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FOOD CHOICE IN CONTEXT:

The application of experimental choice analysis to investigate sensory and cognitive factors in consumer food choice

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ABSTRACT

Knowledge about consumer food choices is fundamental to many areas of research and practice. Food choices can only be fully understood by identifying and measuring sensory and cognitive factors from the consumer's perspective and interpreted with reference to the context in which the food is to be used or consumed. Experimental choice analysis is a technique which integrates conjoint analysis with probabilistic discrete choice theories to investigate influences on consumer choices. This technique was applied and evaluated, in conjunction with qualitative research, to investigate consumer choices for yoghurt. Multiple sets of experimentally designed product alternatives were presented to consumers, and the impact of, and interaction between, different product features determined using a multinomial logit model. Choices for five different use contexts were made on the basis of product descriptions only, blind tasted products and the combined product (information plus tasting). Features to be manipulated for labels and products were sweetness and fat content, each at two levels. Label only attributes included statements related to acidophilus and no additives product features. The results demonstrated that consumers' choices, based on the attributes of the product, vary with different intended use contexts. Context-specific interactions were noted between fat content and sweetness. This suggested that consumers do not always assess product features independently or consistently, and interactions should be incorporated in research designs wherever possible. Participants' frequency of use and degree of health concern were incorporated into the model as interactions with attributes and these significantly improved the model over base models. Combined with the results of the qualitative studies, a comprehensive picture of how consumers' use of yoghurt affected their choices was obtained. This approach can provide valuable information for product development decisions and may be a step towards developing more integrated research methodologies for investigating consumer food choices.

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Chapter one

INTRODUCTION

1.1 Overview

More choices are made in relation to food than almost any other consumer product or service. There are many economic, social and health reasons why research into consumer food choices is important. The challenge is to understand more fully why one food product is chosen over another, or to predict food choice behaviours more accurately.

Choices are largely assumed to be dominated by the sensory appeal of a food (perception of the sight, smell, taste and texture of the food), and this is a major focus of food research. Research into food choices has also benefitted from the contributions of cognitive psychology which broadly studies the mental processes by which a person thinks about, conceptualises, evaluates and discriminates between foods. Alongside this is an increasing recognition that choices cannot be interpreted in isolation from the context in which the food is to be used or consumed (Rozin & Tuorila, 1993). Research which can relate people's food choices to their concurrent judgements of the physical characteristics of the product and the desirability or undesirability of the product features in a particular use situation is likely to advance understanding and practical objectives (Booth, 1995). This is in line with recent calls (Meiselman, 1994; Van Trijp & Schifferstein, 1995) for a more integrated approach towards research into food choice and acceptance which will meet both marketing and sensory objectives.

1.2 Scope and objectives

In order to examine fully the impact of factors underlying consumer food choices, a methodology which could assess the trade-offs between sensory, cognitive and usage factors was required. A methodology based explicitly on consumer choice was utilised in the present research. This thesis demonstrates how experimental choice analysis, a form of conjoint analysis, can be used to model preferences for food products.

The objective of this research was to examine how consumer choices for food products, characterised by different product attributes, vary relative to the context in which the product is to be used. This approach should shed more light on the perceived appropriateness of particular product features for different uses of the product and how this affects consumer choices. It should also demonstrate how this technique can provide practical information which can be used for product development and marketing strategies in the food industry.

There are several ways that the methodology, as applied in this research, differs from traditional conjoint approaches to consumer food research. Firstly, the response measure is based on consumers making discrete choices between product alternatives rather than evaluating products separately on a rating scale. Secondly, not one but several response measures are used, corresponding to different uses of the product. Thirdly, interactions are modelled, to assess the joint impact of product attributes. Finally, the choice methodology used to model choices based on product information alone is further extended to incorporate a sensory component, where consumers taste the products and choose between them.

The study specifically investigates consumer choices for natural yoghurt.

1.3 Outline of this thesis

Chapter 2 of this thesis is a review of the literature which examines current approaches to research into food choices, demonstrates the importance of the use context in food choices and explores ways of incorporating sensory, cognitive and contextual factors into integrated research programmes. Chapter 3 outlines and compares two decompositional methods of modelling consumer preferences: conjoint analysis and experimental choice analysis. Design and measurement issues related to these methods are discussed in assessing the most appropriate methodology for this research. In chapter 4, the methodology and results of two qualitative studies are outlined, together with the development of a use context classification and a conceptual model of the food choice process. The methodology and analysis of the experimental choice study are presented in chapters 5 and 6. In the concluding chapter, chapter 7, issues relating to the methodology are discussed, together with the theoretical, practical and methodological implications for food choice research.

Chapter two

FOOD CHOICE RESEARCH

2.1 Introduction

Making food choices is a part of everyday life. The concept of food choice is inextricably linked with the related concept of food acceptance, yet choice incorporates many considerations beyond simple acceptance. People do not always choose what they prefer, as cultural, economic, social, nutritional, physiological and contextual factors may all influence choices.

Food acceptance has been defined in many different ways, but it is generally accepted that it is the result of the interaction between a food and a consumer which evokes an hedonic response. It has been viewed both as a generally stable response by individuals over time towards particular foods (McEwan & Thomson, 1988), and as a highly context and time dependent integration of many sensory, cognitive and physiological variables in response to a specific food (Cardello, 1996). Food acceptance has most often been measured by direct evaluative ratings of liking.

Food choice goes one stage further than acceptance. It encompasses many more variables, but it can be argued that acceptance is a necessary pre-requisite for subsequent food choices. If a food is not acceptable, then ultimately it is less likely that it will be chosen for consumption. Choice is sometimes used as a measure of food acceptance as it is a direct behavioural measure and can have a real-world validity that self-reports of acceptance do not have.

The focus of this review is food choice, although as food acceptance underlies food choice, it is an integral part of the discussion. It is sometimes hard to distinguish between the two concepts in the literature and they often overlap. Research into food choice is examined here from the point of view of the consumer, with reference to explicit sensory, cognitive and contextual influences.

The first objective of the review is to examine the literature to determine methods of research that have been used to investigate sensory and cognitive factors influencing food choice. The second objective is to review the empirical evidence on the relationship between food choices and usage factors. The final objective is to discuss ways of developing more integrated approaches to research into food choices.

2.2 Overview of food choice research methods

Research into food choice may be conducted from many different perspectives. In the broadest approach, the goal is to identify and define all the variables influencing food choice and to develop conceptual models of the nature of the food choice process. Qualitative methods used to investigate general food choices have included intercept interviews in grocery stores (eg Furst et al, 1996), individual structured interviews (eg Gains, 1994) and focus group interviews (Casey & Krueger, 1994).

Quantitative food choice research has been explored from a variety of theoretical and applied perspectives. There are also distinctions in how food choice is measured. Sensory judgements measure actual perceptions of foods, including overall judgements of like and dislike and judgements of specific sensory attributes. Evaluative survey methods measure intentions to purchase or consume, purchase likelihoods, stated likes/dislikes, stated preferences and self-reported attitudes, beliefs and expectations; and behavioural methods measure the outcome of food choice using actual food purchases and food consumption.

In the consumer sensory literature, research is separated into sensory preference testing and sensory acceptance testing. In preference testing consumers are asked to choose between products, usually pairs, on the basis of sensory preference. Traditional sensory preference testing is discriminative only and cannot identify the underlying causative factors in choice.

Acceptance testing is analytic and consumers rate their degree of liking. The results may be related to other individual characteristics or behaviours, and likely choices between products may be inferred. Food acceptance is measured in several ways. The 9-point hedonic scale (Peryam & Giradot, 1952; Peryam & Pilgrim, 1957) is most commonly used as a direct index of the degree of liking for a food, but other techniques can be used, such as graphic scaling methods, relative to ideal ratings and food action rating scales (Lawless & Heymann, 1998). Consumers may also be asked to rate specific sensory attributes to assess the relative importance of sensory factors for overall acceptance. Sensory attributes may be rated according to the degree to which the attribute is perceived (no acceptability judgements are made), or consumers may judge their liking of the component sensory attributes. This can be done by asking general questions on their liking of the different types of sensory inputs, such as liking of texture, liking of taste, liking of appearance (Moskowitz, 1995), or asking for ratings of specific sensory attributes, such as liking of sweetness. Hedonic and intensity judgements may also be combined in just-right scaling, where consumers judge whether a particular attribute is just-right or just-about-right or, for example, "much too sweet" or "not sweet enough" (Booth & Conner, 1990). Description and comparison of these sensory methods is outside the scope of this review but they are extensively documented elsewhere (eg Stone & Sidel, 1985; Lawless & Heymann, 1998).

Qualitative methods are less useful to investigate sensory factors in food choice, as people find it very difficult to interpret and verbalise sensory perceptions, although focus groups or structured interview methods are often used in preliminary stages to elicit pertinent sensory factors from the consumers point of view. Free-choice profiling methods have been used in food acceptance studies to generate personal vocabularies to describe sensory perceptions (Williams & Langron, 1984; Jack & Piggott, 1991/92).

The goal of most quantitative evaluative methods is to measure the strength of influence of factors determining choice. Broad-based approaches have been taken to investigate general food choices, such as a study by Peters et al (1995), who modelled the dimensions of liking, health, convenience and cost, and used multiple regression techniques to predict preferences for both actual recent meals and hypothetical meals. Marketing research on food choices relies largely on survey methods, to identify determinant factors, and conjoint analysis or regression techniques to estimate the relative importance of the attributes of the marketed product. The goals of such research may include new product/concept identification or evaluation; competitive analysis; market segmentation and market share; positioning, pricing or advertising strategies.

However, two main methodological frameworks which focus on sensory and cognitive factors in food choices have dominated consumer food choice research. These are expectancy-value models of food choice and individualised causal analysis of choice. These are described below.

Expectancy-value models of food choice

Evaluative measures of food choice and acceptance have largely been investigated using social psychological expectancy-value models as a framework. These models, known as Fishbein/Ajzen models after the researchers who introduced them (Fishbein & Ajzen, 1975, 1980), incorporate affective and cognitive components measured as attitudes and beliefs, and relate these to behavioural intentions. It is assumed in these models that attitudes are causally related to behaviour.

The model as applied to food choice is described by Shephard (1990) and Shephard and Sparks (1994). Various forms and extensions of this model have been used in food choice research. The Theory of Reasoned Action is based on the theory that a person's attitude, related personal beliefs and subjective norms determine his or her intention to engage in a particular action. An extension of the theory, the theory of planned behaviour (Ajzen, 1991) includes all the dimensions of the theory of reasoned action plus perceived behavioural control which is thought to have motivational implications for intention and have a direct effect on behaviour. Elements of Triandis' (1977) theory of social behaviour have also been used, which places more weight on past experience than intention and incorporates motivational and physiological components along with facilitating conditions. The Fishbein/Ajzen model has been used in many food studies (Tuorila, 1987; Shepherd et al, 1991/2; Aaron et al, 1994; Tuorila et al, 1997; Saba et al,

1998) and over the years there have been various modifications to increase the utility of the model. In the context of food choice the model assumes that influences on food choices are mediated by consumers' attitudes and beliefs and that intention to purchase or select a food is the best predictor of that behaviour. However, measurement of the intention to perform a behaviour may not always be an accurate reflection of the actual likelihood of that outcome (Sutton, 1998). There may be unmeasured situational constraints which prevent the behaviour being performed, and intention may be overestimated by respondents. There may be a problem for behaviours which are seen as socially desirable, such as dietary change, where people may be less likely to respond to attitude statements in a negative way and where individuals may formulate their answers on the basis of their goals rather than their intentions. Goals are subject to far more uncertainty than intentions (Ajzen, 1985) and a weaker relationship can be expected between attitudes and goals than between attitudes and intentions.

Many studies using Fishbein/Ajzen models include reported purchase or consumption in addition to intentions to purchase or consume. The stronger relationship between attitudes and reported behaviour than between attitudes and intended behaviour (eg Tuorila et al, 1997; Aaron et al, 1994) is to be expected. Previous experience may strengthen both the attitude itself and the accessibility of the attitude from memory (Eagly & Chaiken, 1993). People may also be more inclined to respond to attitude and belief questions in a manner consistent with their past behaviour (justification bias). It has been argued that for low-involvement choices or behaviours, such as some food choices, people may not have well formed attitudes (Wilson and Dunn, 1986).

