions was observed (Table 6.1), indicating that overall liking scores were not only associated with positive emotions but also with unclassified emotions such as, 'eager', 'polite', 'steady' and 'understanding'.

Table 6.1: Correlation coefficient between emotions (positive^{+}, negative^{-} and unclassfied^{u}) and liking for EsSense Profile and CD-CATA data

EsSense		CD CATA	
	Liking		Liking
Active^{+}	**0.951**	Angry^{-}	**-0.786**
Adventurous^{+}	**0.881**	Annoyed^{-}	**-0.934**
Affectionate^{+}	**0.876**	Approval^{+}	**0.929**
Bored^{-}	**-0.828**	At ease^{+}	**0.835**
Calm^{+}	**0.782**	Attentive^{+}	**0.684**
Daring^{u}	0.458	Bored^{-}	-0.519
Disgusted^{-}	**-0.982**	Cautious^{-}	**-0.669**
Eager^{u}	**0.947**	Comforted^{+}	**0.880**
Energetic^{+}	**0.976**	Confused^{-}	-0.537
Enthusiastic^{+}	**0.953**	Curious^{+}	-0.044
Free^{+}	**0.904**	Desire^{+}	**0.754**
Friendly^{+}	**0.879**	Disappointment^{-}	**-0.944**
Glad^{+}	**0.958**	Discontent^{-}	**-0.945**
Good^{+}	**0.952**	Disgust-	**-0.930**
Good- natured^{+}	**0.906**	Displeasure^{-}	**-0.954**
Happy^{+}	**0.890**	Good^{+}	**0.989**
Interested^{+}	**0.935**	Guilty pleasure^{u}	**0.836**
Joyful^{+}	**0.951**	Happy^{+}	**0.977**
Loving^{+}	**0.930**	Interested^{+}	**0.957**
Merry^{+}	**0.906**	Not refreshed^{-}	**-0.843**
Peaceful^{+}	**0.824**	Pleasant surprised^{+}	**0.872**
Pleased^{+}	**0.949**	Pleased^{+}	**0.931**
Pleasant^{+}	**0.931**	Regret^{-}	**-0.875**
Polite^{u}	**0.818**	Reminiscence^{+}	0.556
Satisfied^{+}	**0.960**	Resentment^{-}	**-0.816**
Secure^{+}	**0.814**	Satisfaction^{+}	**0.942**
Steady^{u}	**0.744**	Sceptical^{-}	**-0.677**
Tame^{u}	0.110	Shocked^{-}	**-0.844**
Tender^{+}	**0.784**	Sickly^{-}	-0.351
Understanding^{u}	**0.864**	Trust^{+}	**0.763**
Warm^{+}	**0.841**	Uncomfortable^{-}	**-0.873**
Whole^{+}	**0.864**	Unhappy^{-}	**-0.947**
Worried^{-}	**-0.800**	Unpleasant surprise^{-}	**-0.959**
		Warm^{+}	**0.733**
		Worried^{-}	**-0.702**

Pertinently, many of the emotion terms were more discriminating than liking, despite the fact that emotional measures were only made using a five-point scale. For this product category, emotional measures were able to provide increased product differentiation compared to the hedonic response (Table 4.1 and Table 4.2) by further discriminating products with similar liking scores (high vs. low). For example, in the 'low liked group', product 3 was perceived as significantly less 'tame' than products 4 and 10, but product 4 was significantly more associated with 'disgust' than product 10. On the other hand, in the 'high liked group' (i.e. products 1, 2, 7, 9 and 11), product 2, which was the only NAS squash, was discriminated further using the emotional data. It was rated as being significantly less 'adventurous' than product 9, significantly less 'daring' than product 11 and significantly less 'good-natured' than product 7 (Table 4.2). The latter observations are important because the emotional attributes show that although this NAS product was similarly liked to the AS squashes, the emotional responses were very different. In addition, although the two niche AS products were similarly disliked, they were discriminated by the emotion 'tame' on PC2. Product 4 was perceived to be significantly more 'tame' than product 3. Clearly the emotional analysis from EsSense Profile goes beyond that of the liking data in terms of discrimination.

6.2.2 Experiment 2: Qualitative CD-CATA methodology

6.2.2.1 Overall liking

As with the previous EsSense Profile experiment, significant differences were found in consumers' overall liking for the products ($p < 0.005$); product groupings indicated by the Tukey's HSD multiple comparison tests were similar, albeit fewer, to those obtained from the consumers participating in the EsSense Profile experiment (Table 5.1). Products 1, 2, 7, 9, and 11 were still grouped as scoring high for liking, with the addition of product 5. Products 3, 4 and 10 scored low (below 'neither like nor dislike'), but this time products 6 and 8 were also contained within this subgroup. These results confirmed that consumers generally preferred standard AS squashes over the NAS squashes and the niche AS squashes. It is important to reiterate that this was a blind test where consumers had no knowledge of product types and hence assessments were made solely on the sensory attributes of the products.

6.2.2.2 Emotional response from CD-CATA

As discussed earlier in chapter 5, chi-square tests of independence indicated that 30/33 terms were not independent of products for blind condition, as listed in Table 5.2. Some emotions appeared to be very discriminating: 'at ease', 'disappointment', disgusted', 'displeasure', 'pleased', 'good', 'happy', 'pleasant surprise', 'satisfaction' and 'unpleasant surprise'. Results obtained from chi-square test of independence (Table 5.2) were used to help interpret CA emotion plot and MCA emotion plot.

The CA emotion plot performed on the total frequency consumer counts for each emotion term resulted in two dimensions accounting for 88.5% of variance in the data (Figure 6.3). The first dimension (82.8%) was positively associated with pleasant emotions (e.g. 'happy', 'good', 'satisfaction', 'pleased', 'interested' and 'pleasant surprise') and negatively associated with unpleasant emotions (e.g. 'displeasure', 'unpleasant surprise', 'disappointment', 'discontent' and 'disgust'). The second dimension was related to the level of engagement/activation associated with emotions. For example, it was positively correlated with more engaging/activated emotions (e.g. 'shocked', 'sickly,' and 'desire') and negatively associated with less engaging/activated emotions (e.g. 'at ease' and 'bored'). Interestingly, these two dimensions of emotional response (i.e. pleasantness versus engaging/activation) are in line with the multidimensional circumplex models of emotional response (Larsen and Diener, 1992; Russell, 1980). In addition, Larsen and Diener (1992) categorised emotions along the 45 degree angles within each quadrant as activated pleasant (45^{o}), activated unpleasant (135^{o}), unactivated pleasant (225^{o}), and unactivated unpleasant (315^{o}) (Figure 1.2) and this categorisation can also be observed in the distribution of emotion terms in the CA plot from this experiment (Figure 6.3).

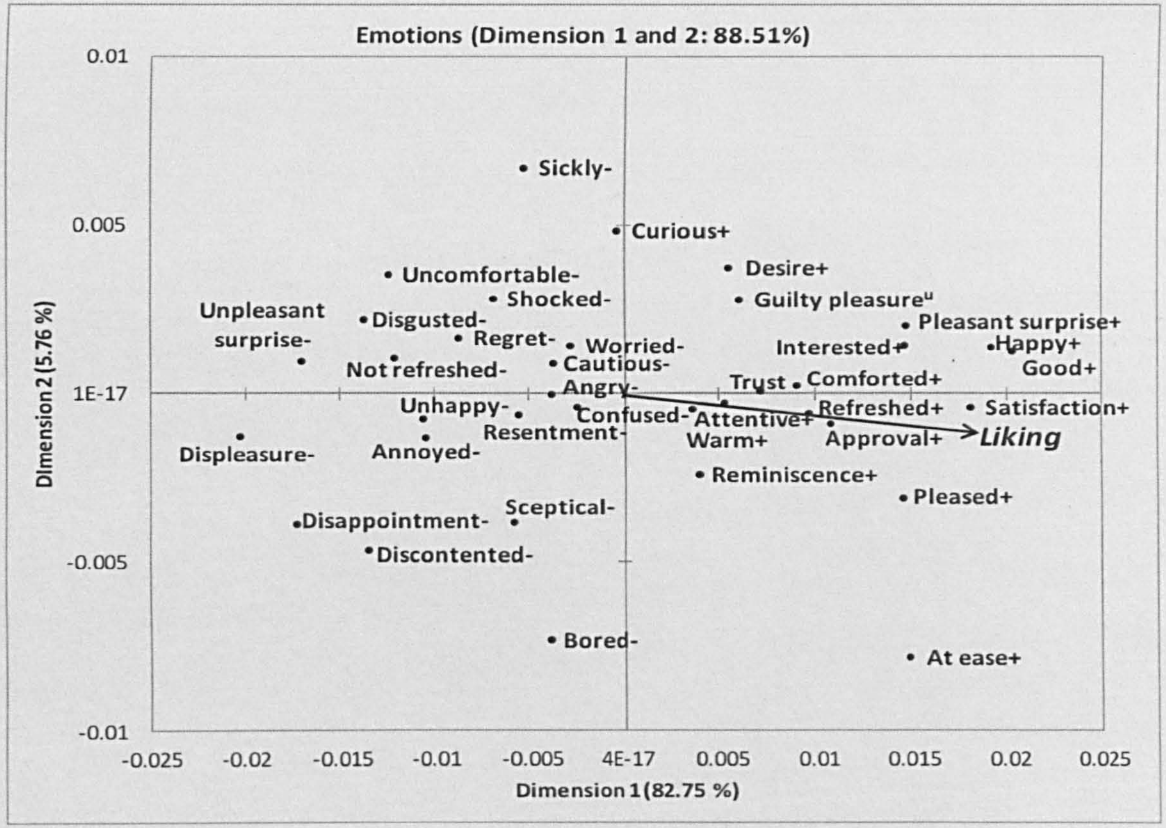


Figure 6.3: CA emotion plot (Dimension 1 vs. Dimension 2) obtained from CD-CATA total frequency counts (liking is considered as supplementary variable) (n=100)

The CA product plot (Figure 6.4) shows product positioning in the emotional space. Niche AS squashes and all NAS squashes were positioned with unpleasant emotions at the far left of the first dimension. By contrast, standard AS squashes were positioned with pleasant emotions, to the right of the first dimension. However, whilst standard AS squashes (products 1, 5, 7, 9 and 11) were distributed with pleasant emotions, they were separated by the second dimension related to level of engagement. For example, product 1 was positioned more closely to the activated emotion 'desire' whereas product 5 was positioned towards the less activated emotion 'at ease'. Although products were separated by the second dimension associated with level of engagement/activation, there was no particular distribution of products relating to market segment and we hypothesise that it may be related to particular sensory attributes. For example, unlike other standard AS products, product 5 was mainly dominated by acidic sensations (see Figure 3.5). Furthermore, whilst niche AS squashes (product 3 and 4) and all NAS squashes (products 2, 6, 8 and 10) were positioned with unpleasant emotions on the first dimension, the second dimension separated out product 8 towards the more activated, unpleasant emotions of 'sickly', 'shocked' and disgust'. Product 10 was separated by the less activated unpleasant emotions 'disappointment' and 'bored'. The relationship between sensory attributes and emotional response will be further discussed in the next chapter.

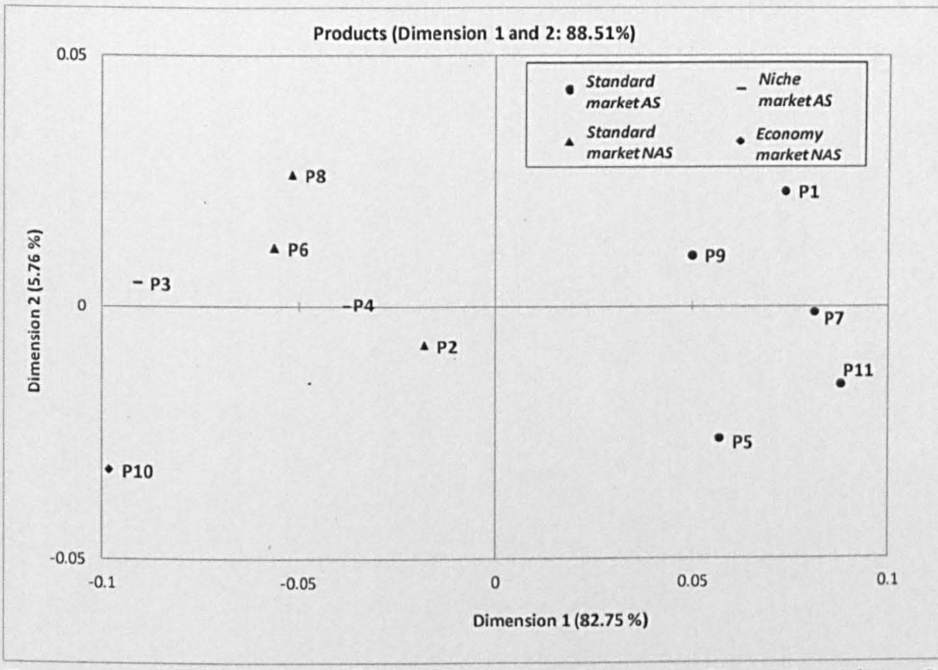


Figure 6.4: CA product plot (Dimension 1 vs, Dimension 2) obtained from CD-CATA method (n=100)

MCA was applied to individual responses to each emotion term and the product configuration obtained (Figure 6.5) was similar to that obtained with CA (Figure 6.4). Interestingly, the distribution of emotions, as illustrated by the Larsen and Diener (1992) emotion model, can be observed even more clearly on the first two dimensions of the MCA emotion plot. The first two dimensions of the MCA emotion plot accounted for about 94% of variance in the data and most emotions were distributed in a 45^0 angle along the first two quadrants: activated pleasant (45^0), activated unpleasant (135^0). For example, the unpleasant emotion 'resentment' is more activated than 'disappointment' whereas the pleasant emotion 'desire' is more activated than 'interested'. However, it is important to note that the latter trend was less obvious with positive emotions than negative emotions. For example, less

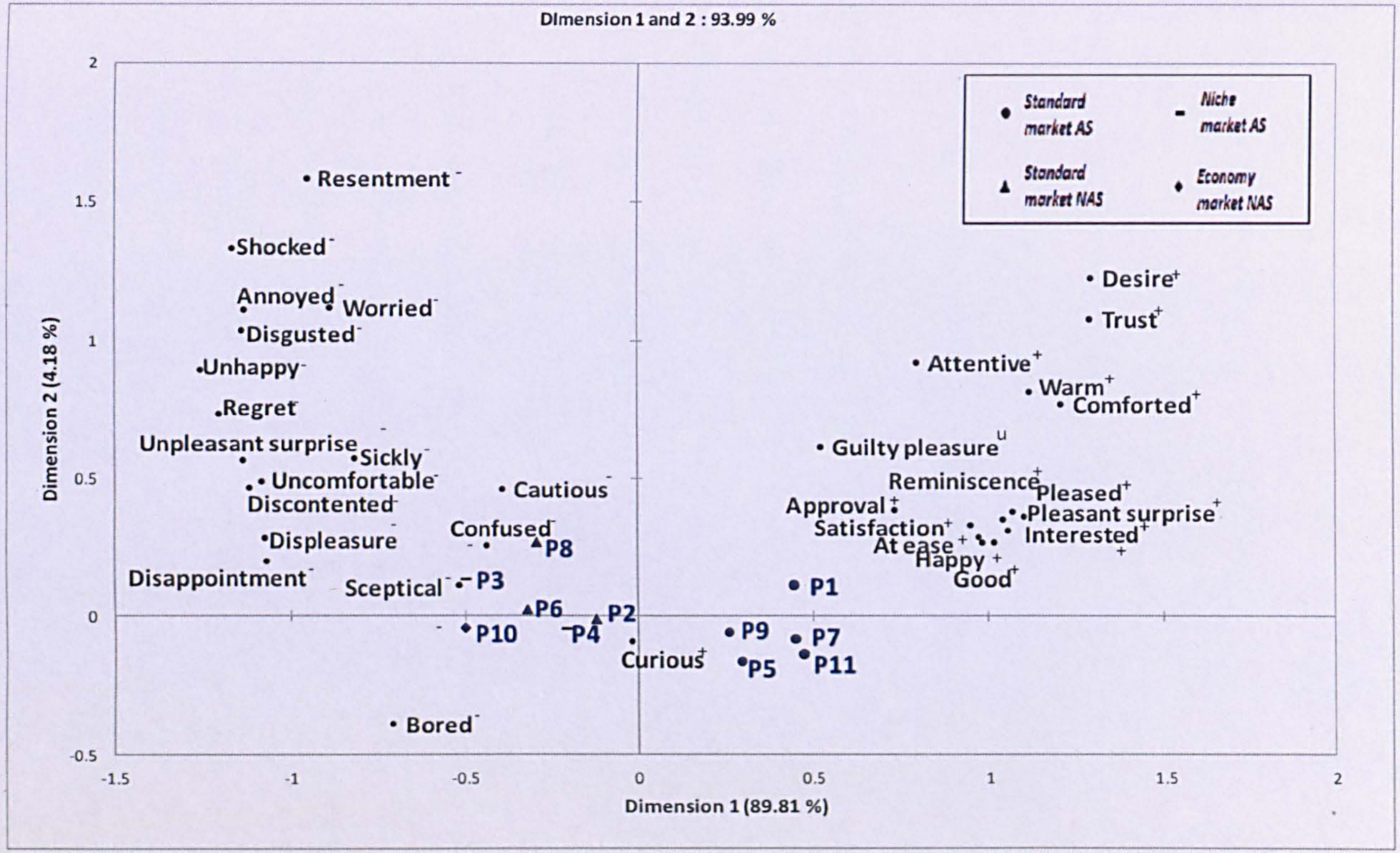


Figure 6.5: MCA emotion plot (Dimension 1 vs. Dimension 2) obtained using CD-CATA individual consumer responses datasets (n=100)

activated emotions like 'warm' and 'comforted' were positively higher than more activated emotions like 'interested' along the second dimension. As emotions were mainly distributed along the first two quadrants, it could be that self report measures are inadequate in capturing less activated emotions and these may require other sophisticated measures such as autonomic measures to discriminate across products. However, further work on the technique used for rating such emotions may improve discrimination. This in combination with the use of less articulate autonomic measures could provide a more comprehensive approach in capturing emotions.

6.2.2.3 Does emotional CD -CATA go beyond liking?

A high correlation between liking and frequency counts of checked emotions was observed (Table 6.1) but there were exceptions: the positive emotion 'reminiscence' and the negative emotions 'bored', 'confused', 'curious' and 'sickly', suggesting that not all emotions followed liking patterns.

Many of the emotion terms discriminated between products more than liking, despite the fact that CATA emotional measures were only measured in terms of presence or absence (check or not checked). As was found with the EsSense Profile, emotional measures were able to provide increased product differentiation for this product category compared to the hedonic response. CATA data further discriminated products within the two subgroups of products with similar degrees of liking scores. For example, although standard AS squashes (products 1 5, 7, 9, and 11) and standard NAS product 2 were similarly liked, product 2 was further discriminated using the emotional data.

Product 2 was significantly less associated with positive emotions 'pleasant surprise' and 'trust', whereas the rest of the standard AS products were significantly less associated with negative emotions 'disgust', 'displeasure', 'uncomfortable' and 'unpleasant surprise' (Table 5.2). In our previous sensory study (chapter 3; Table 3.3 and Table 3.5), the nature of sweetness perceived in NAS product 2 was different from other AS products and therefore suggests that artificial sweetness may be responsible for the more negative emotional responses evoked here. In addition, emotional data further discriminated products 1 and 11 from other standard AS products. Product 1 was significantly more associated with 'trust' and 'warm' and less associated with 'resentment' and 'bored', whereas product 11 was significantly more associated with 'reminiscence' and less associated with 'worried' and 'sceptical'. In the low liked group (i.e. products 3, 4, 6, 8 and 10), products 3 and 10 were significantly more associated with 'disappointment', 'discontent' and less associated with 'interested' and 'refreshed'. However, products 3 and 10 were also further discriminated by other emotional responses, where product 3 was significantly more associated with 'regret' and less associated with 'warm'. Product 10 was significantly more associated with 'bored', 'resentment' and 'sceptical' and less associated with 'curious'. It was evident that the measurement of emotions elicited using a consumer lexicon provided more discrimination across the product category than the hedonic measure.

6.2.3 Comparison of EsSense Profile and CD-CATA methodologies

6.2.3.1 Lexicons

The emotion lexicons used by the two methods shared nine emotion terms: 'good', 'happy', 'interested', 'pleased', 'satisfied', 'warm', 'bored', 'disgusted' and 'worried' (Table 6.2). It could be argued that some of the remaining terms on each list had similar meanings, e.g. affectionate/attentive, calm/at ease, free/at ease or peaceful/at ease, reminiscence/nostalgic, secure/trust, guilty/guilty pleasure. Most of the unclassified emotion terms, i.e. 'polite', 'steady', and 'understanding' in EsSense Profile, and 'guilty pleasure' in CD-CATA were highly correlated to positive emotions in this study, suggesting that they have positive connotations. It is also interesting to note that the emotion 'guilty' from EsSense Profile did not discriminate between the products but the emotion 'guilty pleasure' from CD-CATA did, suggesting that these terms are not describing the same emotion. In addition, this study also indicates that the 'guilty pleasure' emotion, perceived in the consumption context, may have a more positive connotation.

Some terms on both of the EsSense Profile and CD-CATA emotion lexicons did not discriminate between the products for this product category although these were fewer for the CD-CATA lexicon (only three as opposed to six on EsSense) (see Table 6.2). This latter point is not surprising as the CD-CATA lexicon was specifically developed by consumers for this product category. The CD-CATA lexicon also included more negative terms, although some of them could be viewed as polar opposites, e.g. 'pleasant surprise' versus 'unpleasant surprise'. The decision to include emotions with polar opposites on the CD-CATA emotion lexicon was made because data provided by the polar opposites and negative emotions may be important for some product categories. For example, product 8 did not significantly evoke the positive emotion 'pleasant surprise' but one would not be able to deduce that the same product would significantly evoke the negative emotion 'unpleasant surprise', if the latter term were not included in the lexicon (see Table 5.2).