As the model was developed for general theories of behaviour, the application of the model to food research presents some extra problems as hedonic assessments of the food should be taken into account. Hedonic responses to food may be assessed by survey ratings of liking or hedonic ratings of tasted foods. Whether actual tasting improves the predictive ability of the model may depend on each individual's familiarity with the food under investigation. The inclusion of specific sensory attributes in the model has also been incorporated, although this was not found to improve prediction in a study by Saba et al (1998).

While the model has been applied to food choices (Tuorila, 1987; Shepherd et al, 1991/2), in most applications of Fishbein/Ajzen models, choices are only inferred from the results of the evaluative ratings. As acknowledged by Fishbein and Ajzen (1980), the model is not designed to deal with situations in which people are required to choose between alternatives. However, Sheppard et al (1988) in a meta-analysis of studies of consumer behaviour using the model, found that the model actually performed well in situations involving an explicit choice among alternatives. As the model originally intended to predict intention for a single behaviour only, two possibilities have been proposed to account for how the theory might still hold where there are choices between alternatives (Sheppard et al, 1988). One is that consumers might compare the strength of their intention towards each of the alternatives, and the other is that they might compare their attitudes towards each alternative. Neither is entirely satisfactory in the context of food choice, both being complex processes, and neither has been solidly supported by empirical evidence. There is also little comparative evidence of the predictive power of expectancy-value models versus other theoretical frameworks in predicting actual choices made by consumers.

The model has been less successful in predicting specific food choice behaviours such as choices between variants of a product, than for more general food issues such as attitudes and intentions towards new food production and processing techniques (eg genetic engineering; Shepherd & Raats, 1996). While these models have contributed to the understanding of food choice behaviour, there have been calls for the explicit modelling of choices and more context-specific measures (Shepherd et al, 1991/92), more attention to situational factors (Sutton, 1996), the incorporation of more experimentally based research (Conner, 1993), more individualised approaches to assessing attitudinal influences (Conner, 1994) and more empirical research on the model (Saba et al, 1998).

Individualised causal choice analysis

Another theoretical model for investigating influences on food choices is individualised causal analysis of choice (Booth, 1988, 1990; Booth & Conner, 1990; Conner, 1994).

This approach, developed from cognitive experimental psychology techniques, more explicitly investigates food choice as a means of understanding consumer behaviour.

The theory underlying the approach is that for individual consumers in a particular context there is a level at which each perceived attribute of a food is preferred. The relationship between the physical levels of the attribute and the individual's preferences can be represented as an inverted V function, called the acceptance triangle. This takes into account the preferred level of the attribute (or ideal point) and the levels at which deviations from this preferred level are tolerated.

The approach differs from other methods in several important ways. The first is that it relies on individualised analysis to examine how attributes are related to acceptability and how multiple determinants might be cognitively integrated within an individual to influence overall choices. This is done using relative to ideal ratings and selection of samples to suit individual preferences, which has the advantage of minimising response biases. Aggregation of the individual responses may still be achieved by summation of the estimated parameters over the whole sample, and can represent market responses if suitable samples are obtained. The result of this aggregation is not an average response as in other methods of quantifying group data but still takes into account variations in consumers' personal acceptance parameters.

The methodology is also based on experimental principles, as the products presented to individuals are varied systematically so that variations in responses can be causally determined. The third feature of the methodology is in the data collection methods. Booth and Conner (1990) argue that subjective hedonic ratings may not necessarily be correlated to actual behaviour and that the relevance of the results depends on the correspondence to real consumer choice behaviour. Responses collected are therefore based on realistic choice and purchase situations.

The theory can accommodate multiple determinants of choice, non-sensory determinants such as label information, price or advertising strategies, and even unidentified variables, ie products for which instrumental measurements are not available and which cannot be systematically varied. It has also been extended to account for contextual factors (Booth, 1995), where the contextual deviation of a tested product from an individual's ideal is measured. The types of contextual effects which might be represented in this way are not yet demonstrated, and Lawless (1995) has questioned whether context in all its forms can be represented as a single dimension. Booth (1995), however, has recommended the use of sequential studies successively incorporating relevant contextual factors to help build up a fuller picture of product choices for different use contexts.

In all consumer research there is a very real conflict between obtaining usable information and modelling "real" choice processes. Individualised analysis and expectancy-value models, are two different methods of attempting to increase understanding of consumer food-related behaviours.

Observational and naturalistic methods have had limited use in food choice research, although they have been used for studying decision making, for example observing shoppers in supermarkets. A combination of observation and hedonic rating was used in a study of food choices for overall meals (Hedderley & Meiselman, 1995), where the relationship between the acceptability of individual meal components and the overall meal was studied for a group of subjects who made food choices in a normal environment.

A large body of specific food choice research has been conducted in the applied fields of nutrition and marketing, to assess factors influencing food choice, of which sensory factors are just one element. Nutritional research, the goal of which can be to inform or support nutrition education and intervention strategies, is often conducted for specific consumer groups using qualitative methods (eg Kirk & Gillespie, 1990; Weber, 1997), field experiments and survey methods, often accompanied by food diary information and/or physiological or health correlates.

However, there have been surprisingly few multimethod approaches to food choice research. As noted by Brewer & Hunter (1989), some complex research problems "require more and different kinds of information than any single method can provide". As food choice is an inherently complex area of study, the use of multiple methods is likely to be more valid as the combination can provide different information and insights, and therefore a greater understanding. Although many studies do use both qualitative and quantitative methods, the qualitative methods are primarily used for for elicitation of factors in separate preliminary stages rather than both sets of results being used for analysis and interpretation (eg methodological triangulation, Jick, 1979) .

2.3 The use context and its role in food choices

The importance of contextual factors in food choice and food acceptance is widely recognised. A developing focus on real world food evaluation in sensory and consumer research has led to a broader perspective and a move towards more complex strategies of research incorporating contextual factors.

In order to conceptualise contextual effects more adequately, a taxonomy of situational variables related to general consumer choice behaviour was proposed by Belk (1975). He suggested that five dimensions characterise a situation: physical surroundings (the geographical, visual, auditory and olfactory features of a location, climate and weather conditions); social surroundings (persons present, their characteristics, roles and interpersonal interactions); temporal perspective (actual time factors such as time of day and time of year, and relative time factors for an individual, such as past or future events or constraints); task definition (the intent or requirement of an individual); and antecedent states (individual momentary conditions, such as mental or physical state).

This taxonomy may also apply to food choice research. However, research into the role of context in food choice and acceptance has mainly been categorised into factors related to the individual (eg expectations, stereotypes, prior experience, food aversions, neophobia and neophilia, restrained eating, habit, involvement and variety seeking), factors related to the environment (eg eating site, physical and social environment) , and factors related to the food itself (eg packaging and labelling, food interactions, variety and culinary context), (Bell and Meiselman, 1995; Meiselman, 1996) . Research into contextual influences has also been organised on several other levels (Rozin & Tuorila, 1993) - food vs non-food; and simultaneous vs temporal influences, categorised at the bite/sip, dish/meal and overall meal pattern levels. Rozin and Tuorila (1993) concluded that "to ignore such influences is to risk misinterpreting the meaning and significance of human food choice" (p18).

Adequate measurement of some of these situational effects can be problematic as they may be undertaken at an objective level (Belk, 1975) or from the perspective of the individual (Lutz & Kakkar, 1975), or both. Furthermore, contextual factors are dynamic and there are likely to be ever-changing interactions between the various contextual effects.

The decision to buy or choose a particular food may incorporate many of these contextual factors, the majority antecedent to choice and not consciously thought about or recognised. Anticipated product usage, however, is likely to exert a strong influence on buying decisions. Shocker & Srinivasan (1979) suggested that the intended usage of a product needs more research attention as this "determines criteria which serve to restrict an individual's consideration set". The importance of the usage situation has also been highlighted by Schutz (1988) who argues that preference is just one factor in the actual acceptance of a food. Several studies investigating preferences or purchase probabilities have raised the possibility that product usage factors may account for some of the variance in results (eg Shepherd et al, 1991/2; Solheim & Lawless, 1996).
For the purposes of this discussion, the term "use context" is used and is defined as the context in which the food is used or consumed, and includes when, where, why and how the food is consumed; what it is eaten with; and who prepares, eats and is present at the specific eating occasion. It encompasses non-consumption uses, such as when a food is prepared by the food purchaser for consumption by others, used for purposes other than consumption, and when prepared for later consumption, such as an ingredient in a composite dish. Use intentions as well as the actual use experience are relevant, as understanding consumer choice requires examination of the linkages between the

purchase context and use context. This brings into consideration differences in the salience of choice factors between food purchased for immediate consumption and for future consumption.

The next section reviews the research on how product usage and perceptions of use appropriateness influence food choice and subsequent acceptance of food items. It is discussed under the headings: the use situation, food accompaniments and the meal occasion.

2.3.1 The use situation

Most food products have numerous uses that differ between cultural groups, between consumers and within a single household. Products are available in many different varieties and formulations to suit different preferences and uses. For new or unfamiliar products, consumers may only have product information on suggested uses with which to make purchase decisions. Product information may be given on the appropriateness, versatility or uses of the product, and include how the product may be prepared, used or served, and suggestions on when it may be eaten, what it may be served with and who it might be suitable for. Product information on uses may thus enhance or restrict acceptance of new products, or generate expectations of sensory quality. Tuorila et al (1994), in their study of familiar American and comparable unfamiliar Finnish foods, found that information on the product and suggested uses enhanced the acceptance of both the novel and unfamiliar foods. Cardello et al (1985) also found that providing product information on versatility of use had some beneficial effects on purchase likelihood for non-users for some, but not all, use situations. It is unclear to what extent product information on suggested uses influences choices between products.

Some research has been conducted to determine consumers' preferences between varieties of similar products in light of their different uses of the product and how this affects their ultimate purchasing behaviour. The intended use or consumption of products is likely to be a major influence on purchase decisions (Holbrook et al, 1986), although the purchase occasion and use occasion are typically separated and at the time of purchase not all the anticipated usage occasions may be known. If a product is purchased for immediate consumption, it is easy to decide what characteristics are preferred, but if it is to be used some time in the future it is not so easy to decide. Walsh (1995) argues that "the conditions prevailing at the consumption occasion may not be known to the consumer at the purchase occasion", so when buying multiple units within a product category, choosing several different alternatives allows consumers to retain the flexibility of selecting the most appropriate for use at the time of consumption. Hauser & Wernerfelt (1990) illustrate this idea by using wine as an example - a variety of wines may be purchased for future use, but the wine chosen for a particular occasion will depend on many factors relevant to the use context at the time - the people present, the food to be eaten with the wine, sensory preferences at the time, and even the weather. As another example, suppose that a consumer is purchasing a block of cheese and is uncertain whether it will be used just for eating or for cooking purposes during the following week, or both. They may choose two different varieties for the two purposes - perhaps a cheaper variety for the purpose of cooking, or one that melts well, and a tastier, more expensive variety for eating. Alternatively, they may choose just one variety to suit both purposes. Which characteristics are more important for guiding their choice - the price, taste or heating qualities? Raats and Shepherd (1991/2, 1993) in their study of the use of milk, suggested that consumers tended to find their most used type of milk suitable for all their purposes. In some cases there were differences between the consumers' most used milk and most preferred milk, although this was not directly investigated.

Van Trijp (1994) investigated variety seeking within specific product categories and identified sensory variation as the most important determinant of variety seeking behaviour for foods, both at the product type level and the brand/variety level. While this might be explained by a desire for variety, it is possible that this is sometimes due to the appropriateness of the different sensory qualities of the products for different consumption situations. For example, there is little information on the perceived appropriateness of low fat and other nutritionally modified foods for different eating contexts, such as family or social meals versus meals eaten alone, or for various functional uses. Research into actual purchase behaviour and subsequent consumption may shed more light on this.

The role of specific sensory attributes can determine appropriateness in terms of product usage. Miller and Ginter (1979) demonstrated that situational appropriateness is not restricted to grossly different product types. More explicit consideration of differences in perceived appropriateness within specific product groups, rather than for general product classes, may help in explaining some of the variance in food choice models.

Preferences for specific flavour or textural attributes may vary according to different use contexts. For some products, appropriateness for particular uses might take precedence over simple hedonic preference. For example, the attribute perceived to be most important to parents feeding yoghurt to an infant may be consistency, as a thick consistency is less messy than a runnier one. Research on cheese has demonstrated that textural properties rather than flavour can be a more important determinant of appropriateness for many uses (Jack et al, 1994). A cheese which slices well might be chosen in preference to a crumbly, if tastier, cheese. The preferred flavour intensity of a food or beverage may vary according to different usage occasions, as was demonstrated by Gains (1994) in an investigation into the perceived appropriateness of lagers.