Table 6.2: Emotion lexicons for EsSense Profile and CD CATA

EsSense Profile			Consumer defined CATA		
Positive	**Negative**	**Unclassified**	**Positive**	**Negative**	**Unclassified**
Active^{NS}	*Bored*	Aggressive^{NS}	Approval	Angry^{NS}	Guilty pleasure
Adventurous	*Disgusted*	Daring	At ease	Annoyed	
Affectionate	*Worried*	Eager	Attentive	*Bored*	
Calm		Guilty^{NS}	Comforted	Cautious^{NS}	
Energetic		Mild^{NS}	Curious	Confused^{NS}	
Enthusiastic		Polite	Desire	Disappointment	
Free		Quiet^{NS}	*Good*	Discontented	
Friendly		Steady	*Happy*	*Disgusted*	
Glad		Tame	*Interested*	Displeasure	
Good		Understanding	Pleasant surprise	Regret	
Good-natured		Wild^{NS}	*Pleased*	Resentment	
Happy			Reminiscence	Sceptical	
Interested			*Satisfaction*	Shocked	
Joyful			Trust	Sickly	
Loving			*Warm*	Uncomfortable	
Merry				Unhappy	
Nostalgic^{NS}				Unpleasant surprise	
Peaceful				*Worried*	
Pleasant					
Pleased					
Satisfied					
Secure					
Tender					
Warm					
Whole					

^{NS}Non-discriminating emotion in this study; Emotions in italic are shared across both methods

Incorporating the voice of the consumer into the product development process is important to design products that appeal to consumers (Akao, 1990). However, although consumer defined emotion lexicons may be more relevant to the product category, other important discriminating emotional terms evident in the literature may be missed as consumers may not be able to articulate all their emotions. As a result, a combination of both approaches (from literature and the consumers) in lexicon development may provide a more comprehensive strategy.

6.2.3.2 Emotion Profiles

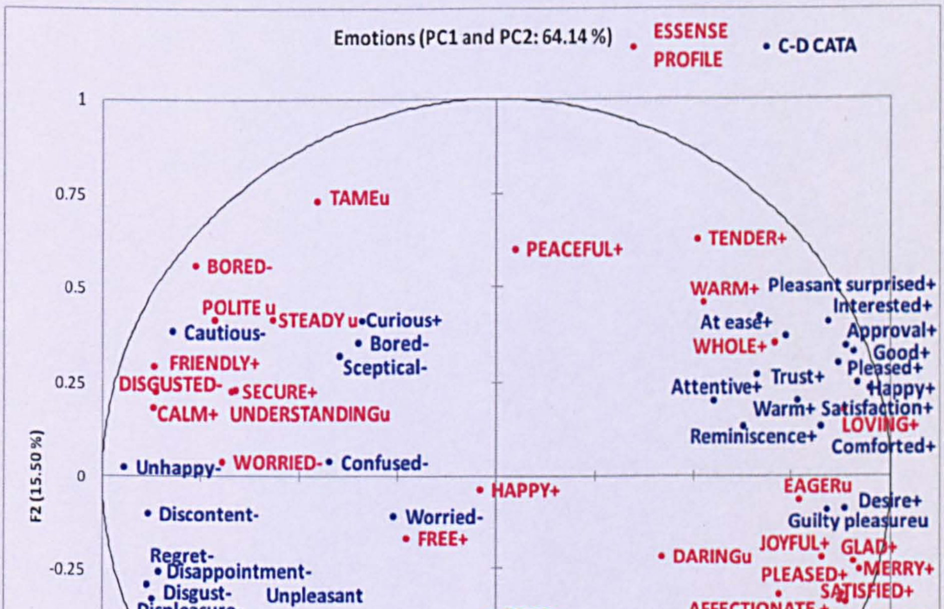
In both the EsSense Profile PCA emotion and product plots (Figure 6.1 and Figure 6.2, respectively) and CD-CATA CA emotion and product plots (Figure 6.3 and Figure 6.4, respectively), the first dimensions were represented at opposing ends by positive and negative emotional terms, which is in line with some recent studies (e.g. Schifferstein et al., 2013). The second dimension of the CD-CATA CA emotion plot was clearly related to level of engagement/activation and, indeed, this trend was also observed on the second PC of the EsSense Profile PCA emotion plot as the positioning of the emotions descended, for example, from 'daring', 'enthusiastic', through 'energetic', down to 'tender', 'steady', 'calm' and 'tame'. Although there are some slight differences in the product positioning in each emotional space, the general product grouping is consistent, with standard AS squashes positioned with positive emotions, niche AS and the economy NAS squashes at the other extreme positioned with negative emotions and finally the standard NAS products in between. The sweet taste of natural sugar normally elicits a positive affect reaction to sensory pleasure (Berridge, 2003; Steiner, 1973; Steiner et al., 2001) and therefore, not surprisingly, standard AS products were associated with positive emotions and were generally more preferred than NAS. However, interestingly, no relationship was found between natural sweet taste of niche AS products as shown in previous sensory study (see Table 3.3 and Table 3.5) and positive emotions. This indicates that other sensory attributes are driving the acceptability of these products and hence, the relationship between sensory attributes and emotional response is the focus of the next chapter.

An interesting question that was not investigated here, is whether the positioning of the liking question at the beginning of the product evaluation influences the subsequent emotion profiles, and this warrants further investigation in a future study.

6.2.3.3 Product configurations

The application of MFA enabled a statistical comparison of the two product configurations to be obtained. Figure 6.6 shows the MFA emotion plot comparing emotional responses obtained by EsSense Profile mean scores and CD-CATA frequency counts.

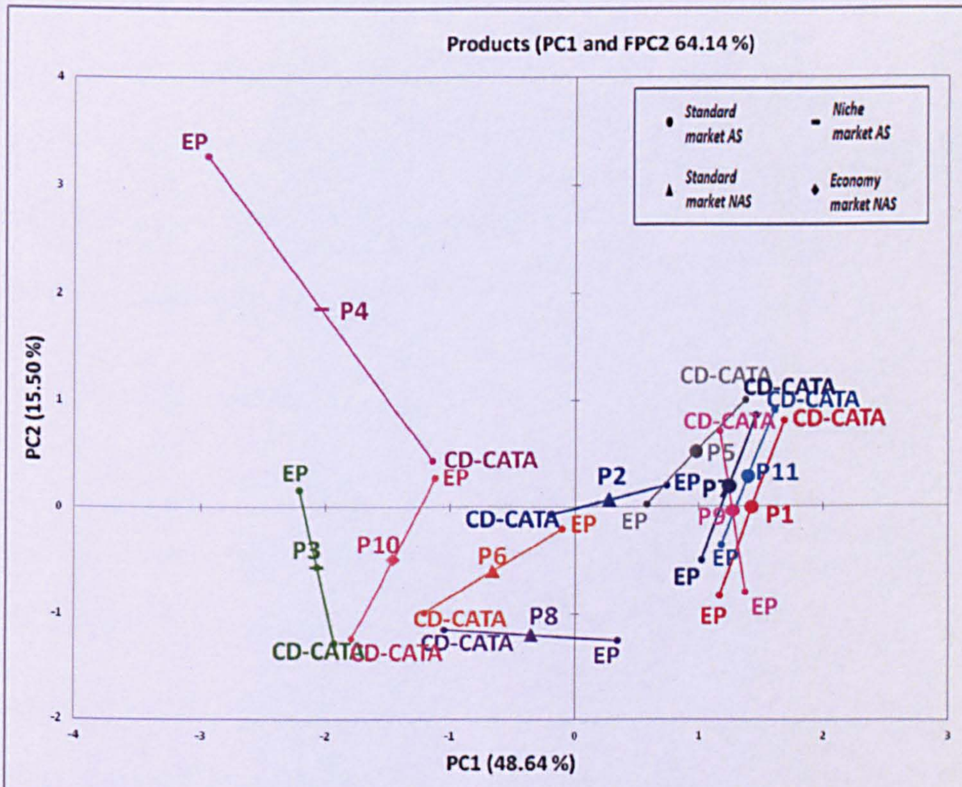
Figure 6.7 shows MFA emotion plot comparing individual product maps obtained by EsSense Profile mean scores and CD-CATA frequency counts. In general, MFA emotion plot showed good agreement between the two approaches (RV coefficient 0.63), although only 64% of the variation was explained by the first two MFA dimensions. Product 4 (niche AS product) showed the largest variance between the two methods across both dimensions. Product 8 (standard NAS product) also showed considerable variation between the two methods for first dimension which also refers to the degree of pleasantness of emotions. Interestingly, the main differences in terms of the product positioning are along the second dimension, level of engagement/activation, suggesting a difference in how the two methods capture this aspect of the emotional response. Distribution of emotions according to the level of engagement/activation was more obvious with the



***UPPERCASE EMOTIONS- EsSense Profile; lower case emotions cd-cata** Note that here the direction of PC 2 descends from less engaging/active to more engaging/active*

Figure 6.6: MFA emotion plot from EsSense Profile and CD CATA datasets

CD-CATA analysis compare to EsSense Profile analysis, although this component of differentiation was even more evident with CA emotion plot (Figure 6.3) and MCA emotion plot (Figure 6.4) from CD-CATA analysis. These findings demonstrate a benefit of using consumer self defined lists versus a predetermined emotion lexicon.



Each product[1] is represented using two points corresponding to each method, and its compromise position in the middle

Figure 6.7: Superimposed representation of the products[1] in the MFA space taking into account both EsSense Profile (EP) and CD CATA data

6.2.3.4 Differentiating products of similar hedonic scores

Strong correlations between liking and emotional scores were evident in each of the lexicons (Table 6.1). However, several emotional terms were more discriminating than the liking variable. In both methods most notably, within products of similar liking scores, the emotions 'tame' and 'disgust' from the EsSense Profile enabled further differentiation of the disliked products, and 'adventurous', 'daring' and 'good natured' also further discriminated the liked products. Both 'tame' and 'daring' were not correlated with liking and hence provided additional insight into product acceptance in this category. These two terms may also be viewed as extremes in terms of level engagement/ activation. CD-CATA also further discriminated within products of similar liking but to a greater extent. Considerably more terms, as discussed earlier in the CD-CATA section, could be drawn upon to differentiate the liked and disliked product subgroups.

6.2.3.5 Relative merits of EsSense Profile and CD CATA

It is important to acknowledge that, had this study been a complete design, the results may have been slightly different. However, time and resource called for some compromise on data collection and analysis and based on the results (blind data) that were obtained from this study, it is still possible to discuss some of the relative merits of each method in terms of different use of scale and emotion lexicon.

In terms of performing the experiments, EsSense Profile was relatively easier in that it did not require the fairly labour intensive lexicon development stages, and was quicker and cheaper to perform. In addition, the results of quantitative EsSense Profile readily lent themselves to conventional statistical analysis. However, as the list of emotional terms was predetermined and was populated with mainly positive emotions it missed emotions important to this product category, especially negative ones. Focusing mainly on positive terms can only tell us whether a person is generally having a positive experience.

On the other hand, there was a better balance of positive and negative terms using CD-CATA and it was somewhat more discriminating than EsSense Profile, which is likely to be due to the use of more focused consumer language relating to the product category. It would therefore be interesting to further develop methods that probe deeper into the consumer language as this was shown to be more discriminating than the predetermined list. However, conducting triadic elicitation interviews one-to-one is a fairly labour intensive approach. Interviews with a small group of articulate subjects (n=3 to 5) may enable deeper discussion and would be more efficient.

Unlike EsSense Profile, the CATA process was, as Adams et al. (2007) has previously stated, relatively easier and more natural for consumers to use. The qualitative nature of the data obtained from CD-CATA, however, limited the extent of the statistical analysis, making it difficult to make the clear inferential conclusions obtained with EsSense Profile. The effectiveness of Rate-All-That-Apply (RATA) approach where consumers simply rate the emotions they have checked warrants further investigation. Nevertheless, the use of correspondence and chi square analysis on CATA data was successful in enabling a statistically based objective map of the emotional space to be produced, and differences between the products to be observed. In addition, emotion data from CD-CATA could be explained using degree of engagement/pleasantness as illustrated by multidimensional circumplex models (Larsen and Diener, 1992), e.g. 'desire' is more activated/ engaging and pleasant than 'interested'.

It is important to reiterate that emotional data collected under the blind condition from EsSense Profile and CD-CATA experiments have confirmed previous findings that human senses are powerful elicitors of emotions (Chrea et al., 2009; Chrea, 2008; Gibson, 2006; Porcherot et al., 2012; Thomson et al., 2010). A natural extension to this study is to apply emotional measurement in conjunction with sensory analysis in order to understand how taste, olfactory and visual aspects of a product evoke subconscious feelings and emotions which ultimately drive hedonic measures (Ferrarini et al., 2010) which will be discussed in the next chapter.

6.3 Conclusion

Both quantitative EsSense Profile and qualitative CD-CATA approaches to measuring emotional response produced similar emotional spaces and product configurations. However, each method had its advantages and limitations. Using lists solely from literature or as defined by the consumer may result in omission of important discriminating emotions and so a combined approach, specific to the product category of interest would be more comprehensive. A hybrid of the two, where a more product focused lexicon of emotional terms is developed from both the consumer and the literature may be even more diagnostic, especially if the terms were then rated quantitatively to allow for in depth statistical analysis.

The study also highlighted the two dimensional nature of the emotional response. Although much of the variation could be accounted for in terms of the pleasantness of emotions, it was evident that a second dimension relating to level of activation and corresponding with published psychological models for emotion, was also important, for this product category at least, and was not related to liking. This was more evident in the CD-CATA approach which may be due to a better balance of positive and negative emotion terms as opposed to EsSense Profile which only consisted of three negative emotions.

Although liking was strongly correlated with many of the emotional terms, the latter were shown to discriminate more widely than liking. The value of measuring the emotional response was further exemplified where emotional terms were able to discriminate between products of similar liking levels. This is of particular benefit to industry where many products within a category can no longer be differentiated on acceptability (King and Meiselman, 2010; Porcherot et al., 2010; Thomson et al., 2010). This study has demonstrated how emotional measures go beyond liking and offer a decisive and competitive advantage for industry. Although all emotion data reported in this chapter were from blind tastings from EsSense Profile and CD-CATA experiments, emotion data from other conditions (pack and informed) were also found to discriminate better than liking measurement (data not discussed in this thesis). On saying that, the results presented in this chapter demonstrate that sensory attributes are important in inducing emotional response, and this will be the subject of the next chapter.

7 Relating sensory attributes (QDA and TDS) to consumer response (EsSense Profile and CD-CATA methods)

7.1 Introduction

Traditional sensory and consumer research into understanding product performance has always tended to focus on the relationship between sensory perceptions and liking measures. However, findings from this PhD research, as discussed in chapter 6, have clearly pointed out that using liking measurement alone is inadequate to understand the consumer product experience. Indeed, the preceding chapters 4 and 5 also highlighted that emotions have stronger associations with sensory attributes than packaging cues. Therefore, understanding the relationship between sensory attributes and consumer responses will provide an opportunity for competitive advantage and will no doubt be a key area for future emotional research. Interestingly, Lindstrom (2005) has illustrated how some product brands tune their sensory profiles to evoke emotions that best fit the brand's positioning, which could essentially help to increase consumer loyalty. Take the brand 'Coke' and 'Pepsi' for example, the brands differ in the way the people describe their sensory profiles. Coke has been described by Coke drinkers as *'having a good blend of sweetness and sharpness'*, whereas Pepsi was described by Pepsi drinkers as being *'light sweetness, smooth, no bite or strong aftertaste'*. As Lindstrom (2005) pointed out, although both sets of drinkers believe their brand is equally distinctive, slightly more Coke drinkers agreed that they felt very positive about the taste of Coke, than Pepsi drinkers did for Pepsi. Lindstrom

(2005) believes that this could be due to the more challenging taste experience of Coke that leads to a stronger emotional response in consumers. Clearly, understanding the relationship between sensory attributes and emotional responses may prove even more insightful than traditional focus on sensory attributes and liking.

For this PhD research, consumer responses were obtained using two different techniques, i.e. EsSense Profile (as discussed in chapter 4) and CD-CATA methodology (as discussed in chapter 5) for 11 blackcurrant squashes under blind, pack and informed conditions. However, this chapter focuses on the data collected from blind tastings from each of the experiment. It is important to restate that different group of subjects (n=100) took part in each of the experiment. In addition, consumers' emotional responses were collected in EsSense Profile experiment whereas consumers' conceptual responses (emotions, abstract and functional) were collected in CD-CATA experiment. The results from these experiments revealed that different conceptual profiles (and even liking profiles) were obtained for each product; suggesting different sensory attributes in commercial blackcurrant products could give rise to very different profiles within the same product category. Therefore, it is of the project sponsor's interest to understand the relationship between sensory attributes and consumer response.

However, very few attempts can be found in the current sensory literature to identify the relationship between sensory attributes and consumer emotional response. Indeed, it might be commercially sensitive for companies to publish such findings. To the authors' knowledge, Thomson et al. (2010) were probably the only one in the current sensory arena who have attempted to demonstrate the relationship between sensory attributes and consumers' conceptualisations by identifying which of the sensory attributes in commercial chocolate, measured by QDA, evoked which conceptual response in consumers. For example, 'cocoa' flavour (sensory attribute) was found to evoke 'energetic' and 'powerful' conceptualisations in consumers.

However, in chapter 3, we have discussed the limitations of using QDA techniques alone in measuring sensory attributes. In fact, we have also demonstrated how combining conventional QDA and temporal TDS sensory techniques enables a fuller sensory profile of the product category to be obtained. For example, whilst QDA aims to describe and quantify the intensity of a larger number of sensory attributes, TDS provides additional information beyond QDA measurement by illustrating the temporal sequence of dominant sensations (see section 3.3.5 for more discussion). Therefore, we hypothesised that TDS could potentially be used to better understand the effect of temporal sensory attributes on consumers' responses. However, the relationship between temporal sensory information and consumers' emotions (or even other abstract/functional conceptualisations) has not yet been explored in the current sensory literature, although some have attempted to link TDS data with consumer preference data (Meillon et al., 2010). However, the authors did not link TDS data directly with preference data. They measured *'consumers' perceived complexity'*, assuming it was associated with

'TDS curves with many sensations' and then evaluated the link between the *'perceived complexity'* and preference data. A new way was adopted in the present PhD study in order to link TDS data directly with consumer data. First, only the dominant sensory sensations were selected (those that were above the 'significant line' on TDS curves; see Table 2.6 for the list of dominant sensory attributes), and then their dominance rates across all time points were identified (T0 to T100). As it was not possible to look at every time point for each of the selected dominant sensation (too much data), a reduced set of time points was representative of the two time segments: before (T6, 8, 10, 12, 14, 18, 25) and after swallowing (T28, 35, 45, 50, 60, 65, 75, 80, 85, 95, 100) were selected. The selection was made using STATIS method (see section 2.6.8 for further details on the data analysis).

The objectives of this chapter were to (i) determine the relationship between sensory attributes (as measured by QDA and TDS) and consumer response (emotional data from EsSense Profile; conceptual data from CD-CATA methodology); (ii) test the hypothesis that TDS data provide additional insight beyond QDA measurement; and (iii) explore whether abstract/functional conceptual data (from CD-CATA) gives additional consumer insights beyond emotion data.

7.2 Results

7.2.1 Correlation between consumer emotions (EsSense Profile) and sensory attributes (QDA and TDS)

The relationship between emotional response and sensory attributes was determined by Pearson correlation (assuming $r \geq 0.7$ indicated some level of association). In addition, PCAs were also performed on both emotion (EsSense Profile) and QDA/TDS sensory datasets in order to obtain multivariate graphical representation of the datasets. The latter allowed the overall relationship between consumer emotions and sensory attributes of blackcurrant squashes to be visualised.

Figure 7.1 depicts the PCA emotion and QDA plot, illustrating the relationship between emotion mean scores (35 significant terms; as listed in Table 6.2) and sensory QDA mean scores (15 attributes; as listed in Table 2.3). On the other hand, Figure 7.2 depicts the PCA emotion and TDS plot, showing the relationship between emotion mean scores (35 significant terms; as listed in Table 6.2) and sensory TDS dominance rates (10 attributes at selected time point; as listed in Table 2.6). Only dominance rates of *significant* dominant sensory attributes that were above the 'significant lines' on the TDS curves were selected for each selected time point. For example, the curve line of attribute 'catty' (in product 10) was above the 'significant line' on TDS curves from T15 to 20, T35 to 48 and T60 to 63 (see Figure 3.5 for illustration); so the

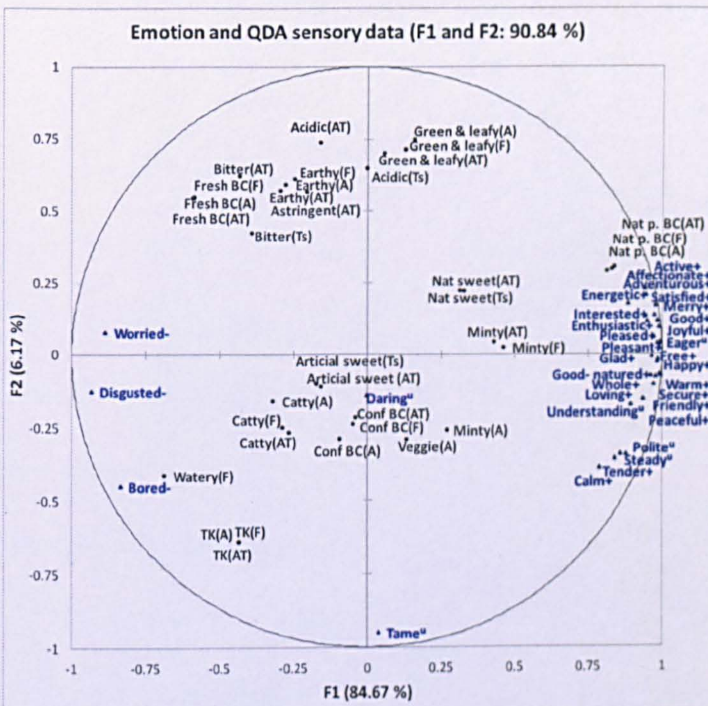
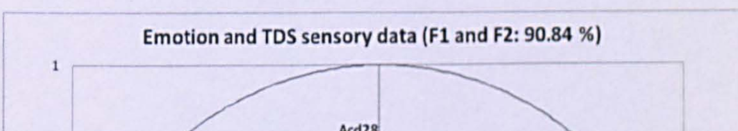


Figure 7.1: PCA of emotions (EsSense Profile) and mean scores of sensory attributes (QDA) obtained from the blind condition



Dominance rates of dominant sensory attributes for selected time points (before swallow: T6, 8, 10, 12,14, 18, 25 and after swallow: T28, 35, 45, 50, 60, 65, 75, 80, 85, 95, 100)

Figure 7.2: PCA of emotions (EsSense Profile) and dominance rates of sensory attributes before and after swallow (TDS) obtained from the blind condition

dominance rates of 'catty' for T18, T45 and T60 were included for data analysis (Table 2.6). In both PCA emotion and QDA/TDS plots (Figure 7.1 and Figure 7.2), their first PCs were positively associated with positive emotions, i.e. 'active', 'adventurous', 'affectionate', 'energetic', 'enthusiastic', 'free', 'friendly', 'glad', 'good', 'good-natured', 'happy', 'interested', 'joyful', 'loving', 'merry', 'peaceful', 'pleased', 'pleasant', 'satisfied', 'secure', 'warm', and 'whole', although some are unclassified emotions (i.e. 'eager', 'polite', 'steady', 'understanding') and negatively associated with negative emotions 'worried' and 'bored'. The second PCs, however, were negatively associated with the unclassified emotion 'tame' (AT).