In the marketing of products, sensory descriptions on packaging or in advertisements often relate specific sensory attributes to their appropriateness for particular usage occasions, for example "rich and creamy" for a special occasion or treat. Expectations of sensory attributes, whether generated from product advertising, past experience or social and cultural norms, play an important role in food acceptability (Cardello, 1994), and these expectations may relate to the usage experience as well as the hedonic experience.

Some sensory attributes at the time of use depend on how the food is served, notably the temperature at which the food or beverage is served, and the appropriateness of these normally reflect cultural and social norms. In a study which highlighted how appropriateness information may affect liking ratings of beverages, Zellner et al (1988) gave information which led one group of subjects to believe that unfamiliar beverages (guanabana and tamarind juices) were normally consumed at room temperature. These subjects gave significantly higher liking ratings for the room temperature beverages than subjects who were not given this information.

The appropriateness of sensory attributes must also be considered on a temporal perspective. The sensory properties at the time of use may dictate how the food is used or consumed. This takes into account changes in the intrinsic properties of the food due to storage - for example, the soured cream, hardened cheese or oxidised butter being used for culinary purposes when they might not otherwise be eaten.

The relative importance of flavour, texture and appearance to overall consumer acceptance is important for product development (Moskowitz & Krieger, 1995), and a fuller examination of how these may change for different uses of the product may provide even more valuable information. Consideration of the use context is also important for market positioning, and it may be that this is another example of the need for more integration of market research and sensory analysis.

2.3.2 Food Accompaniments

Whether at the level of mouthful by mouthful, an entire meal or a week's meals, the effect of accompanying food items is perhaps one of the most important factors influencing food and product choices. The majority of foods are not eaten in isolation and the sensory interactions between foods is likely to be a major factor in food acceptance. Much of the pleasure in eating comes from contrast between different foods, e.g. hot and cold, sweet and sour, creamy and crunchy. Hyde and Witherley (1993) call this "dynamic contrast" and suggest that this contributes significantly to the motivation for eating and the palatability of foods. Consumer choices may be different for items eaten alone from those eaten or combined with other foods. Day to day food choice may be largely determined by the appropriateness of food combinations and depend on what accompanying foods are available at the time. Research in this area has largely focused on overall food compatabilities and menu planning rather than on specific product groups, and has indicated that the acceptability of food items is at least partially determined by the foods with which they are served (Meiselman, 1996).

It seems likely that the sensory characteristics of a product will be more important for a food or beverage eaten or drunk by itself than with other foods, as sensory variation between products may be masked in the context of combinations of foods or flavours. Raats and Shepherd (1992) investigated whether sensory differences between milks of different fat content were noticeable in different contexts of use. They found that no difference between the milks could be discerned when used in coffee, in oat cereal and in whipped dessert, but there were significant differences when the milks were used on cornflakes, in flavoured milk, in savoury sauce and in tea. This has implications for acceptance of product variants which may have benefits (eg low fat) but which are not perceived to be the sensory equivalent of regular products. They may be more acceptable in some contexts than others.

Sensory research has not generally progressed into the area of complex foods and meals or the compatability of food items, and "very little is known about how people evaluate combinations of foods based on sensory properties" (Meiselman, 1994, p.397). As some research has shown that traditional 'taste and spit' sensory tests do not always predict preferences of actual intake after prolonged exposure to the food (Lucas & Bellisle, 1987), it seems likely that they also may not reliably predict sensory preferences when a food is combined with other foods.

2.3.3 Meal Occasion

The meal occasion is an important factor in any examination of how the perceived appropriateness and use of a product relates to food choice and preference, as it underlies what is acceptable in terms of when and how and what we eat. While the cultural "rules" governing the foods eaten at different meal occasions are not as rigid as they once were, it is still largely true that:

> *"every culture has its own distinctive cuisine characterised by a range of basic foods, frequent use of a set of recipes, flavourings, specific processing characteristics as well as rules about how those foods are combined and what is appropriate for the occasion"*
>
> (Marshall, 1995, p280).

There is a vast literature on the sociological and anthropological factors influencing meal structures (eg Gofton, 1986; Murcott, 1986; Fiddes, 1995). Research into the perceived appropriateness of foods for different meal occasions has generally taken this wide socio-cultural focus and attempted to document or classify overall meal patterns, meal structures, meal components and combinations. Investigations have generally been conducted at this "macro" level into the perceived and actual use of a wide variety of foods for different meal occasions, although increasingly data have been obtained on the use of particular food groups in relation to the meal occasion. Marshall (1993), for example, examined the use of fish products in British households and offered insights into how different fish varieties were used across meal occasions in terms of product forms, methods of preparation and accompanying foods.

Consumer preferences according to meal occasion have also been investigated. A study by Peters et al (1995) indicated that the criteria of food preferences were weighted somewhat differently for different meals. Their findings, based on both actual meals consumed and hypothetical meals, suggested that there are clear differences in the way people evaluate morning meals as compared to midday and evening meals. For morning meals, preference was based less on liking and more on convenience and health factors than for midday and evening meals. Perceived attribute importances and purchases of specific brands also differed significantly across meal occasions in a study by Miller and Ginter (1979).

The acceptability of food as a function of meal time appropriateness has also been investigated experimentally (Birch et al, 1984), with significant preference shifts with time of day being noted when foods more appropriate for breakfast or dinner were presented to subjects at times more consistent with these meal occasions.

Traditional socio-cultural patterns of thinking about food also influence general perceptions of what foods are appropriate for different people. These have to do with age (infants, children, the elderly), roles in life (head of the household, workers), states of health (the sick, pregnant women) or social status. There are clear hierarchies in the prestige value of foods, both across food groups and within food categories and these change over time (Crockett & Stuber, 1992). Foods which might be chosen to serve to important guests or to project an image of social status may not be those most preferred.

The growing trend to more individualistic eating and single serve packaged foods may have effects on the appropriateness of foods for different meal occasions and people (Gofton, 1995). The associative meanings related to meal preference predictors were investigated by Peters et al (1995), and there were some suggestions that meals eaten alone as opposed to those eaten with others, either socially or with family, differed in evaluative criteria such as liking and healthiness. There were considerable age, gender and meal specific differences, and the authors suggested that further in-depth studies may uncover more comprehensive and interpretable data.

2.4 Towards an integrated approach to food choice research

In order to understand food choices fully, it is necessary to measure the sensory, cognitive and contextual factors which influence choices. For this reason food choice research is situated between product-related (sensory) and consumer-related (marketing) fields, and there have been many calls in the last decade for a closer link between these two approaches to food choice and food acceptance (Wilton & Greenhoff, 1988; McBride, 1989; Moskowitz, 1993*a*; Meiselman, 1994;Van Trijp & Schifferstein, 1995; Deliza & MacFie, 1996).

In product-related research into food choices all extraneous factors are minimised in the evaluation of the product's sensory properties. In contrast, cognitive and contextual research emphasises methods which can more adequately represent how products are experienced by consumers in the real world. The problem for researchers wishing to investigate interactions between sensory and cognitive/contextual factors is how to retain the experimental control of sensory evaluation methods while attaining the greater external validity of consumer-oriented methods.

Some of the methodological procedures suggested for sensory research involving cognitive/contextual factors include realistic testing locations instead of laboratory testing, ad-lib consumption rather than limited tasting exposure, normal eating conditions rather than isolating samples and cleansing the palate between samples, behaviourally-based measures rather than hedonic measures and evaluation under, or with reference to, normal usage conditions (Van Trijp & Schifferstein, 1995).

For marketing research involving sensory evaluation, the consumer's perception of the sensory experience is just one of the many potential influences on food choices, but the use of controlled sensory testing practices is recommended to accurately identify the contribution of the sensory properties to overall preferences. Comparison of consumer evaluations of blind-tasted products with labelled products has been one strategy to identify the relative contribution of sensory product characteristics and concept or informational features.

Experimentally based methods incorporating both cognitive and sensory components may hold the most promise for future fully integrated consumer research (McBride, 1990; Moskowitz, 1993*a*) by simultaneously varying intrinsic product attributes and label attributes. While many studies have manipulated labels and tested the effects of incorrect labels on perceptions, systematic variation of product and label combinations may hold even more promise for unravelling sensory and cognitive interactions. Experimentally designed combined models must however be realistic for the consumer evaluating the product. Incongruent product/label combinations or qualitatively different evaluation tasks (for example mixing unlabelled and labelled samples) may reduce validity.

One of the recommendations to increase external validity in food choice research is to measure choices in as close to a normal context as possible. For some products, however, "normal use" may include many different use occasions. Measurement of choices without reference to any context of use, or where "normal use" is assumed, cannot provide a thorough understanding of how the product attributes 'perform' for different users and use situations.

Measurement of the relationship between product usage and food choices has largely focused on the concept of appropriateness and how this may influence food choice and acceptance with regard to the use context. Schutz (1988, 1994) introduced the concept of appropriateness to food research as an aid to understanding food acceptance and the concept has been applied to a wide variety of food items. The measurement technique ("item-by-use appropriateness") involved consumers rating the appropriateness of foods for a variety of uses. While this gives an indication of consumer perceptions of appropriateness, the uses reflect different levels of abstraction. For example, Schutz (1994) defined "uses" as person, type of meal, how, where and when eaten, psychological and physiological states, cost, sensory and nutritional factors. Subsequent studies (eg Raats & Shepherd 1991/92, 1993; Scriven, et al, 1989; Gains, 1994) more clearly separated the dimensions into actual uses (when, where, how and for whom the product is used), and constructs or attributes differentiating the products (sensory qualities, perceived quality, cost, nutritional composition, perceived physiological effects and functional attributes, or why the product is used) according to use.

In terms of stimuli, most early research into appropriateness was based on pencil and paper evaluations of the names of food items (Bruhn & Schutz, 1986; Sukhumsuvan & Resurreccion, 1988; Scriven & Mak, 1991). Later studies have used photographs (Raats & Shepherd, 1991/92, 1993; Jack et al, 1994) or visual examination of actual products (Gains, 1994). Item-by-use appropriateness rating incorporating the tasting of actual products, has been a more recent development, to take into account the specific sensory nature of the food items. Lähteenmäki and Tuorila (1995) obtained appropriateness ratings as well as hedonic ratings for different brands of ice cream, and found that the appropriateness ratings differentiated the brands in only one use context (for dessert).

Cardello and Schutz (1996) assessed the general feasibility, reliability and validity of collecting item-by-use appropriateness ratings in conjunction with hedonic ratings of food products in laboratory taste tests. They concluded that it was an effective procedure, did not appear to bias hedonic ratings and could be used to provide useful information about product usage. It was also demonstrated that the procedure could be used equally well for tasted products and conceptual (untasted) products.

Lähteenmäki and Tuorila (1997) went one step further and examined whether drinks varying in sweetener and fat content also varied in appropriateness ratings, on the basis of perceived sensory differences. Results indicated that while sweetness did affect appropriateness ratings, fat content did not. The appropriateness ratings of 18 different contexts were subjected to factor analysis to help extract common dimensions, but interpretation of these was not elaborated upon.

The problem faced in item-by-use appropriateness methodology is that the number of uses rated is large and unweildy and attempts to reduce these to a few key dimensions using factor analysis does not appear to explain how consumers discriminate between use contexts. Schutz (1994) questioned whether a set of use situations could be developed for general application, to structure studies, and suggested basic categorisations of the dimensions of use, but to date such dimesnsions have not been used to guide or structure specific research problems.

Appropriateness as a measure of food choice has been studied using actual product usage (Marshall, 1993; Holbrook et al, 1986). In the latter, Holbrook et al (1986) used consumer reports of most recent purchases of a variety of products and their reasons for the purchase choices. The same consumers' perceptions of usage characteristics, use functions and user benefits of these products were also obtained to suggest some linkages between choosing and using.

The "means-end approach" (Gutman, 1982) explicitly investigates how product attribute preferences vary with use context. It models how product features are linked to functional self-relevant consequences of product use, which in turn are linked to psychosocial consequences and the attainment of life values. This is measured using a qualitative elicitation process called laddering, where respondents are asked a series of linked questions about why particular product features are important to them. It has generally been used in qualitative research, although the theory has been used in quantitative research using conjoint analysis (Grunert, 1995).