As illustrated by Figure 7.1, PC1 of the PCA emotion and QDA plot was positively associated with the sensory attribute 'natural processed blackcurrant' (A, F, AT) and negatively associated with sensory attributes 'fresh blackcurrant' (A, F, AT) and 'watery' (A, F, AT). PC2 was negatively associated with 'tomato ketchup' (A, F, AT) and positively associated with 'green and leafy' (A, F, AT) and 'acidic' (Ts, AT). On the other hand, the first PC of the PCA emotion and TDS plot (Figure 7.2) was positively associated with dominant sensory attributes 'natural processed blackcurrant' (all time points), 'natural sweetness' (particularly in aftertaste; T28-100) and 'minty' (T95). The second PC was positively associated with 'acidic' (T28) and negatively associated with 'tomato ketchup' (all time points).

7.2.2 Correlations between consumer conceptualisations (CD-CATA methodology) and sensory attributes (QDA and TDS)

The relationship between conceptual response and sensory attributes was determined by Pearson correlation (assuming $r \geq 0.7$ indicated some level of association). Similarly, PCAs were performed on both conceptual response (CD-CATA) and QDA/TDS sensory datasets in order to visualise their overall relationship. Figure 7.3 depicts the PCA conceptual response and QDA plot showing the relationship between total frequency counts of conceptual terms (33 emotion terms and 20 abstract/functional terms; as listed in Table 2.5) and sensory QDA mean scores (15 attributes; as listed in Table 2.3). Figure 7.4 depicts the PCA conceptual response and TDS plot which illustrates the relationship between total frequency counts of conceptual terms and sensory TDS dominance rates (10 attributes at selected time points; as listed in Table 2.6).

In both of the PCA conceptual response and QDA/TDS plots (Figure 7.3 and Figure 7.4) their first PCs were positively associated with positive emotions (i.e. 'happy', 'approval', 'good', 'interested', 'pleased', 'satisfaction', 'comforted', 'pleasant surprise', 'trust', 'at ease', 'warm, 'guilty pleasure', 'attentive' and 'desire'), but also with other positive conceptual terms which include: abstract (i.e. 'familiar' and 'natural') and functional (i.e. 'refreshed', 'fresh', 'treat' and 'good quality'). PC1 was negatively associated with negative emotions (i.e. 'annoyed', 'disappointment', 'disgust', 'displeasure', 'resentment'); abstract (i.e. 'artificial'); and functional (i.e. 'not refreshed' and 'unhealthy').PC2 of the both PCAs (Figure 7.3 and Figure 7.4) was positively associated with negative emotion (i.e. 'curious', 'sickly') and functional (i.e. 'bad for your teeth' and

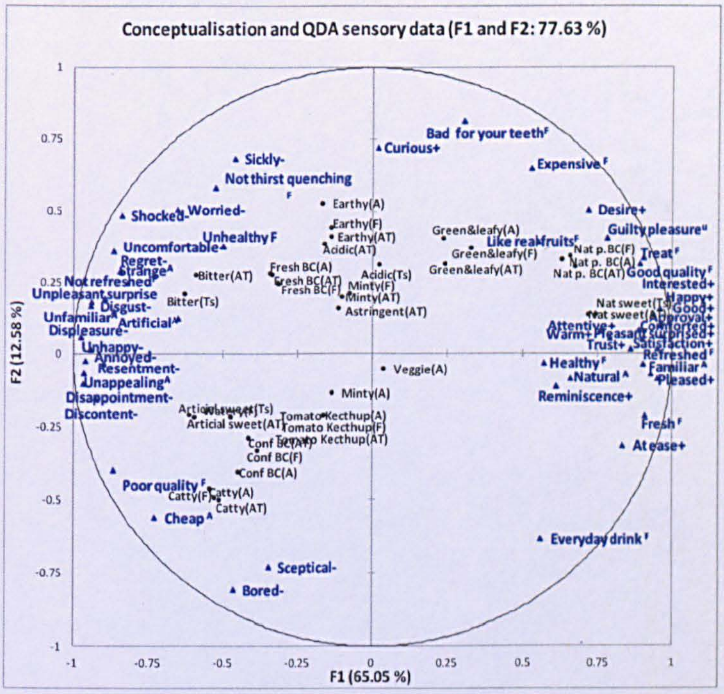
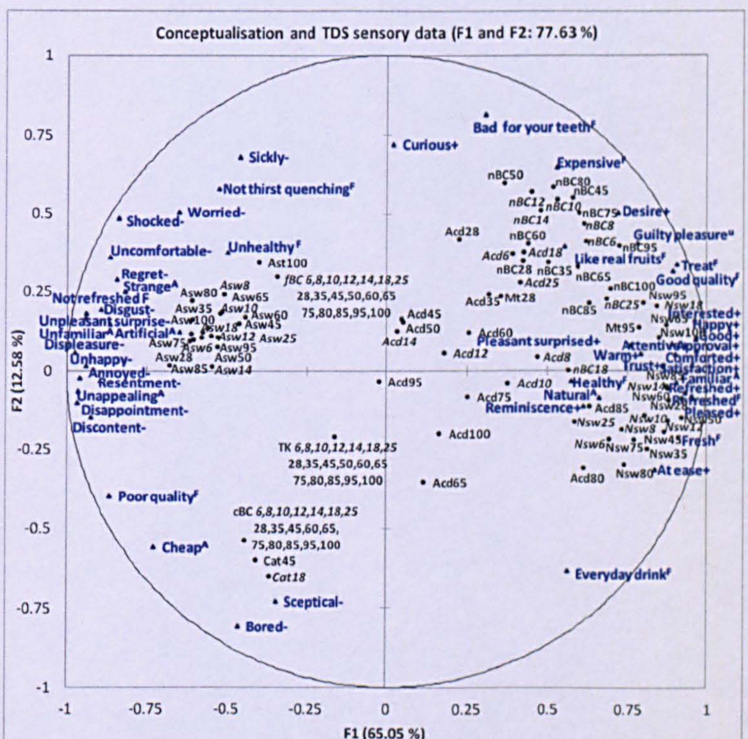


Figure 7.3: PCA of conceptualisations (CD-CATA) and mean scores of sensory attributes (QDA) obtained from the blind condition



Dominance rates of dominant sensory attributes for selected time points (before swallow: T6, 8, 10, 12, 14, 18, 25 and after swallow: T28, 35, 45, 50, 60, 65, 75, 80, 85, 95, 100)

Figure 7.4: PCA of conceptualisations (CD-CATA) and dominance rates of sensory attributes before and after swallow (TDS) obtained from the blind condition

'expensive') and negatively associated with negative emotions (i.e. 'bored' and 'sceptical').

The first PC of the conceptualisations and QDA PCA plot (Figure 7.3) was positively associated with sensory attributes 'natural sweetness' (Ts, AT) and 'natural processed blackcurrant' (F, AT) and negatively associated with 'bitter' (Ts). On the other hand, the first PC of the emotion and TDS PCA plot (Figure 7.4) was positively associated with dominant sensory attributes 'natural sweetness' (all time points), 'natural processed blackcurrant' (mainly aftertaste) and 'minty' (T95) and negatively associated with 'astringent' (T85). PC2 was positively associated with 'natural processed blackcurrant' (T50) and negatively associated with 'catty' (T18).

7.3 General discussion

Due to the nature of commercial products tested in this PhD research, it was not possible to investigate the impact of sensory attributes in a systematic way. Nevertheless, it is still possible to identify key sensory drivers of blackcurrant squashes for liking and positive conceptual responses.

Starting with the relationship between consumer responses and sensory attributes of blackcurrant squashes determined by QDA technique; although sensory datasets were linked to different consumer datasets (one from EsSense Profile and another from CD-CATA method), similar findings were observed as to which sensory attributes drive liking and positive emotions in consumers, i.e. sensory attributes 'natural processed blackcurrant' (A, F, AT) and 'natural sweetness' (Ts, AT). However, the quality of positive emotions reported by EsSense Profile approach was slightly different from the ones reported by CD-CATA method; e.g. 'affectionate', 'energetic', 'enthusiastic', 'free' and 'friendly' in EsSense Profile, whereas 'happy', 'approval', 'good', 'interested', 'pleased' and 'satisfaction' in CD-CATA method. The relationship between the latter positive emotions and sensory attributes 'natural processed blackcurrant' and 'natural sweetness' can also be confirmed by high correlation coefficients $r \geq 0.7$. Interestingly, EsSense Profile and CD-CATA approach were found to yield slightly different findings as to which sensory attributes induced negative emotions. For example, in EsSense Profile study, 'fresh blackcurrant' (A, F, AT) and 'watery' (A, F, AT) were found to evoke negative emotions like 'worried' and 'bored' whereas in CD-CATA study, 'bitter' (Ts) was found to induce negative emotions, e.g. 'annoyed', 'disappointment', 'disgust', and 'displeasure'.

When the dominance rates of sensory attributes at different time points (TDS) were linked to different consumer datasets (EsSense Profile and CD-CATA methodologies), 'natural processed blackcurrant' and 'natural sweetness' were also identified as the key dominant sensory attributes (before and after swallow) in evoking positive emotions in consumers. However, in the EsSense Profile study, a higher correlation was found between the aftertaste of dominant 'natural sweetness' and positive emotions. In the CD-CATA study, a higher correlation was found between the aftertaste of dominant 'natural processed blackcurrant' and positive emotions. The latter findings, however, were not reflected by the mean scores of aroma, flavour or aftertaste of sensory attributes determined by QDA, again illustrating the difference between the concept of dominance and intensity.

Furthermore, TDS data was shown to provide additional information that was not identified via QDA measurement. As illustrated by Figure 7.2 and Figure 7.4, the dominant sensory attribute 'minty' (T95) was also found to induce positive emotions in consumers, e.g. 'affectionate', 'energetic', 'enthusiastic', 'free', 'friendly' in the EsSense Profile study; and 'happy', 'approval', 'good', 'interested', 'pleased', 'satisfaction' in CD-CATA study. The 'minty' note can be observed in product 2 (see Table 3.1) and interestingly the latter product was the only standard NAS products that was found to be liked similarly to other standard AS products during the blind tasting sessions in both of the consumer studies (see Table 4.1 for EsSense Profile and Table 5.1 for CD-CATA method).

Unlike the CD-CATA study, no dominant sensory attribute was found to elicit negative emotions in the EsSense Profile study and this could be due to the fact that the lexicon was mainly populated with positive emotions and only consisted of three negative terms. However, in the CD-CATA study, dominant 'astringent' (T85) was found to elicit negative emotions, e.g. 'annoyed', 'disappointment' and 'displeasure'; dominant 'catty' (T18) was found to elicit negative emotion 'sceptical'. This again supports the earlier discussion (section 6.2.3.5) that having a better balance of positive and negative emotions on a lexicon would be important for better product discrimination and consumer understanding.

Understanding the relationship between emotions and sensory attributes may not be sufficient for the researchers to understand why certain sensory attributes evoke positive emotions and why some elicit negative emotions. Unlike EsSense Profile, CD-CATA approach also measured consumers' additional conceptual responses about the products and this included abstract feelings (e.g. 'familiar', 'natural') and functional connotations (e.g. 'good your teeth', 'refreshing'). The latter information can be used to further investigate the relationship between sensory attributes and positive emotions. Take the key sensory driver attribute 'natural processed blackcurrant' as an example; this attribute was found to promote positive abstract feelings of 'familiar' and 'natural'. This could have led to functional connotations like 'refreshed, 'good quality' and 'treat' which might have induced positive emotions in consumers (Figure 7.3).

7.4 Conclusion

As this study used commercial products, it was not possible to investigate the impact of sensory attributes on consumer response in a systematic way. However, results presented in this chapter clearly demonstrated that 'natural processed blackcurrant' and 'natural sweetness' were the key sensory attributes in commercial blackcurrant squashes that evoked similar positive emotional response in consumers (as measured by EsSense Profile and CD-

CATA). However, unlike EsSense Profile, the better balance of positive and negative emotion terms on CD-CATA lexicon enabled better description of negative emotions that were induced by certain sensory attributes like 'bitter', 'astringent' and 'catty'.

In addition, TDS data was shown to provide additional information beyond conventional QDA measurement by illustrating how some temporally dominant sensory attribute (e.g. minty) evoked positive conceptual responses in consumers (in both EsSense Profile and CD-CATA experiments). Therefore, the relationship between temporally dominant sensory attributes and emotional response warrants further investigation. Furthermore, additional abstract/functional conceptual data from CD-CATA results was also proven to add additional consumer insight as it allows researchers to better understand the relationship between certain sensory attributes and emotional response. Conceptualisation research again, was shown to offer a fresh and interesting perspective that might not be captured by just emotion research.

Due to the nature of the commercial products tested (with complex ingredient lists), the authors had no control over the ingredients, making it difficult to identify which ingredients were responsible for the *'sensory drivers'* that were identified in this chapter. However, in the industry, it might be possible for the sensory researchers to work with the product developers on identifying these ingredients and to design a systematic beverage model based on that. It would be interesting to study whether different levels of 'blackcurrant processed blackcurrant' (for an example) would affect consumers' conceptualisation. It would then be possible for the company to pin-point directions for flavour optimisation to improve consumer liking and conceptualisations.

8 Conclusion and future work

The main aim of this PhD research was to investigate the effect of sensory attributes and packaging cues on consumers' liking and conceptual responses (emotional/functional/abstract) using commercial blackcurrant squashes as the vehicle. Blackcurrant squash was chosen for this PhD study as it was of key relevance to the project sponsor. Eleven UK commercial blackcurrant squashes which represented the range of sensory and packaging properties observed in the UK market segment were selected. A summary of the key findings are discussed below.

The sensory results demonstrated that combining QDA and TDS methods in a sequential approach can be used in a commercial context and, more importantly, enables a fuller sensory profile of the product category to be obtained. For example, mean intensities provided by QDA could not be used to predict the dominant sensations as well as their temporal changes. Nevertheless, TDS only enabled the evaluation of a limited number of attributes and so cannot replace QDA completely as subtle, less dominant sensory attributes may also contribute to product differentiation.

The effectiveness of quantitative EsSense Profile and qualitative CD-CATA methodology in measuring emotional response was also compared. Results obtained from both approaches to measuring emotional response produced similar emotional spaces and product configurations. However, each method had its advantages and limitations. For example, EsSense Profile was relatively easier, quicker and cheaper to perform as compared to the fairly labour intensive lexicon development stages in CD-CATA method. However, CD-CATA approach seemed to be more discriminating than EsSense Profile, which is likely to be due to the use of a better balance of positive and negative terms and a more focused consumer language relating to the product category. The two dimensional nature of the emotions relating to level of pleasantness and activation as found in published psychological emotion model (Larsen and Diener, 1992; Russell, 1980; Watson and Tellegen, 1985) (see Figure 1.2 for multidimensional circumplex emotion models) were also observed in both EsSense Profile and CD-CATA experiments. However, it was more evident in the CD-CATA approach.

Another key finding discussed in the thesis was that emotional results from both EsSense Profile and CD-CATA methodologies were found to discriminate products with similar liking scores (see section 6.2.1.3 and 6.2.2.3). This confirmed findings in previous studies (King and Meiselman, 2010; Porcherot et al., 2010; Thomson et al., 2010) that emotional measures go beyond liking and offer a decisive and competitive advantage in industry. However, additional abstract/functional datasets from CD-CATA methodology were found to provide notable consumer insights beyond emotion measurement (see section 5.3.4 to see how this can be achieved). Therefore, conceptualisation research may provide industry with a much better understanding of consumer choice behavior than sole emotional research and hence provide opportunity for competitive advantage.

A particular novelty of the study was the finding that consumers' liking and emotional responses were shown to be more influenced by sensory attributes than packaging cues (observed in both EsSense Profile and CD-CATA experiments). The latter findings confirmed previous findings that human senses are powerful elicitors of emotions (Chrea et al., 2009; Gibson, 2006; Porcherot et al., 2012; Thomson et al., 2010). However, interestingly, consumers' abstract/functional conceptual responses appeared to be more influenced by packaging cues than sensory attributes (observed in CD-CATA experiment). This supports the author's hypothesis that most of abstract/functional terms have already been formed prior to product consumption, based on the evaluation of packaging. These findings have important implications for developing marketing strategies, especially when designing the brand and packaging.

Finally, the key sensory attributes that were found to promote consumers' liking and positive conceptual responses in consumers were 'natural processed blackcurrant' and 'natural sweetness'. Interestingly, TDS was shown to provide additional information beyond QDA mean intensities by illustrating how some temporally dominant sensory attributes (e.g. minty) evoked positive conceptual responses in consumers (in both EsSense Profile and CD-CATA experiments).

Throughout this thesis, recommendations have been put forward regarding practical implications for emotion measurement and these are further summarised below.

When developing an emotion (or conceptual) lexicon, researchers should consider using a hybrid of a more product focused lexicon of conceptual terms developed from both the consumers, and the literature. Using lists solely from literature or as defined by the consumer may result in omission of important discriminating emotions and so a combined approach, specific to the product category of interest would be more comprehensive. A Repertory Grid interview with a small group of articulate subjects may enable deeper discussion and would be more efficient.

A RATA approach was proposed to measure emotions where consumers simply rate the emotions they have checked. The approach not only allows respondents to simply check attributes that are relevant to them without having to be forced to rate all attributes on scale, but allows researchers to use more conventional and probing statistical analyses.

One point that emerged during the study was to question if subjects were evaluating the product category in general, in this case blackcurrant squash, rather than focusing on profiling individual differences across the products. The former would lead to less differentiation across the products within a category. In future studies the use of a warm up sample may increase product differentiation on emotional profiles.

Emotion research is a new area of research for sensory and consumer science and the impact is far reaching. Consequently, the potential for further work is considerable and general ideas for future research are as follow.

Some interesting observations were made on the distribution of emotions (collected from CD-CATA) on MCA emotion plot relating to level of activation in emotion (Figure 6.5). As emotions were mainly distributed along the first two quadrants ('activated' region), it could be that verbal self report measures are inadequate in capturing less activated emotions and these may require other sophisticated measures such as autonomic measures to discriminate across products. To investigate this hypothesis, combining the use of verbal self report and autonomic measures (e.g. eye tracking, EEG) and determining whether this provides a more comprehensive approach in capturing emotions is suggested.

Before generalising the findings of the effects of sensory attributes on emotions across all contexts (as discussed in chapter 5), systematic experimental designs are required, e.g. through conjoint studies varying sensory attributes within a model blackcurrant squash category. In addition, the relationship between temporally dominant sensory attributes and emotional response warrants further investigation, using a model blackcurrant squash category and or other product types.

A fascinating discovery from this PhD was that most abstract/functional conceptual responses were more associated with packaging cues. The impact of the different elements of packaging was not considered here and an obvious next step is to understand which elements of the packaging are associated with abstract/functional conceptual and emotional response. For this purpose, main packaging elements could be identified: graphic, size, form, material, colour, text and brand. Apart from packaging, other factors (e.g. price, knowledge about the brand, familiarity) and credence attributes (e.g. environmental and ethical issues, processing method) may influence consumer perceptions of blackcurrant squashes. Further research could focus on identifying these attributes and evaluating their impact on abstract/functional conceptual responses. However, trials testing different food categories would also be needed to further investigate the hypothesis regarding the relative roles of sensory attributes and packaging cues on consumer conceptualisations.

One of the issues in the current emotion research is that different people have different psychological, cultural, memory and even social experiences and therefore different emotions. Further research could focus on identifying consumer segments, considering both demographic (e.g. young versus old people; niche versus the mass market; gender and etc.) and non-demographic variables (e.g. lifestyles, occasion based and need states). The latter information could yield valuable insights for exploring future target market and optimising product positing.

Emotions are temporal and have an onset, duration and an end point (Lundalh, 2012). Further work needs to be considered concerning the potential use of temporal technique to track dynamic changes in emotion over time. In addition, it is also important to consider that consumers may change their opinions and emotion of food products over longer periods of time. Researchers have shown that repeated exposure to familiar food leads to reduced liking for those foods and boredom (Rolls, 2006; Koster, 1990; Porcherot and Issanchou, 1998). Increased exposure to novel foods can lead to increased liking of the foods (Birch and Marlin, 1992). Therefore, it would be interesting to measure and monitor the dynamic changes in emotions over a number of exposures to the food.

Cross-cultural validation could be a topic of further research to explore similarities and differences with respect to conceptualisations of blackcurrant squash (or other product categories) between consumers across different countries. This is of particular interest to global companies who wish to develop a method that would work globally.

For this PhD research, consumer testing of products was conducted under controlled laboratory condition and this setting does not represent how food and drink are consumed in reality. Food intake is usually immersed in social rituals, daily routines and is also often related to behaviour such as preparing, consuming and sharing (Bourdieu, 1984). In addition, the whole concept of asking the question might also affect consumer responses as it requires them to think about how they feel, instead of having them to respond at an emotional level that accurately reflects the emotional state at the time of the assessment. Interestingly, Hein et al. (2010) have recommended using a written scenario to evoke a consumption context in a laboratory setting. Indeed, they have reported that it was easier for subjects to indicate their product liking or disliking when used evoked context. If this works for consumer liking, further work will be needed to gain awareness of the potential use of an evoked context in a controlled setting for eliciting consumer conceptual responses.

An interesting question that was not investigated here is whether the positioning of the liking question at the beginning of the product evaluation influences the subsequent emotion profiles, and this warrants further investigation in a future study.

This research did not take into account physiological factors (e.g. hunger, satiety) that usually influence emotions and liking. Therefore, further work would need to take account of these factors, and understand its impact on conceptual ratings.