Booth (1995) has also recognised the need for incorporating context in his cognitive theories of food choice and food quality, and has modelled a contextual dimension as a deviation from ideal. However, this assumes that there is one "ideal" product or an ideal level of each attribute in a product. As Lawless (1995) observed, ideal food quality, and arguably ideal food preference, "is a moving target" (p.206), due both to contextual and temporal factors.

Consideration of the use context has many practical applications. Food manufacturers and marketers need to know how their product is used in order to understand the market's structure, identify trends in food consumption habits and to position products relative to competing products. Comparisons between products for a particular type of use context may be useful for product development purposes (Raats & Shepherd, 1991/2). Knowledge of the perceived appropriate contexts of use, in addition to sensory acceptance testing, is potentially useful for product development in new markets, and for identifying common contexts for cross-cultural food product development (Nantachai et al, 1991/2).

The context in which consumers may use products is important for advertising purposes and one of the main aims of concept development for new products is to determine this (Moskowitz, 1993*b*). Advertising strategies emphasising new use contexts may help increase sales of existing products. In addition, if particular features of a product are perceived as more important in one context than others, advertising strategies may be directed at promoting that attribute in a particular use context (Miller & Ginter, 1979).

It is important in many areas of food service to be able to identify perceptions of the food offered, to guide food preparation and menus, for example in hospitals (Schutz, 1994) or military establishments (Cardello et al, 1996). Nutritionists in general may benefit from a more holistic view of food choice behaviour which takes into account contextual influences, to help develop and evaluate intervention strategies (Furst et al, 1996).

2.5 Summary

In this chapter the food choice literature was reviewed. Firstly, the methods that have been used to investigate sensory and cognitive factors in food choice were summarised, and a general review of the role of the use context in food choices was presented. Finally, an overall view was taken in discussing ways of integrating the various approaches into a unified framework for incorporating sensory, cognitive and contextual factors in future food choice research.

Consumer food choice behaviour has been investigated from many perspectives. Behavioural methods emphasise actual choices made by consumers, whereas evaluative methods tend to infer choices from acceptance ratings. Cognitive influences are increasingly being investigated alongside sensory factors. Expectancy-value models and individualised causal analysis of choice have dominated research into food choices.

The review of literature on the role of the use context in food choices has highlighted the substantial influence that factors related to usage may exert on food choices. Consumer preferences may vary according to different use situations, different food accompaniments and for different meal occasions. There has been little integration of use context variables into food choice and acceptance studies as an aid to understanding food choice behaviour.

Measures of use appropriateness focus directly on the contextual basis of choices, but the methodology has been less suitable to specifically address the interconnectedness of sensory, cognitive and contextual factors in assessing overall food choices. Research into use appropriateness has been concentrated at the level of whole food items within general product groups. Examination of consumer perceptions of the appropriateness of specific sensory attributes within products has been rarer, and there is a lack of an adequate classification system for the use context.

It seems reasonable that choices and/or preferences between products vary according to different eating circumstances (and indeed many products are marketed for different consumption contexts). However, much of the food acceptance research has tended to assume that consumers have one ideal product preference. As Marshall (1995) points out, "much of the current debate about what people eat stops after the point of purchase" (p285). The role of the use context is ideally incorporated more directly into food choice research. Examination of how sensory preferences relate to use of the products, while methodologically more difficult, may uncover important factors underlying day to day food choice.

While this chapter has discussed food choice research methods in general, the next chapter specifically evaluates one methodological approach for investigating consumer food choices.

Chapter three

REVIEW OF CONJOINT AND EXPERIMENTAL CHOICE ANALYSIS

3.1 Introduction

In this chapter a review of two related research methodologies is presented. Firstly, the research approaches which led to the selection of a methodology are outlined. A review of conjoint analysis is then presented, followed by a review of experimental choice analysis. Methodological considerations which are important to the design of food choice studies and which are common to both these research techniques are then discussed. The principles of experimental design, treatment of heterogeneity of data and reliability and validity issues are presented as they apply to both methodologies. In summarising the chapter, conjoint analysis and experimental choice analysis are compared in order to select the most appropriate methodology to gain a better understanding of sensory, cognitive and contextual influences on consumer choices.

3.2 Selection of methodology

In selecting the methodology, three main aspects were evaluated within the context of existing sensory and consumer research methods: multivariate versus univariate techniques, descriptive versus experimental research and compositional versus decompositional methods.

Multivariate techniques, which simultaneously analyse multiple measurements, are becoming increasingly important in consumer research, as food choice and acceptance problems are inherently multivariate in character. Sensory research has traditionally relied on univariate descriptive methods, while consumer research has developed using increasingly complex multivariate techniques.

A number of multivariate methods have become increasingly popular in sensory and consumer research. Some of the most common uses of multivariate techniques are: to simultaneously evaluate multiple attributes in multiple products (eg MANOVA); to interpret interrelationships among multiple attributes and products (eg Principal Components); to relate consumer perceptions of products and descriptive data (eg multidimensional scaling) and in exploratory sensory and consumer research to try to find common points of perception (eg General Procrustes analysis).

Relatively new multivariate techniques used in consumer research to study complex relationships in food acceptance and choice are canonical correlation and structural equation modelling. Canonical correlation analysis is an extension of multiple regression which measures the strength of the overall relationships between multiple metric dependent variables and multiple metric independent variables. It is a method which places fewer restrictions on the type of data and has been used to study sensory - instrumental relationships. Structural equation modelling combines aspects of multiple regression and factor analysis to estimate a series of interrelated relationships simultaneously, rather than only a single relationship as in other multivariate methods.

Multivariate methods have many benefits and can give far greater information on interrelationships between variables. However, it should be noted that these are not necesssarily "better" than univariate methods. They are more difficult to interpret and they are often used injudiciously without regard to the assumptions on which the procedures are based (Tabachnik & Fidell, 1989).

Many of the methods of analysis described above are applied to descriptive or non-experimental research. Experimental research, where the levels of the independent variables are systematically controlled by the researcher and their effect assessed, is less common for food choice research. One advantage of experimental research is that the statistics involved to analyse the data are often relatively simple and in many instances results can be plotted graphically to illustrate the patterns of response. Multivariate statistical techniques were therefore mainly developed for non-experimental research to analyse and interpret complex relationships among variables.

While descriptive multivariate techniques are valuable, some researchers are cautious about their use (Booth, 1988). McBride (1990) refers to descriptive multivariate methods in sensory research as "science upside down, as they can only discover relationships among variables and not the cause of the relationship" (p199).

There are two different multivariate approaches to modelling consumer preferences for products or services with multiple attributes. In the compositional approach, respondents separately make subjective judgements of specific attributes defining the product and these are used to build up or compose a predicted model of preference which is then compared to a rating of overall evaluation by the consumer, to assess the model. Common compositional methods used in sensory and consumer research include multiple regression analysis, multiple discriminant analysis, factor analysis and the related principal components analysis.

In contrast, the decompositional approach begins with the overall evaluations. These are decomposed by relating the attributes of the product to the overall preferences (Green & Srinivasan, 1978). Compositional methods in consumer preference behaviour are more explicitly based on cognitive theories than decompositional approaches which have been seen predominantly as measurement techniques. Decompositional methods rely on overall perceptions or preferences. This can be an advantage, as consumers can find it difficult to isolate why they like or dislike a product.

Two decompositional approaches are common in consumer research - multidimensional scaling and conjoint analysis. Both methods can use an overall evaluation and avoid the need for obtaining data on large numbers of attributes. They allow consumers to make instinctive judgements rather than judge each dimension explicitly for each product. Both methods allow different preference patterns to be incorporated through individual level analysis.

Multidimensional scaling (MDS) is a descriptive method which can take a decompositional approach by obtaining overall judgements of similarity or preference.

These are transformed into distances represented in multidimensional space from which the key dimensions underlying consumers' evaluations of objects are obtained. MDS has been most often used for positioning products and identifying consumer segments according to product preference. Preference mapping is a form of MDS which has been applied in a variety of areas in food research (Greenhoff & MacFie, 1994). Internal preference mapping (eg MDPREF) analyses individual preference data, and external preference mapping (eg PREFMAP) uses both preference judgements and some other form of data relating to the stimuli, and may for example be used to relate consumer preference and instrumental measures.

Conjoint analysis refers to a group of decompositional methods which deal with the way in which people compare complex products, objects or services on sets of determinant attributes and combine this information to form overall impressions. These methods can estimate the structure of consumers' preferences for multiple products with systematic variation of the attributes which characterise the product and which are potentially relevant to consumer choice.

There is no one general 'conjoint analysis' technique but rather a group of techniques with different assumptions, experimental procedures, methods of data collection and analysis. However, all the different forms of conjoint analysis, whether using ranking, rating or choice data, are experimental rather than descriptive methods. The strength of these methods is that they do not rely on consumers reporting their own perceptions of the importance of the different attributes.

MDS has been positioned as a technique to explore consumers' perceptions, whereas conjoint has been used to examine preference, and both methods have a place in consumer research. As MDS relies on subjective interpretation and labelling of the dimensions by the researcher, it can be as much an art as it is a science. Conjoint analysis on the other hand, being based on experimental design, is more explanatory in nature. The methods differ in that in conjoint analysis the main research effort is spent at the outset of the study, in the selection of factors and design of the experiment, whereas in MDS the main research effort is spent after the data are analysed.

Conjoint analysis is therefore a method which is multivariate in nature, is experimental rather than descriptive, and decompositional in that the task for consumers is to give an overall evaluation. These three factors were thought to be important for investigating food choices in the present research.

A search of the literature revealed that conjoint analysis was common in food-related topics, particularly in applied marketing research or concept research, but very little had been done on food choice research or research incorporating a sensory component. The practical difficulties of having to formulate a large number of equivalent products varying in a number of attributes at several levels is a major disadvantage and it is much easier to use descriptive studies using real foods. However the potential of conjoint analysis to understand consumers' choice judgements and preference structures has not been fully explored.

An extensive review of conjoint analysis was undertaken and its appropriateness for studying food choice in an integrated manner was assessed. In the following section, a review of conjoint analysis is presented, followed by a review of experimental choice analysis which arose from the conjoint review. The basis, theory and issues common to each of these two methods are outlined, followed by a comparison of conjoint and experimental choice analysis.

3.3 Conjoint analysis - review of theory and applications

3.3.1 Development and basis of conjoint analysis

Conjoint analysis developed primarily from the field of mathematical psychology (Luce & Tukey, 1964). The method was introduced to marketing researchers in the 1970s (Green & Rao, 1971; Green & Wind, 1973) for studying consumer decision processes, and since then it has gained widespread acceptance in many fields. Conjoint analysis has become popular for several reasons. It relies on traditional experimental principles and can incorporate highly different and often very qualitative attributes in the design. It is a very flexible technique in terms of studying the relationships among variables, and is relatively simple to interpret. The use of overall profiles means that it is appealing conceptually for studying both real and hypothetical products. The method is based on the proposition that an individual's evaluation of a product is based on the features of that product (Lancaster, 1966).

Conjoint methodology has developed a lot in the last two decades. The early studies progressed from a two-factor-at-a-time approach, known as trade-off analysis (where respondents were presented with combinations of pairs of factor levels), to non-metric conjoint measurement based on rank-orderings of preference. This latter (developed by Krantz & Tversky, 1971) is known as axiomatic conjoint analysis. Metric conjoint analysis utilises rating scales for the preference responses, and has dominated current research applications of conjoint analysis.

The statistical theory and techniques applied in metric conjoint analysis are closely allied to an approach known as functional measurement, based on information integration theory (Anderson, 1970) for research into consumer information processing (Lynch, 1985). It has provided a framework for determining the model that best represents the psychological processes by which consumers combine information (Louviere, 1988). It is assumed in metric conjoint analysis that measurement of the category-rating scaled responses can be thought of as approximately interval scaled.

3.3.2 Conjoint experiments

Design of conjoint studies involves three main steps: i) identification of the determinant attributes and levels for the research problem ii) selection of the model, and iii) construction of the experimental design.

Most conjoint studies firstly require that the product attributes that influence consumer preferences are determined. These may be known, or determined from prior research. Methods of elicitation of attributes are discussed in section 4.3. The full set of relevant attributes can then be narrowed down to include only those which most differentiate the products. Conjoint studies in sensory research may also be conducted with pre-specified product attributes. Levels must then be associated with the attributes to represent the range of variation relevant for each attribute. The levels chosen must be both realistic to respondents yet sufficiently different to be able to detect attribute effects. The number of levels is important to the factorial design and this should be taken into account.