There is still a long way to go before some of these issues are unravelled, especially as measuring a person's emotional state is one of the most vexing problems in affective science (Mauss and Robinson, 2009). However, findings from this PhD research have demonstrated that conceptualisation (emotion, abstract and functional) research provides a new way to look at and discriminate products that are equally liked. Understanding conceptual drivers of products may improve chances of launching successful products on the market. This PhD research will provide an impetus and a starting point for those who desire to measure emotion (and other conceptualisations), and fill in the many gaps in a critical area for which there has been far too little research in the current sensory and consumer field.

'Human behaviour flows from three main sources:

desire, emotion, and knowledge.'

Plato (Greek philosopher), 424/423 BC – 348/347 BC

References

Adams J., Williams A., Lancaster B., Foley M. (2007). Advantages and uses of check-all-that-apply response compared to traditional scaling of attributes for salty snacks, in *7th Pangborn Sensory Science Symposium, Minneapolis,MN.*

Akao Y. (1990). Quality function deployment: integrating customer requirements into product design. *Boston, MA: Productivity Press.*

Ares G., Deliza R., Barreiro C., Gimenez A., Gambaro A. (2010). Comparison of two sensory profiling techniques based on consumer perception. *Food Quality and Preference*, **21**:417-426.

Bagozzi R.P., Gopinath M., Nyer P.U. (1999).The Role of Emotions in Marketing. *Journal of the Academy of Marketing Science*, 27:184-206.

Baldwin R.E., Korschgen B.M. (1979). Intensification of fruit flavors by aspartame. *Journal of Food Science*, **44**:937.

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

Bechara A., Damasio A.R., Damasio H., Anderson S.W. (1994). Insensitivity to future consequences following damage to human prefrontal cortex. *Cognition*, **50**:7-15.

Berridge K.C. (2003). Pleasures of the brain. *Brain and Cognition*, **52**:106-128.

Bonnans S., Noble A.C. (1993). Effect of sweetener type and of sweetener and acid levels on temporal perception of sweetness, sourness and fruitiness. *Chemical Senses*,18:273-283.

Brandt M.A., Skinner E.Z., Coleman J.A. (1963). Texture profile method. *Journal of Food Science*, **28**:404-409.

Brunsø K., Grunert K.G. (2007) Consumer attitude measures and food product development. In Hal Macfie (Ed.), *Consumer-led food product development* (pp. 197-222), Woodhead, Cambridge, UK.

Cairncross S.E., Sjostrum L.B. (1950). Flavour profiles: a new appeach to flavour problems. *Food Technology*, **4**:308-311.

Cardello A.V. (2007). Measuring consumer expectations to improve food product development. *In: Consumer-led Food Product Development*, pp. 223-261. H.J.H. MacFie (ed). Cambridge, UK: Woodhead.

Chaya C., Perez-Hugalde C., Judez L., Wee C.S., Guinard J.-X. (2004a). Use of the STATIS method to analyze time-intensity profiling data. *Food Quality and Preference*, **15**:3-12.

Chaya C., Perez-Hugalde C., Judez L., Wee C.S., Guinard J.X. (2004b). Use of the STATIS method to analyze time-intensity profiling data. *Food Quality and Preference*, **15**:3-12.

Chrea C., D. G., Delplanque S., Cayeux I., Calve´ B.L., Aymard L., Velazco M., I., Sander D., Scherer K., R. (2009). Mapping the Semantic Space for the Subjective Experience of Emotional Responses to Odors. *Chemical Senses*, **34**:49-62.

Chrea C., Grandjean. D., Delplanque, S., Cayeux, I., Calve', B. L. ., Aymard, L,. Velazco, M, I., Sander, D., and Scherer, K, R,. (2008). Mapping the Semantic Space for the Subjective Experience of Emotional Responses to Odors. *Chemical Senses*, **34**:49-62.

Churchill A., Behan J. (2010). Comparison of methods used to study consumer emotions associated with fragrance. *Food Quality and Preference,* **21**:1108-1113.

Civille G.V., Dus C.A. (1991). Evaluating tactile properties of skincare products: A descriptive analysis technique. *Cosmetic and Toiletries*, **106**:83-88.

Clark C.C., Lawless H.T. (1994). Limiting response alternatives in time-intensity scaling: an examination of the halo-dumping effect. *Chemical Senses,* **19**:583-594.

Cliff M., Heymann H. (1993). Development and Use of Time-Intensity Methodology for Sensory Evaluation - a Review. *Food Research International*, **26**:375-385.

Clore G.L., Orthony A., Foss M.A. (1987). Psychological foundations of the affective lexicon. *Journal of Personality and Social Psychology,* **53**(4):751-766.

Cordella C.B.Y., Leardi R., Rutledge D.N. (2011). Three-way principal analysis applied to noodles sensory data analysis. *Chemometrics and Intelligent Laboratory System,* **106**:125-130.

Costa A.I.A., Schoolmeester D., Dekker M., Jongen W.M.F. (2007). To cook or not to cook: a means-end study of motives for choice of meal solutions. *Food Quality and Preference*, **18**:77-88.

Creusen M.E.H., Schoormans J.P.L. (2005). The Different Roles of Product Appearance in Consumer Choice. *Journal of Product Innovation Management,* **22**:63-81.

Dalgleish T. (2004). The emotional brain. *Nature Reviews Neuroscience,* **5**:582-585.

Damasio A. (1994a). Descartes' Error. *New York: Grosset/Putnam.*

Damasio A. (1994b). Descartes' Error: Emotion, Reason, and the Human Brain, *Avon Books.*

Damasio A. (1999). The feeling of what happens: Body and emotion in the making of consciousness. *Harcourt Brace, Orlando, Florida.*

Damasio A.R. (2006). Descartes' Error: emotion, reason and the human brain. *London: Vintage.*

Davis C. (2010). A question of science. *Drinks International,* February:22-23.

Deliza R., MacFie H.J.H. (1996) The generation of sensory expectation by external cues and its effect on sensory perception and hedonic ratings: A review. *Journal of Sensory Studies* **11**:103-128.

Deliza R., MacFie H.J.H., Hedderley D. (1996). Information Affects Consumer Assessment of Sweet and Bitter Solutions. *Journal of Food Science,* **61**:1080-1084.

Desmet P.M.A., Schifferstein H.N.J. (2008a). Emotional influences on food choice: Sensory, physiological and psychological pathways. *Appetite,* **50**:290-301.

Desmet P.M.A., Schifferstein H.N.J. (2008b). Sources of positive and negative emotions in food experience. *Appetite*, **50**:290-301.

Desmet P.M.A., Hekkert P., Jacobs J.J. (2000). When a car makes you smile: Development and application of an instrument to measure product emotions. In: Hoch, S.J. and Meyer, R.J. (Eds.), *Advances in Consumer Research*, **27**:111-117.

Dijksterhuis G.B., Flipsen M., Punter P.H. (1994). Principal Component Anlaysis of Time Intensity Data. *Food Quality and Preference*, **5**:121-127.

Dooley L., Lee Y.S., Meullenet J.F. (2010). The application of check-all-thatapply (CATA) consumer profiling to preference mapping of vanilla ice cream and its comparison to classical external preference mapping. *Food Quality and Preference*, **21**:394-401.

Dransfield E., Zamora F., Bayle M.-C. (1998). Consumer selection of steaks as influenced by information and price index. *Food Quality and Preference*, **9**:321-326.

Eilers P., Dijksterhuis G.B. (2004). A paramteric model for time intensity. *Food Quality and Preference*, **15**:239-245.

Enneking U., Neumann C., Henneberg S. (2007). How important intrinsic and extrinsic product attributes affect purchase decision. *Food Quality and Preference*, **18**:133-138.

Ferdenzi C., Schirmer A., Roberts C., Delplanque S., Porcherot-Lassallette C., Cayeux I., Velazco M.-I., Sander D., Scherer K.R., Grandjean D. (2011a). Affective Dimensions of Odor Perception: A Comparison Between Swiss, British, and Singaporean Populations. *Emotion*, **11**:1168-1181.

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

Ferrarini R., Carbognin C., Casarotti E.M., Nicolis E., Nencini A., Meneghini A.M. (2010). The emotional response to wine consumption. *Food Quality and Preference*, **21**:720-725.

Frijda N.H., Kuipers P., ter Schure E. (1989). Relations among emotion, appraisal, and emotional action readiness. *Journal of Personality and Social Psychology*, **57**:212-228.

Gacula M.C.J. (1997). Descriptive Sensory Anlaysis in Practice. Food and Nutrition Press, Inc, USA.

Gibson E.L. (2006). Emotional influences on food choice: Sensory, physiological and psychological pathways. *Physiology & Behavior*, **89**:53-61.

Green S. (1992). Validation and extension of the Repertory Grid Technique and Generalised Procrustes Analysis in food acceptability research. PhD Thesis, University of Reading, U.K.

Gschwandtner G. (2004). The powerful sales strategy behind Red Bull. Selling Power, September.

Guinard J.-X., Marty C.c. (1997). Acceptability of fat-modified foods to children, adolescents and their parents: Effect of sensory properties, nutritional information and price. *Food Quality and Preference* ,**8**:223-231.

Guinard J.-X., Uotani B., Schlich P. (2001). Internal and external mapping of preferences for commercial lager beers: comparison of hedonic ratings by consumers blind versus with knowledge of brand and price. *Food Quality and Preference*, **12**:243-255.

Hair J.F., Black W.C., Babin B.J., Anderson R.E., Tatham R.L. (2006). Multivariate Data Analysis, Pearson Prentice hall, New Jersey.

Hein K.A., Hamid N., Jaeger S.R., Delahunty C.M. (2010). Application of a written scenario to evoke a consumption context in a laboratory setting: Effects on hedonic ratings. *Food Quality and Preference*, **21**:410-416.

Helgesen H., Nais T. (1995). Selection of dry fermented lamb sausages for consumer testing. Food Quality and Preference, **6**:109-120.

Hinton P.B., Henley T.B. (1993). Cognitive and affective components of stimuli presented in three modes. *Bulletin of the Psychonomic Society,* **31**:595-598.

Hirschman E.C., Holbrook M.B. (1982). Hedonic Consumption: Emerging Concepts, Methods and Propositions. Journal of Marketing, **46**:92-101.

Juslin P.N., Vastfjall D. (2008) Emotional responses to music: the need to consider underlying mechanisms. *Behav Brain Sci,* **31**:559-75.

Kelly G.A. (1955) The psychology of personal constructs. *New* York: Norton.

Kemp S., Hollowood, T., Hort, J. (2009). Sensory Evaluation: A Practical Handbook. *John Wiley & Sons.*

King S.C., Meiselman H.L. (2010). Development of a method to measure consumer emotions associated with foods. *Food Quality and Preference,* **21**:168-177.

Koster E.P. (2009). Diversity in the determinants of food choice: A psychological perspective. *Food Quality and Preference,* **20**:70-82.

Kreibig S.D. (2010). Autonomic nervous system activity in emotion: a review. *Biol Psychol,* **84**:394-421.

Labbe D., Schlich P., Pineau N., Gilbert F., Martin N. (2009). Temporal dominance of sensations and sensory profiling: A comparative study. *Food Quality and Preference,* **20**:216-221.

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

Larsen R.J., Diener E. (1992). Promises and problems with the circumplex model of emotion. *Review of Personality and Social Psychology,* **13**:25-59.

Larsonpowers N., Pangborn R.M. (1978). Paired Comparison and Time-Intensity Measurements of Sensory Properties of Beverages and Gelatins Containing Sucrose or Synthetic Sweeteners. *Journal of Food Science,* **43**:41-46.