This set of attributes is then used to generate a design. Experimental design issues are covered separately in section 3.5. The experimentally designed set of treatment combinations is then presented to consumers, who rate each combination or rank the set of stimuli according to a specified response variable. Conjoint measurement can be applied to any type of overall judgement. In consumer research, preference or likelihood of purchase are common evaluative responses.

3.3.3 The conjoint model

In order to use conjoint analysis to explain or predict consumer preference structures, a model must be specified which approximates consumer judgement or decision processes. This model is used to represent how consumers are assumed to integrate the information presented by the combination of attribute levels, to arrive at an overall evaluation of worth. As this integration is a cognitive process and therefore unobservable, a conceptual model must be developed specific to the research problem.

The additive model is the simplest and most widely used in conjoint analysis. This model implies that the process by which a consumer arrives at an overall evaluation of the total worth of each alternative is strictly additive. Main effects plans which use only a limited number of attribute combinations, are used to estimate additive models. More complex multilinear models, in which consumers responses are more accurately described by interactive effects, are less common. In interactive models the responses to levels of one attribute are not independent of responses to levels of one or more other attributes. Overwhelmingly, additive models are assumed in most conjoint studies, arguably due to the reduced number of evaluations required by respondents and the simplicity of analysis. As the objective of most conjoint studies is to predict rather than determine the most accurate representation of the psychological processes underlying the judgement task, the additive model is generally assumed to be an adequate representation and other models are not tested (Hagerty, 1986; Louviere, 1988). This assumption is questioned and discussed further in the section on experimental design (section 3.5).

In addition to specifying how the factors relate to each other in determining total worth, the relationship between the levels of a factor and consumer preference must also be specified. For continuous variables, the relationship between each factor level may be linear, quadratic (often referred to as ideal-point) or part-worth (Hair et al, 1992). In the linear model, the simplest, the data are expected to be linearly related to the factor. In the quadratic model, there is an ideal factor level and the preference is negatively related to the squared distance from this ideal point. This is generally a curvilinear shape. The part-worth model allows each level to have its own part-worth estimate and is represented as a piecewise linear shape. This is the most flexible model and is therefore the most widely used as it is easily interpreted graphically. However it means that a large number of parameters have to be estimated, thereby increasing predictive error. As each factor may have a different type of relationship, a mixed model may be the most appropriate.

3.3.4 Estimation and interpretation

The main output of a conjoint analysis is a set of interval-scaled part-worth values representing how important each level of each attribute of the product is to the respondent's overall preference for the product. The estimation technique selected depends on the model specification, whether rank-order or rating data are collected and which computer programme is used.

For non-metric (eg ranking) data, analysis consists of a modified form of analysis of variance, using an algorithm to find estimates of part-worths so that the rank order of their sum (i.e. the total worth of each treatment combination) is correlated as closely as possible to the rank-order given by the respondent (Jain et al, 1979). Specialised computer programmes such as MONANOVA and LINMAP are used for analysis.

For metric (rating) data, multiple regression (least squares) techniques are most commonly used (Wittink & Cattin, 1989) to estimate the part-worth values. Dummy variable coding is used to estimate the marginal means in these regression models so that the regression coefficients that represent the marginal means are interval-scaled estimates of the part-worths.

The additive model of consumer preferences can be specified as follows:

$$U(k) = \sum_{i=1}^{n} w_{ij} . x_{ij}$$

where U = the respondent's overall evaluation of a treatment combination (k); W is the part-worth associated with level j of attribute i for n number of attributes; x_{ij} is level j of attribute i for each k treatment from the design matrix. The outcome of this model is a set of part-worths or utilities for each attribute level.

The estimated part-worth values can also be used to calculate the relative importance of each attribute to overall preference. As the part-worth estimates are on a common scale, the range of values of the part-worths over all levels of the attribute can determine the importance of each attribute. The range values are normalised so that the total of the attribute importances sum to one and can thus be compared over respondents.
It is usual firstly to perform a conjoint analysis at an individual level, so that the fit of the model can be evaluated for each respondent. Analysis can then be undertaken at the aggregate level, if appropriate, or be subjected to further analysis according to the

research objectives. As the ultimate objective of commercial applications of conjoint analysis is to predict choices among competing products or for new product concepts, rating data can be used to simulate consumer choices for specified sets of stimuli. While some of these choice simulators use probabalistic choice rules, they do not have an error component (Louviere, 1994). The only advantage over direct choice models is that in conjoint studies individual level analysis is usual and this may be used to identify preference segments thus avoiding aggregation biases. However, if conjoint models are misspecified, errors may be carried forward through several different analyses and give misleading results. The issue of individual versus aggregate analysis and heterogeneity of consumer responses is addressed in section 3.6.

3.3.5 Applications

While conjoint techniques can be applied to any type of overall judgement and are used in many diverse fields, they have found particular favour in marketing and consumer research. Commercial applications include new product evaluation, market share predictions, identification of market segments, advertising and pricing strategies for durable and non-durable products (Wittink & Cattin, 1989). As well as product evaluation, there is considerable use of conjoint methods for evaluating choices among services. Health care services, financial services, transportation, housing and education are just some of the more frequent applications. Other fields such as plant science have made use of the technique; for example, to evaluate preferences for features of outdoor ornamental plants (Brascamp, 1996). There has also been a substantial academic literature on conjoint theory, methodology and use.

Applications to food products are many and varied. They include quality evaluations, eg for ham (Steenkamp, 1987), eggs (Ness & Gerhardy, 1994) and beef (Grunert, 1997); consumer preferences for food safety attributes, eg for apples (Baker & Crosbie, 1994); consumer attitudes towards different food processing technologies (Frewer et al, 1997); and food preferences of traders and consumers in developing countries (Janssen et al, 1991/2).

Most of these studies have investigated preferences either by written profiles of product attributes or, less frequently, by photographs, labels or actual products. Where actual products have been presented, evaluation has generally been by appearance only and not included actual tasting in the evaluation of the products. This is probably due in part to the practical problems in tasting a large number of samples. However, there have been several studies which have included tasting in one phase of the research. Cheng et al (1990) investigated the influence of selected marketing factors on consumer responses to raw and cooked restructured beef steaks, and compared purchase probability responses before and after tasting. Packaging, price, brand and nutritional information were varied, as well as different formulations of beef particle size, fat content and binder levels. Vickers (1993) investigated the practicality of having participants taste a limited number of samples prior to a conjoint task of evaluating yoghurts varying in brand, price, health statements and sensory quality. Conjoint techniques were also used to study purchase probabilities for cheddar cheeses, varying in fat content and price (Solheim & Lawless, 1996), using conjoint techniques for pre-tasting and post-tasting evaluations.

In spite of the widespread acceptance of this research method, there are still some uncertainties on reliability and validity issues. These are covered in section 3.7. On a broader note, there have been only limited attempts to expand the content of conjoint analysis to more thoroughly understand consumer choice behaviour. Although the advantages of conjoint analysis are evident, some of its limitations led to consideration of the related method of experimental choice analysis for investigating consumer food choices.

3.4 Experimental Choice Analysis

3.4 Overview

Experimental choice analysis, also referred to as choice-based conjoint, has developed from traditional metric conjoint analysis as a means of predicting consumer choices. It uses discrete multivariate statistical analysis techniques. Experimental choice analysis as an extension of conjoint analysis was first outlined by Louviere and Woodworth (1983), who developed the conceptual and methodological foundations. This approach is derived from probabilistic discrete choice models. In experimental choice analysis, the objective is to estimate how the probability that an individual will choose a particular alternative varies with changes in the level of the attributes characterising that alternative. Choice techniques model the explainable component of utility as estimated from choices, but also take into account random variation.

Non-experimental discrete choice techniques have been used for some time to analyse the actual choices made by people of actions, products or services and to explain these in terms of individual explanatory variables. These methods were firmly positioned as suitable only for revealed preference data (data on actual behaviour) in fields such as econometrics and transportation research. The adoption of experimental choice analysis as an alternative to conjoint analysis to study consumer preferences from stated preference data has been relatively slow, arguably due to this perception. Limitations in the availability of software for analysis and lack of guidelines for design strategies have also contributed.

3.4.2 Probabilistic choice theories

Probabilistic choice theories were introduced to account for apparent inconsistencies in observed choice behaviour. They can be traced back to experimental observations of stimulus response in psychophysical research (Thurstone, 1927), and were adapted and extended to model choice behaviour largely by mathematical psychologists (Luce & Suppes, 1965) and economists (McFadden, 1974). The impetus for the development of these models arose to a large extent from observations that, given a number of choice situations with seemingly identical features, people will sometimes make different choices. The rationale for these inconsistent responses broadly are that they are either due to the cognitive limitations of decision makers, combined with the complexity of the set of alternative choices, or randomly changing preferences. Probabilistic models therefore have a level of uncertainty built into the model.

There are two different approaches to probabilistic choice models, which vary in how the utility function relates to the choice probabilities. In constant utility models, the alternatives have fixed utilities and the choice probability structure is such that the probability of choosing an alternative or action is systematically related to its fixed utility. The person making the choice is assumed to behave with choice probabilities defined by a probability distribution function over the alternatives that includes the constant utility of each alternative as one of the parameters.

Random utility models were largely developed by Thurstone (1927), a psychophysicist working in the area of discrimination using paired comparisons. These models have been proposed as "being more consistent with consumer theory" (Ben-Akiva & Lerman, 1985, p58) and the decision maker is always assumed to select the alternative with the highest utility. The utilities are treated as random variables and so can capture the effects of unobserved variations that impact upon choice from one occasion to the next (Ben-Akiva & Lerman, 1985).

The assumption of probabilisic models, that choice behaviour is not consistent, departs significantly from classical deterministic models of choice behaviour. Deterministic models assume that the consumer will make a choice with certainty and that choice will remain the same under any given set of conditions. The development of choice models arose from the thesis that human decision making is constrained by cognitive limitations which result in degrees of uncertainty, fluctuation and inconsistency in choice behaviour.

The random utility model can be represented as:

$$U_{jk} = V_{jk} + \varepsilon_{jk}$$

where U_{jk}, being the utility individual (k) has for alternative (j) is made up of a deterministic component V_j (which is the proportion of variance in choice that can be explained), and a random component ε_{jk} (which is the portion of variance that is random).

There are two facets of choice behaviour which could be modelled - the choice process itself and the probability structure of the observed choice. While some choice models can accommodate both, most choice models do not try to infer the actual process by which the decision maker makes choices.

Probabilistic choice theories are appealing, as very rarely can all the conditions associated with a particular choice be specified, and they model the explainable component of utility as estimated from choices, but also take into account random variation. Of course, it can be stated that the inconsistencies noted in choice behaviour are not probabilistic behaviour but appear to be so because of limitations in the researchers ability to identify and measure the factors that affect choice behaviour, and that choice behaviour is really deterministic. The random utility approach encompasses measurement errors in the model along with variation in choice behaviour.

3.4.3 The Choice Model

The multinomial logit (MNL) model is used to model the relationship between a discrete response (choice) and a set of explanatory variables. Multinomial refers to the existence of more than two possible outcomes. The model calculates the probability that an individual (or group of individuals) will select an alternative as a function of the attributes of the alternatives in the choice set.

MNL models generally refer both to models which treat a choice among alternatives as a function of the attributes of the alternatives (conditional logit models) and models which treat the choice as a function of the characteristics of the individual making the choice (generalised logit models). The terminology in the literature is not consistent (Hoffman & Duncan, 1988; So & Kuhfeld, 1995), and MNL sometimes refers to a generalised model and sometimes to a conditional model. In many cases, a mixed model is used, including both the characteristics of the alternatives and the individual, although the emphasis is generally on one or the other. In this review the conditional form of the MNL model is assumed when referring to the MNL model, although much of the discussion applies to both forms. The conditional logit model was developed by McFadden (1974), an econometrician.

The MNL model calculates the probability (P) that an individual (i) will select an alternative (j) such that:

$$P_{ij} = \frac{exp\ (X_{ij}\beta)}{\sum_{k=1}^{J} exp\ (X_{ik}\beta)}$$

where X is a vector of alternative attributes and β is the corresponding parameter vector. Simply put, the probability that an individual will select one of the J alternatives from the choice set is the exponential of the utility of that alternative divided by the sum of all the exponentiated utilities.

The behavioural assumption of the MNL model is that individuals will choose the alternative which they think has the highest utility, subject to constraints.

3.4.4 Properties of the MNL Model

The MNL model has some important assumptions and properties related to how the error terms are treated. The error terms are assumed to be independent and identically distributed (IID). Hensher and Johnson (1981, p105) describe this as follows: "Independence indicates that the correlation between the unobserved attributes associated with each and every pair of alternatives in a choice set and across choice sets is zero. Identically distributed says that taste variation exists over the observed attributes (and is allowed for in the random component), yet is is neutral between alternatives, having equal variance around the mean".

The distribution of the random component is also assumed to follow a Gumbel distribution (also known as type II extreme value, double exponential or Weibull distribution). This distribution is very similar to a normal distribution, except that it has a thicker tail.

The result of these assumptions is the Independence of Irrelevant Alternatives (IIA) property. This property means that the ratio of the choice probabilities of any two alternatives is not systematically affected by any other alternatives in the choice set. This is the most widely known aspect of MNL models and is often cited as a major drawback of MNL choice models. However, this property is sometimes misinterpreted (Ben-Akiva & Lerman, 1985) and as long as the assumptions and implications are well understood it need not be a problem (Hensher & Johnson, 1981). The advantage of the IIA property is the simplicity of estimating the model. Other choice models such as the multinomial probit model, in which the random component has a normal distribution and does not have the restriction of IIA, is far more complex to estimate and has not been widely used (Ben-Akiva & Lerman, 1985; Hensher & Johnson, 1981). Ben-Akiva and Lerman (1985) point out that IIA applies to individuals, not the population as a whole, and this is a common misinterpretation.

Breaches of the IID and IIA properties can affect the precision of the estimates (Bell, 1996) and can produce unrealistic or counter-intuitive predictions. Violations of IIA can occur if the alternatives are not distinctly different and have correlated characteristics which are not accounted for. An example of this relevant to the present study illustrates the property. In a study of yoghurt choices, assume choice between different yoghurts is predicted to be a function of attributes such as price and fat content. If the choice alternatives in a choice set are a natural yoghurt and a strawberry flavoured yoghurt, the probabilities might be 0.5 each. If a raspberry flavoured yoghurt is added to the choice set, the MNL model would predict 0.33 probability for each. This is an unlikely result as common sense would indicate that the probability would remain at 0.5 for natural yoghurt and that the consumers choosing the raspberry flavour would come from the existing half choosing a flavoured yoghurt. Therefore probabilities of 0.5, 0.25 and 0.25 would make more sense.

Although the IIA property is a major consideration in using choice models, attention to the design of the study should ensure that the property is valid. To avoid violations of IIA when choice alternatives are not distinct, the following actions should be considered:

i) combining similar alternatives (Hensher & Johnson, 1981);
ii) including additional variables (for example where there may be an unobserved correlated attribute, convert this to an observed attribute);
iii) segmenting the sample to allow for heterogeneity of preferences, or including

individual characteristics in the model (Louviere, 1994; Ben-Akiva & Lerman, 1985);

iv) redesigning the study to take account of correlated alternatives, such as nested models (discussed later); or

v) using different estimation procedures such as multinomial probit.

Tests to determine whether the assumptions of IIA are legitimate have been developed by several researchers. A simple but powerful test is to compare models using a subset of alternatives with those using the full set of alternatives (Hausman & McFadden, 1984). Parameter estimates for both models should be similar if IIA is legitimate. The restricted model omits those observations of consumers choosing the alternative which has been deleted from the choice set. There are several variations of this test, and these are outlined by Ben-Akiva and Lerman (1985).

In brand choice studies, where the absence or presence of competing brands may have an effect on the utility to a consumer of a particular brand, the ability to test for deviations from IIA is very important. Designs are now available (Lazari & Anderson, 1994) to test for these effects (called availability cross effects), which is in effect a test for IIA. If IIA is satisfied, these cross effects should be zero. Tests of these effects can be done by fitting a "mother logit" model (McFadden, 1975, cited in Batsell & Louviere, 1991), which allows the attributes of one alternative to influence the utility of another alternative.

If IIA assumptions are not valid, a nested model may be estimated. This is useful where alternatives have some unobserved correlation in utility. For the yoghurt example of IIA presented earlier, a nested model could be used to sequentially estimate the parameters, in two nests, as shown in figure 3.1.

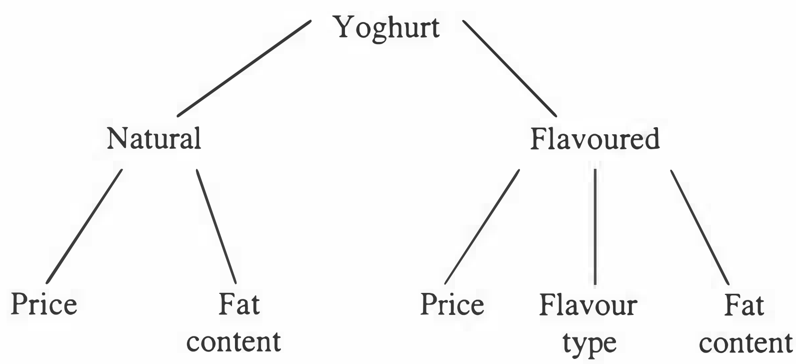

Figure 3.1 Example of nested MNL model

In nested models there may be several levels of nests. The nesting does not imply equivalent consumer behaviour, i.e. that decision making on the part of the individual is sequential. If a nested model is not appropriate, the more complex probit model may be used for estimation.

3.4.5 MNL Estimation

Estimation of the parameters of the MNL model can be made through various different estimators. Maximum likelihood estimation is the most common and most straightforward, but other estimators such as ordinary least squares, non linear least squares and maximum chi square have also been used, particularly in earlier studies. Bunch and Batsell (1989) made a comprehensive study of the various estimators and concluded that maximum likelihod was far superior to other estimators. The maximum likelihood estimates of the parameters are "the value of the parameters for which the observed sample is most likely to have occurred" (Ben-Akiva & Lerman, 1985, p20)

A feature of the MNL random utility model is that the random component of the utility has a fixed variance, and this impacts on the estimation of the scale parameters and probability estimates. Because the size of the parameter estimate (β) directly affects the amount of variance explained by the systematic component, the systematic component will dominate the error component as the βs get larger. Conversely, as β approaches zero, the error component will dominate the systematic component and there will be no difference in the probabilities of each alternative being chosen (Chen & Anderson, 1993). Therefore the error variability is explicitly incorporated into the model (Louviere, 1994).

The overall fit of the model is tested using the log likelihood test:

$$-2\,(L(0) - L(\beta))$$

where L (0) is the value of the log likelihood function when all parameters are zero and L (β) is the value of the log likelihood function at its maximum. It tests the null hypothesis that the attributes do not influence choice and has a χ^2 distribution with k degrees of freedom.

Available computer-based software packages for estimation of choice data includes SAS, SST, Limdep, HieLow, ALOGIT (Hague Consulting Group), CBC (Sawtooth Software) and NTELOGIT (Intelligent Marketing Systems), among others. The most widely available of these is SAS, which is a standard statistical package. In SAS, the SAS/STAT procedure PHREG is used to estimate MNL models. This is a proportional hazards regression procedure, used for survival analysis but which has the same mathematical form as the likelihood function of the multinomial logit model. It is very versatile and can accommodate a variety of models. Procedures for using this programme are extensively described by Kuhfeld (1996). There is no published information on the comparative performance of different programs. Carmone and Schaffer (1995) reviewed conjoint analysis software available at the time, which included only one choice based program, CBC from Sawtooth Software.

The next sections cover methodological issues relevant to conjoint analysis and experimental choice analysis: experimental design, heterogeneity of data and reliability and validity issues.

3.5 Experimental design

Both conjoint analysis and experimental choice analysis use formal experimental design principles to generate and combine sets of multiattribute profiles. Factorial and fractional factorial designs are used.

In factorial experiments the effects of two or more factors are examined simultaneously by systematically manipulating the levels. As the effects of a factor may also be estimated for every combination of the other factors, it is possible to examine whether the effects of one factor depend on the level of one or more of the other factors, i.e. an interaction effect. In the context of consumer research, an interaction may show that consumer preference for levels of one attribute depends on the levels of a second attribute. Factorial experiments however, especially those with many factors, are necessarily larger and there may be practical constraints to running them. Standard errors also increase as the number of factor combinations increase (Cochran & Cox, 1992).

Factorial and fractional factorial designs are discussed below, as they are central to the design and evaluation of conjoint and choice experiments. Despite the current availability of design catalogues and computer generated designs, it is still essential to have a full understanding of experimental design issues. Comprehensive explanations of factorial and fractional factorial design principles may be found in many texts and reviews, e.g. Kempthorne (1962); Cochran & Cox (1992); Addelman (1962, 1972) and Box & Hunter (1961), and extensive use was made of these in evaluating various design strategies.

The full-factorial design consists of all possible combinations of the levels of the factors. Designs may be symmetrical, where each factor has the same number of levels, or asymmetrical where factors have different numbers of levels. An experiment with three factors each at two levels (a total of eight treatment combinations) is denoted 2^3 and an experiment with two factors at three levels each (a total of nine treatment combinations) is denoted 3^2. Asymmetrical designs, such as one with five factors, two at three levels and three at two levels is denoted $2^3 3^2$ or $2^3 \times 3^2$, with 72 possible treatment combinations. In the full factorial experiment, all main effects, two-way interactions and higher-order interactions are estimable and uncorrelated. Designs increase exponentially in size with increasing attributes, levels or both, so full factorial designs are impractical for many situations in terms of cost and subject fatigue in rating all possible combinations.

Fractional factorial designs use only a fraction of all possible treatment combinations. The statistical cost of fractional designs is that because there are far fewer treatments, some of the effects are confounded, i.e. are not distinguishable from each other. The smaller the fraction the more assumptions must be made and the higher the possibility of biased results if these assumptions are incorrect. It is important to know exactly which effects are confounded, to be able to identify and allocate variables to the effects to be estimated. If an interaction effect is not known to be zero, it is impossible to separate the contribution of each of the main and interaction effects (see Box & Hunter, 1961; Addelman, 1962; Kempthorne, 1962).

Designs can be constructed for ½ fractions (known as 2^{k-1} designs for 2-level variables). Quarter fractions of the 2^k design are known as 2^{k-2} designs, and any fractional factorial can be denoted as a 2^{k-p} design, the k-p denoting the run numbers. The smaller the fraction, the more information about interactions must be sacrificed. As 3-factor or higher order interactions are in most cases negligible and account for very little of the explained variance (seldom exceeding 2-3%, according to Louviere, 1988), a fractional design which confounds main effects with these higher order interactions may be used, resulting in a substantially smaller number of runs. In this case there is less likelihood of biased results than if main effects were confounded with 2-factor interactions. Most texts on experimental design warn against arbitrarily dispensing with interaction terms, yet in much applied research such as marketing, it is commonplace to ignore the possibility of interactions for the sake of greater economy of design.

Three main types of fractional designs are important and defined according to the design resolution (Box & Hunter, 1961). In general, the number of letters in the defining relationship is equal to the resolution.

Resolution III designs are those in which no main effect is confounded with any other main effect, but main effects are confounded with 2-factor interactions and 2-factor interactions are confounded with each other. Most highly fractionated designs are Resolution III. If interactions are known to be zero, these designs are an efficient alternative, particularly in identifying dominant factors. If, however, it cannot safely be assumed that all interactions are non-existent, then the main effects will be biased if interactions do in fact exist, and larger fractional designs should be selected (Carmone & Green, 1981; Louviere, 1988).

Plackett-Burman designs are a class of two-level Resolution III designs used for studying k=N-1 variables in N runs, where N is a multiple of 4. Plackett & Burman (1946) introduced these designs which are obtained from prescribed blocks of plus and minus signs and cyclically generating successive rows. They are especially useful for designs with 12,20,24,28 and 36 runs. However they are very limited in that they cannot estimate interaction effects, their confounding structures are complicated, and they are non-geometric designs which are not easily collapsed into subsets of full factorials (Montgomery, 1997)

Resolution IV designs are those in which no main effect is confounded with any other main effect or 2-factor interaction, but where some or all 2-factor interactions are confounded with one another. Resolution IV designs must have at least 2k runs. Resolution IV designs may permit selected 2-way interactions to be estimated independently, still with relatively few runs compared to a full factorial.