Lavit C., Escoufier Y., Sabatier R., Traissac P. (1994). The ACT (STATIS method). *Computational Statistics & Data Analysis*, **18**:97-119.

Lawless H.T., & Heymann, H. (1999). Sensory evalution of food: Principles and practices. Gaithersburg: Aspen.

Lazarus R.S. (1991). Emotion and Adaptation. New York: Oxford University Press.

Le Reverend F.M., Hidrio C., Fernandes A., Aubry V. (2008). Comparison between temporal dominance of sensations and time intensity results. *Food Quality and Preference,* **19**:174-178.

Lê S., Pagês J., Husson F. (2008). Methodology for the comparison of sensory profiles provided by several panels: Application to a cross-cultural study. *Food Quality and Preference,* **19**:179-181.

Ledauphin S., Evelyne V., Qannari E.M. (2006). A procedure for the analysis of time intensity curves. *Food Quality and Preference,* **17**:290-295.

LeDoux J.E. (1996). The Emotional Brain: The mysterious underpinnings of emotional life. New York: Phoenix.

Lee L., Amir O., Ariely D. (2009). In Search of Homo Economicus: Cognitive Noise and the Role of Emotion in Preference Consistency. *Journal of Consumer Research,* **36**:173-187.

Lehrer J. (2006). Driven to Market. *Nature,* **443**:502-504.

Lindstrom M. (2005). Brand Sense: Build Powerful Brands through Touch, Taste, Smell, Sight, and Sound. New York: Free Press.

Lundahl D. (2012). Breakthrough Food Product Innovation. Elsevier.

Mandler G. (1982). The Struture of Value: Accounting for Taste. In Affect and Cognition: The Seventeenth Annual Carnegie Symposium on Cognition.

Matysiak N.L., Noble A.C. (1991). Comparison of temporal perception of fruitiness in model systems sweetened with aspartame, an aspartame+acesulfame K blend, or sucrose. *Journal of Food Science,* **56**:823-826.

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

McNair D.M., Lorr M., Droppleman L.F. (1971). Profile of mood states. San Diego:Educational and Industrial Testing Service.

Meillon S., Urbano C., Schlich P. (2009) Contribution of the Temporal Dominance of Sensations (TDS) method to the sensory description of subtle differences in partially dealcoholized red wines. *Food Quality and Preference,* **20**:490-499.

Meillon S., Viala D., Medel M., Urbano C., Guillot G., Schlich P. (2010). Impact of partial alcohol reduction in Syrah wine on perceived complexity and temporality of sensations and link with preference. *Food Quality and Preference,* **21**:732-740.

Meyers-Levy J., Tybout A.M. (1989). Schema congruity as a basis for product evaluation. *Journal of Consumer Research,* **16**:39-54.

Meyners M., Pineau N. (2010). Statistical inference for temporal dominance of sensations data using randomization tests. *Food Quality and Preference,* **21**:805-814.

Morand E., Pagès J. (2005). Procrustes multiple factor analysis to analyze the overall perception of food products. *Food Quality and Preference,* **17**:36-42.

Moskowitz H. (2007). Consumer-driven concept development and innovation in food product development. H.J.H. Macfie (Ed.), Consumer-led food product development, Woodhead publishing, Cambridge, pp. 342-382.

Munoz A.M. (2002). Sensory evaluation in quality control: an overview, new developments and future opportunities.. *Food Quality and Preference,* **13**:329-339.

Murray J.M., Delahunty C.M. (2000). Mapping consumer preference for the sensory and packaging attributes of Cheddar cheese. *Food Quality and Preference,* **11**:419-435.

Murray J.M., Delahunty, C.M., & Baxter, I.A. (2001). Descriptive sensory analysis: past, present and future. *Food Research International,* **34**:461-471.

Neisser U. (1994). Multiple systems: A new approach to cognitive theory. *European Journal of Cognitive Psychology,* **6**:225-241.

Nestrud M.A., Lawless H.T. (2008). Perceptual mapping of citrus juices using projective mapping and profiling data from culinary professionals and consumers. *Food Quality and Preference,* **19**:431-438.

Olson J.C. (1981). The importance of cognitive processes and existing knowledge structures for understanding food acceptance. In J. Solms & R. L. Hall, (Eds.), *Criteria offood acceptance.* Zurich: Forster.

Ortony A., Clore G.L., Collins A. (1988). The cognitive structure of emotions. Cambridge, England: Cambridge University Press.

Ovejero-López I., Bro R., Bredie W.L.P. (2005). Univariate and multivariate modelling of flavour release in chewing gum using time-intensity: a comparison of data analytical methods. *Food Quality and Preference,* **16**:327-343.

Panksepp J. (2003). Damasio's error? *Conscious Emotion,* **4**:111-134.

Perrin L., Symoneaux R., Maıtre I., Asselin C., Jourjon F., Pages J. (2008). Comparison of three sensory methods for use with the Napping procedure: case of ten wines from Loire valley. *Food quality and Preference,* **19**:1-11.

Piggott J.R. (2000). Dynamism in flavour science and sensory methodology. *Food Research International,* **33**:191-197.

Pineau N., Cordelle S., Schlich P. (2004). Méthode d'acquisition, de codage et d'analyse de profiles sensoriels temporels. 8ème journées Agro-industrie et méthodes statistiques:10–12, 87–94.

Pineau N., Schlich P., Cordelle S., Mathonniere C., Issanchou S., Imbert A., Rogeaux M., Etievant P., Kosterf E. (2009). Temporal Dominance of Sensations: Construction of the TDS curves and comparison with time-intensity. *Food Quality and Preference,* **20**:450-455.

Piqueras-Fiszman B., Spence C. (2012). The weight of the bottle as a possible extrinsic cue with which to estimate the price (and quality) of the wine? Observed correlations. *Food Quality and Preference* , **25**:41-45.

Poels K., Dewitte S. (2006). How to capture the heart? Reviewing 20 years of emotion measurement in advertising. *Journal of Advertising Research,* **46**:18-37.

Porcherot C., Delplanque S., Planchais A., Gaudreau N., Accolla R., Cayeux I. (2012). Influence of food odorant names on the verbal measurement of emotions. *Food Quality and Preference,* **23**:125-133.

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

Richins M.L. (1997). Measuring Emotions in the Consumption Experience. *Journal of Consumer Research,* **24**:127-146.

Robert P., Escoufier Y. (1976). A unifying tool for linear multivariate statistical methods: The 'RV' coefficient. *Applied Statistics,* **25**:257-265.

Rousmans S., Robin O., Dittmar A., Vernet-Maury E. (2000). Autonomic Nervous System Responses Associated with Primary Tastes. *Chemical Senses,* **25**:709-718.

Rozin P. (1999). Food is fundamental, fun, frigtening, and far-reaching. *Social Research,* **66**:9-30.

Russell C.G., Cox D.N. (2004), Understanding middle-aged consumers' perceptions of meat using repertory grid methodology. *Food Quality and Preference,* **15**:317-329.

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

Sandell M., Laaksonen O., Jarvinen R., Rostiala N., Pohjanheimo T., Tiitinen K., Kallio H. (2009). Orosensory profiles and chemical composition of black currant (Ribes nigrum) juice and fractions of press residue. *Journal of Agriculture and Food Chemistry,* **57**:3718-28.

Scherer K.R., Schorr A., Johnstone T. (2001). Appraisal processes in emotion: Theory, methods, research. New York: Oxford University Press.

Schifferstein H.N.J., Frijters J.E.R. (1990). Sensory integration in citric acid/sucrose mixtures. *Chemical Senses,* 15:87-109.

Schifferstein H.N.J., Frijters J.E.R. (1991). The effectiveness of different sweeteners in suppressing citric cid sourness. *Perception and Psychophysics,* **49**:1-9.

Schifferstein H.N.J., Fenko A., Desmet P.M.A., Labbe D., Martin N. (2013). Influence of package design on the dynamics of multisensory and emotional food experience. *Food Quality and Preference,* **27**:18-25.

Schoormans J.P.L., Robben H.S. (1997). The effect of new package design on product attention, categorization and evaluation. *Journal of Economic Psychology,* **18**:271-287.

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**:278-292.

Spence C., Gallace A. (2011). Multisensory design: Reaching out to touch the consumer. *Psychology and Marketing,* **28**:267-308.

Steiner J.E. (1973). The gustofacial response: Observation on normal and anencephalic newborn infants. *Symposium on Oral Sensation and Perception,* **4**:254-278.

Steiner J.E., Glaser D., Hawilo M.E., Berridge K.C. (2001). Comparative expression of hedonic impact: Affective reactions to taste by human infants and other primates. *Neuroscience and Biobehavioral Reviews,* **25**:53-74.

Stone H., Sidel, J.L., Oliver, S., Woolsey, A., & Singleton, R.C. (1974). Sensory evaluation by Quantitative Descriptive Analysis. *Food Technology,* **28**:24-33.

Szczesniak A.S. (1963a) Classification of textural characteristics. *Journal of Food Science,* **28**:404.

Szczesniak A.S., Brant, M.A., &Friedman, H.H. (1963b) Development of standard rating scales for mechanical parameters of texture and correlation between the objective and the sensory methods of texture evaluation. *Journal of Food Science,* **28**:397.

Thomson D.M.H. (2007). SensoEmotional optimisation of food products and brands. H.J.H. Macfie (Ed.), Consumer-led food product development, Woodhead publishing, Cambridge, pp. 281-303.

Thomson D.M.H., McEwan J.A. (1988). An application of the repertory grid method to investigate consumer perceptions of foods. *Appetite,* **10**:181-193.

Thomson D.M.H., Crocker C., Marketo C.G. (2010). Linking sensory characteristics to emotions: An example using dark chocolate. *Food quality and Preference,* **21**:1117-1125.

Tuorila H., Andersson Ã.s., Martikainen A., Salovaara H. (1998). Effect of product formula, information and consumer characteristics on the acceptance of a new snack food. *Food Quality and Preference,* **9**:313-320.

Varela P., Ares, G., Giménez, A., & Gámbaro, A. (2010). Influence of brand information on consumers' expectations and liking of powdered drinks in central location tests. *Food Quality and Preference,* **21**:873-880.

Villegas B., Carbonell I., Costell E. (2008). Effects of product information and consumer attitudes on responses to milk and soybean vanilla beverages. *Journal of the Science of Food and Agriculture,* **88**:2426-2434.

Walsh G., Shiu E., Hassan L.M., Michaelidou N., Beatty S.E. (2011). Emotions, store-environmental cues, store-choice criteria, and marketing outcomes. *Journal of Business Research,* **64**:737-744.

Watson D., Tellegen A. (1985). Toward a consensual structure of mood. *Psychological Bulletin,* **98**:219-235.

Watson D., Wiese D., Vaidya J., Tellegen A. (1999). The two general activation systems of affect: structural findings, evolutionary considerations, and psychobiological evidence. *Journal of Personality and Social Psychology,* **76**:820-838.

Wiet S.P., Beyts P.K. (1992). Sensory Characteristics of Sucralose and other High Intensity Sweeteners. *Journal of Food Science,* **57**:1014-1992.

Zuckerman M., Lubin B. (1965). Manual for the multiple affect adjective check list. San Diego: Educational and Industrial Testing Service.

Zuckerman M., Lubin B. (1985). The multiple affect adjective check list revised. San Diego: Educational and Industrial Testing Service.