It is possible to obtain a Resolution IV design from a Resolution III design by "folding over" the Resolution III design (Montgomery, 1997). This is done by reversing the signs for the factors in the design and using the combined design to estimate all main effects clear of any 2 factor interactions. The fold over technique may also be used to separate out some of the confounded 2-factor interactions in Resolution IV designs.
It is often useful to be able to use different fractions to form a full factorial design for some of the factors under investigation, and a 2^{k-p} design can collapse into a full

factorial for a subset of k-p of the original factors. For example, a 2^7 design run in a 2^{7-3} fractional factorial can become a 2^4 full factorial for four of the factors. As there are usually dominant factors that are more likely to have a greater effect and may interact, these can be assigned to those four factors.

iii) Resolution V designs are those in which no main effect or 2-factor interaction is confounded with any other main effect or 2-factor interaction, but 2-factor interactions are confounded with 3-factor and higher interactions. As most 3-way and higher interactions are less likely to be meaningful in most research studies, Resolution V designs are the best alternative if practical constraints allow.

Efficient fractional designs are both orthogonal and balanced (Addelman, 1962). Orthogonality refers to the property that the joint occurrence of any 2 levels of different attributes appear in treatment combinations equally often. Orthogonal arrays, a type of fractional design, satisfy this criterion (see Plackett & Burman, 1946)

Balance in a design refers to the requirement that the levels of an attribute occur with equal frequency. The goals of orthogonality and balance may conflict, especially for asymmetrical designs. Despite the widely held view that orthogonality is the only important criterion for fractional designs and must be preserved at all costs, Kuhfeld et al (1994) and Huber & Zwerina (1996) argue that a balanced non-orthogonal design may be better than a non-balanced orthogonal design.

Computer generated designs produce and report on selected design efficiency measures to evaluate potential designs. Design efficiency is a measure of design goodness which encompasses orthogonality and level balance and is based on the information matrix (X'X). The variance-covariance matrix of the vector of parameter estimates β is proportional to $(X'X)^{-1}$ and the eigenvalues of $(X'X)^{-1}$ provide a measure of the size of the variance matrix.

Design efficiency measures used (from Kuhfeld et al, 1994) are:

A-efficiency $(X'X)^{-1/p}$ is a function of the arithmetic mean of the eigenvalues, and can be thought of as minimising the variances of the estimated parameters;

D-efficiency $|(X'X)^{-1}|^{1-p}$ is a function of the geometric mean of the eigenvalues, and can be thought of as maximising the volume of the design space; and

G-efficiency is based on the maximum standard error for prediction over the candidate set.

Fractional designs are useful in many circumstances: where interactions are assumed to be zero, ascertained from previous studies or from prior knowledge; where the study is a preliminary one to try and identify which variables are the most important to undertake further more comprehensive studies on; where the study is one of a series of studies, each one informing and guiding the next; and where there are some variables which are expected to have a lesser effect than others. In the latter case, only the main effects are required to be estimated for these minor variables, but interactions as well as main effects need to be estimated for the major variables.

3.5.1 Experimental Designs for Conjoint Studies

Design catalogues (eg Hahn & Shapiro, 1966; McLean & Anderson, 1984; Gunst & Mason, 1991) can be used for selecting a design for conjoint studies. These cover a wide range of design problems and the confounding structure is generally outlined.

Software programmes specially designed for conjoint analysis may also be used to provide experimental designs. However the majority of these generate only main effects plans and this is a major limitation, although some, such as Consurv (Intelligent Marketing Systems), allow a limited number of interactions to be estimated (Carmone & Schaffer, 1995). Other general statistical software such as SAS can generate experimental designs, and this is often a better option than the specific conjoint software.

There are many research situations which do not conform to pre-specified designs. For example, asymmetrical designs, very large or small designs or designs which require many interactions to be estimated. Therefore it is important that there is an understanding of experimental design principles in order to select, adapt or manually construct a design to suit the specific research problem.

In conjoint analysis, where there is a limit to the number of treatment profiles that can be given to subjects, compromises must usually be made between having a small enough number of treatment combinations for subjects to evaluate, and having a large enough number in order to make unbiased estimates of the effects. In fact some designs, sometimes called 'compromise designs', allow unbiased estimation of main effects by having several blocks of different main effects designs which, when aggregated over all subjects, also permit estimation of some or all interactions. This is done by confounding the interactions with blocks.

Conjoint studies often use 3^k designs where the attributes have low, medium and high, or poor, average and good levels. Fractional designs are usually essential as the number of runs in a full factorial increases at a rapidly increasing rate as the number of factors increases. Unfortunately there are many more complexities in 3^k designs, as there are often partial confounding structures and if there are not well founded assumptions of zero interactions, interpretation is very difficult. Also, the strategies that can be used in 2^k designs, such as foldovers, are not available, and some experimental design researchers (eg Montgomery, 1997) therefore advocate that two level designs are used wherever possible, rather than 3-level designs.

Asymmetrical designs, also common in conjoint studies, present some limitations compared with 2-level designs. The number of runs generally has to be a multiple of each of the factor levels. Collapsing the levels of some of the factors can sometimes be used to achieve symmetrical designs (Addelman, 1962). For example, a 3-level factor can be collapsed to a 2-level factor by coding levels 0,1,2 into 0,1,0, and a 5-level factor to a 3-level factor (1,2,3,4,5 becomes 1,1,2,2,3). This retains orthogonality but not balance. Expanding is another alternative, where say a 4-level variable is expanded into three orthogonal 2-level variables. If estimable interactions are required in an asymmetrical design, strategies to incorporate these are less straightforward.

The majority of conjoint studies use main effects fractional factorial designs of Resolution III because only the individual effects of factors are considered to be important (Green & Srinivasan, 1990). The reliance on main effects fractional designs was supported by Carmone, Green and Jain (1978) in a Monte Carlo study of conjoint methods. They found than an orthogonal array of 18 combinations from a 3^5 design produced part-worth estimates almost as good as from a full factorial design of 243 combinations. Hagerty (1986) explored this topic further and agreed that additive main effects designs were more accurate in predicting preference in a validation sample when estimating individuals' preferences, but when predicting for aggregate responses this was reversed, due to decreased variance and increased bias. He therefore proposed that the aim should be to model the correct form of consumer preferences, both for predictive purposes and exploring consumers' preferences, and recommended that interactions be added to the model. Carmone and Green (1981) and Louviere (1988) also argued that the extra experimental runs needed to estimate interactions are justified, even if only protecting against the possibility of interaction effects. Darmon and Rouzies (1994) broadly advised against conjoint designs with too few degrees of freedom

3.5.2 Experimental designs for choice experiments

Choice designs present a further challenge over conjoint designs, because as well as treatment combinations, choice sets (the sets of alternatives between which consumers are required to choose) also have to be constructed.

For simplicity, choice designs may be denoted as $2^3/3/9$, which in this case means a design with three attributes each at two levels, run as nine choice sets each comprising three alternatives. The number of choice alternatives per choice set, the total number of choice sets and the sample size all have to be selected to obtain an efficient design, which requires balancing statistical concerns with the practical considerations of running the experiment, including subject fatigue (Kuhfeld et al, 1994).
The number of choice alternatives per set depends on the particular research problem and is influenced by the type and number of attributes, the complexity of the task, presentation constraints and data collection methods, and statistical considerations. Sometimes it is pre-determined by the research problem or situational factors (Carson et

al, 1994).

The series of profiles shown to respondents may be composed of a number of sets with the same number of alternatives in each set, or a different number of alternatives in each set. Studies involving choices between brands with differing product attributes often have a flexible number of alternatives in the choice set. For studies where there are the same attributes across all alternatives (generic attributes), fixed choice sets are usual. Chen and Anderson (1993) studied the effect of the number of choice alternatives in the choice sets on estimation of the parameters, and found that the size of the choice set is important, but that a varying number of choice alternatives across the sample did not have any effect on the sensitivity of estimation of the choice model. A binary choice simplifies the study for design purposes (in addition to providing computational ease).

Alternatives constant across all choice sets are often added to provide for choices which are the same. This is appropriate when the choice response is 'intention to buy' or some other market-realistic response, to allow for a specified base alternative or a 'none', 'no purchase' or 'my current' option. There should be careful consideration before including such an alternative as it can unbalance the design and also provide an "out" for participants if they find making a choice difficult or are bored, so decreasing the information obtained from the participant. However, inclusion of such an option can provide more accurate estimates for forecasting potential market share.

The decision as to the total number of choice sets must be guided by several considerations. The number of attributes and the number of levels of each attribute must be balanced by the precision of the estimates required, in conjunction with a feasible number of sets which can be presented to subjects. This will vary according to the study type. Sensory studies involving tasting will be far more limited than pencil and paper questionnaires.

Experimental design guidelines for choice experiments are limited by the sheer number of possible design problems. Researchers in this area have assumed that the design principles developed for the standard general linear model will also be appropriate for discrete choice models (Kuhfeld et al, 1994). This assumption has also been made in the present discussion.

In common with conjoint designs, orthogonality and level balance are important in constructing efficient choice designs. Additionally, Huber and Zwerina (1996) demonstrate that two other properties should be considered - minimal overlap and utility balance. Minimal overlap means that wherever possible an attribute level should not be repeated in each choice set, as contrasts between attribute levels are meaningful only as differences within a choice set. If the levels of one attribute are the same across all alternatives of a choice set, that choice set provides no information about the attribute. Utility balance can provide improvements in the efficiency of a design if some prior estimates of the coefficients can be specified. Either by relabelling attribute levels or by swapping one level of an attribute within a choice set, more equal choice probabilities are produced. This can help eliminate dominant alternatives or unbalanced choice sets, although there are limiting conditions for these procedures.

Design Options

A number of ways of generating choice designs have been reported in the literature.

1) For designs with the same or a lesser number of alternatives as the maximum number of levels, a fractional factorial design may be generated and designated as the first alternative (Bunch et al, 1994, cited in Huber & Zwerina, 1996). Subsequent alternatives are constructed by systematically adding 1 to the level of the attributes of the previous alternative. These designs are orthogonal and level balanced but are generally not suitable for designs where interaction effects are to be estimated (Huber & Zwerina, 1996).

2) For small designs, the design can be multiplied by the number of alternatives and a fractional design found (Elrod et al, 1992). For example, a 2^3 design with two alternatives becomes a 2^6; a 2^3 with three alternatives becomes a 2^9. This is often not practical in terms of experimental runs required and they are more suitable for designs with two alternatives.

3) Two or more fractions from a full factorial can be generated and used for each

set of alternatives (Chrzan, 1994). Some interactions may be estimable with this method.

4) Random samples may be taken from the full factorial design (CBC, Sawtooth Software, cited in Carmone & Schaffer, 1995) or fractional factorial design (Hensher, 1992). These strategies do not ensure level balance and there is the potential for confounding of effects, although if this is accepted, choice sets generated can be adapted according to practical considerations and common sense. For example, redundant, dominant or unrealistic choice set alternatives may be eliminated (Lakshmi-Ratan et al, 1992).

5) For designs with two alternatives, a "foldover" design is possible to estimate main effects. This is when the signs of the variables are switched for the second alternative.

6) Concatenation of two fractional designs has been a relatively common strategy (Louviere & Woodworth, 1983; Elrod et al, 1992; Oppewal et al, 1994). Attribute combinations may first be generated from a main effects or other design and these combinations are used as factors in a second design to generate choice sets. These are most useful where there are attributes specific to alternatives, such as price, or where choice set sizes are not fixed and the second design specifies absence or presence of the attribute combination in the choice set.

7) A fractional factorial design can be selected for the total number of alternatives and these put into choice sets by generating blocks (Wedel et al, 1998).

8) Designs for branded products with attributes specific to only some of the alternatives the consumer is choosing between can be constructed using a single design to specify the alternatives and choice sets. For example, a choice problem may be to construct choice sets comprising a number of branded products at two levels of price. A two-factor design can be generated, one factor being brand, the levels representing all available brands, and the other factor representing both availability and price, making a 3-level factor: absence of the brand, presence of the brand at the low price, and presence

of the brand at the high price. Lazari and Anderson (1994) have generated a catalogue of these "availability" designs, which have been constructed to be able to estimate the cross effects of the availability of other brands on consumers' preferences for a brand.

9) Computer generated designs. Various computer programmes exist which find efficient designs by using an algorithm to select a design from the full set of factor-level combinations. The designs generated are the most efficient in terms of an efficiency criterion, generally D-efficiency. Efficient designs tend to be selected from design points which are spread out as far as possible, usually the corners of the design space. Computer generated designs have many advantages over manually constructed designs, as they can evaluate combinations of alternatives much faster than could be done manually. Even for small choice studies the number of potential combinations of alternatives is impossibly high. For a 2^4 factorial design, there are 256 possible combinations for a 2-alternative choice set, 4,096 for a 3-alternative choice set, and 65,536 for a 4-alternative choice set.

Computer generated designs using the OPTEX and FACTEX programmes in SAS statistical software are fully described by Kuhfeld (1996). The OPTEX programme uses the Federov algorithm which selects design points from the candidate set (all treatment combinations from the full factorial), and iteratively refines the design to improve efficiency. The top 10 designs are sorted by decreasing efficiency. The process does not guarantee the optimal design but does find an efficient design. With larger numbers of factors the process is limited by the candidate set used. A full factorial candidate set is often impractical, so resolution III, IV or V candidate sets can be specified. Kuhfeld (1996) demonstrated that using larger candidate sets increases the chances of obtaining a more efficient design, although improvements are not guaranteed. In his experience however, the first few iterations will give a very efficient design which is hard to improve on.

One strategy outlined by Kuhfeld (1996) to find better designs, is to concatenate designs of different resolutions to create a candidate set. This strategy can also be used to create asymmetrical designs, for ensuring selected interactions are estimable in addition to a main effects design, or for designing a study with many factors.

If the design generated means that there would be too many treatment profiles to present to each person, PROC OPTEX can generate a design where not every individual sees the same choice set. This can be done in blocks or even individual designs for each respondent. The advantage of this is that the aggregate responses can have the resolution power of a full factorial while ensuring balance across individuals, parameter estimates and presentation ordering. Adoption of this strategy depends on the practical aspects of the study as it may generate a great deal of work in preparing the stimuli and collecting data.

While the availability of computer generated designs has made designing for choice experiments more accessible, Kuhfeld et al (1994) advise that they be used cautiously and in conjunction with the researcher's own design skills. They do not bypass the need for knowledge of traditional experimental design principles.

3.6 Heterogeneity of data

Heterogeneity of data refers to the individual differences which exist across respondents in a data set. Most quantitative methods of analysis are based on grouped data so that inferences can be made on those data. Homogeneity is assumed and data are averaged over the whole group or consensus forced on the data.

Individual differences in sensory perception and sensory preferences have been recognised for many years (Pangborn, 1970), but there has been little theoretical development in the area or attempts to find "the organising principles underlying those differences" (Moskowitz, 1993*a*, p248). In applied consumer research, heterogeneity has been harder to ignore and it is an ongoing and ever present problem. The cost of ignoring heterogeneity is potentially biased results where real influences on preference may be masked or misrepresented.

Data may be treated in several ways. They may be analysed at the level of the individual consumer, allowing for complete heterogeneity; they may be segmented, in which case it is assumed that grouping the data into discrete groups of individuals captures the heterogeneity; or they may be analysed at the aggregate level. Which method is chosen depends on the purpose of the research, the sample population, and whether explanation or prediction is the objective.

Individual level analysis allows the maximum flexibility in accounting for heterogeneity and enables the researcher to fully understand the processes involved in consumer judgements. Booth (1988, 1995) advocates an individualised approach to choice behaviour. He argues that the patterns of influences on preferences may differ across individuals and may interact in different ways. In order to unravel the causal structure of these differences he proposes that these cognitive integration processes be measured for individual consumers, and only then be aggregated across a representative sample of consumers by summing all the individual data. This method is likely to substantially increase understanding, but is unlikely to be embraced for practical applications where prediction is required. Individual level analysis does require that a large amount of data be collected from each individual, which may also be restrictive in applied work.

Segmented data may be obtained by: clustering on the basis of individual response parameters; by grouping according to pre-defined groups (*a priori* segmentation); or building into the model interaction terms between the attributes and background variables of the respondents. The two latter groupings could be based on demographic, attitudinal, usage or any other grounds, if these factors are assumed to be more homogeneous within groups than across groups. Clustered segments may also be analysed separately, by discriminant analysis for example, to determine if groups can be differentiated in terms of background variables.

For analysis at the aggregate level, data are pooled across the entire sample. This may be appropriate if the sample has been identified as relatively homogeneous for the particular study variables. This assumption is often made without explicit consideration of possible heterogeneity and if it does exist, interpretation of results can be difficult because this heterogeneity can mask real effects. A simple example of this is given by DeSarbo et al (1997). If data are obtained from consumers on likelihood of purchase of a product and price is one of the determinant attributes, aggregating the data may result in a non-significant utility function for price, indicating that it does not affect purchase probability. However, the 'true' picture may be that there are two distinct segments, one favouring high prices because this group infers high quality from high prices, and the other group favouring low prices. They in effect cancel one another out. The same may occur for many other attributes.

3.6.1 Heterogeneity in Conjoint Analysis

Conjoint analysis is one of the few research methodologies which uses individual level analysis. In order to do so, respondents are required to complete enough evaluations to estimate the parameters and all respondents must evaluate the same profiles. Conjoint analysis is based on individual-level theories and the ability to use individual level data to identify distinct preference groups has traditionally been seen as one of the strengths of the technique. Post hoc clustering segmentation seems a logical way to approach heterogeneity as groups with similar part-worths or importance values can be identified and profiled. However, Louviere (1994) raises some concerns about segmenting on the basis of individual utilities when there may be specification errors in the original conjoint model. For example, if additive models are incorrectly assumed, then the resulting segments will be at least biased or at worst grossly misleading. Louviere (1994) also points out that many segmentation methods assume error-free data and it is not known what consequences there might be if there are errors in the conjoint data.

A disadvantage of individual level analyses is that if conjoint models are to be specified correctly and subsequently tested, the amount of data required from each subject increases. If there are too many treatment combinations for each subject to evaluate and interactions can only be estimated by aggregating over blocks of subjects, then individual level analysis is not possible and some kind of aggregate analysis needs to be used. If aggregate level analysis is performed on whole group data with methods such as ANOVA, attribute effects will only be detected if a large proportion of the sample judge an attribute to be important plus substantial agreement on the level at which the attribute is preferred (Moore, 1980). Some researchers (eg Brascamp, 1996) suggest that asking respondents directly about the importance they attach to the different attributes, in a separate phase prior to the conjoint task, provides a basis for assessing homogeneity in a similar group. However, as the rationale for using conjoint analysis is to a large extent based on the premise that consumers find it hard to break down an overall evaluation into separate attribute importances, this approach is questionable.

Individual difference variables may explicitly be accounted for by performing a second separate analysis in which the individual part-worth parameters are used as dependent variables and individual difference measures treated as independent variables in a MANOVA analysis (Louviere, 1988). Individual differences may also be accounted for in an aggregate study by directly incorporating subject variables in the model as interactions with attributes, referred to as componential segmentation in conjoint analysis (Green & Srinivasan, 1978; Green & DeSarbo, 1979). This is a straightforward means of providing a great deal of practical information on patterns of response across consumers (Moore, 1980).

If the aim of the research is to predict market shares of product variants or obtain information on different consumer segments to guide marketing strategies, then individual level analysis is necessary. If this is not the case then aggregate level analysis may be more suitable for the research problem, provided that respondent heterogeneity is taken into account. Recent applications of conjoint analysis outside the marketing field have demonstrated the use of aggregate approaches to conjoint analysis (Brascamp, 1997; Grunert, 1997).

Other researchers have proposed procedures to overcome the problem of heterogeneity, and these include Hagerty's (1985) factor analytic method, Kamakura's (1988) least squares benefit segmentation approach, and DeSarbo and co-workers' cluster-wise latent class conjoint model (DeSarbo et al, 1992). There have been few studies comparing these different approaches (Carroll & Green, 1995) so the whole issue of heterogeneity in conjoint models remains an ongoing dilemma for practitioners.

3.6.2 Heterogeneity in Choice Analysis

In contrast to conjoint analysis, experimental choice analysis was originally positioned as an aggregate technique (Louviere & Woodworth, 1983). However, individual parameters from choice experiments can just as easily be obtained and subjected to segmentation techniques as in conjoint analysis (Louviere, 1994). It requires that all respondents evaluate the same choice sets from the entire experimental design, so individual level analyses are not suitable for large studies, which is the same restriction as conjoint studies. The output obtained from choice experiments is equivalent to part-worth utilities, and these can be subjected to clustering techniques, with the different segments subsequently profiled according to preference structures.

Aggregate approaches to heterogeneity range from the simple - eg cross tabulations of the data by alternative, attribute and individual difference measures- to the more complicated multiple correspondence analysis of the choice data, design matrix and individual difference data (Carson et al, 1994).

Another approach is to incorporate individual difference measures directly into the choice model, as is common in non-experimental discrete choice models (Ben-Akiva & Lerman, 1985). The respondent variables are not analysed directly but are modelled as interactions with attribute variables as in componential segmentation in conjoint studies. This method allows for greater flexibility as it allows prior specification of predicted influences of individual differences on choices. It has more potential to offer insights into choice behaviour than the limited number of clusters produced by post hoc segmentation (Louviere, 1994). An added advantage of this method is that it can simultaneously test for violations of the IIA property if it is due to heterogeneity of preferences (Louviere, 1994).

There are practical problems in incorporating individual difference variables into the analysis. For example, Chakraborty et al, (1992) demonstrated a method of screening for demographic/attribute interactions in a study of preferences for health insurance plans, in which there were 24 attributes and five demographic variables, making an extra 138 interaction terms in the model. Most experimental studies would be considerably smaller than this and have pre-determined hypotheses about sociodemographic or psychographic interactions, so would be much less complex, but it should be noted that it can add many more terms to the model.

The most appropriate method of accounting for heterogeneity of consumer preferences in conjoint and experimental choice analysis will depend on the aims of the research. Clustering based on individual level conjoint data can provide a greater understanding of different homogeneous preference groupings. This method does however assume that there are distinct clusters which can be captured. There are many different aproaches to clustering and strategies inherent in some applications of the technique, such as standardisation of variables (Qannari et al, 1997) may present limitations. Additionally, Louviere (1994) warns against potential misapplications.

One possible source of heterogeneity which has not been explored in depth is situational variation. That is, product preferences across different types of situations or uses may be more homogeneous than product preferences across different types of individuals. If preferences are measured without reference to context, respondents may use their own reference context, and across the whole group these may form homogeneous groups which are not captured either by clustering or individual difference variables. Belk (1975) demonstrated that for some product groupings (meat and beverages), the interaction terms for responses by situations were more dominant than individual product preferences.

Another related issue is the effect of other people on an individual's preferences (eg Wind, 1976). In some response contexts it is conceivable that respondents may make an evaluation on the basis of household rather than personal preference. If there are differences in these evaluations which are not addressed, this source of heterogeneity may distort results. Despite the widespread recognition of the importance of context, this has not been translated into explicit methods of accounting for such effects.

3.7 Validity and reliability

Validity and reliability are two separate but interrelated indicators of the adequacy of measurement of the concepts under investigation. Reliability refers to the consistency of measurements, while validity refers to the ability of the measurement tool to accurately measure the concept. Validity does not guarantee reliability and reliability does not guarantee validity.

3.7.1 Validity

Validity in conjoint and experimental choice analysis tends to focus on predictive validity (whether the results will predict actual behaviour). Other important types of validity (derived from psychological testing) are face validity (whether the study appears sensible to the people taking part), content validity (whether the attributes and levels of the product in the study actually represent the attributes of the product) , concurrent validity (whether the results correlate with other existing methods of study), and construct validity (whether the study actually measures the theoretical construct it claims to measure.

The ability to predict future behaviour is seen as the main goal of preference models. Green and Srinivasan (1990) in their review of conjoint analysis suggested that the empirical evidence did support its validity as a predictive technique; however relatively few studies have compared conjoint predictions with actual choices. This may be done by comparing predicted with actual current choices (eg Leigh et al, 1984), actual future choices (eg Wright & Kriewall, 1980) or aggregate level current or future market share. In the latter case there are difficulties in assessing predictive validity as other factors such as advertising and availability may confound comparisons.

In experimental choice analysis, predicted choice probabilities can be compared with actual or reported most recent choices, future choices for a new product or current market share (Louviere & Woodworth, 1983). While Batsell and Louviere (1991) reported that studies to date generally supported the predictive validity of choice studies, Carson et al (1994) noted that there was a lack of published studies on external validity and current evidence was insufficient.

In conjoint analysis, and to a lesser extent experimental choice analysis, a common measure of validity has been to predict choices for a set of profiles not evaluated by participants. This is sometimes referred to as a type of predictive validity. This is questionable on two grounds. Firstly, this could more correctly be thought of as internal consistency or test-retest reliability (Batsell & Louviere, 1991) rather than validity; and secondly, it would not be surprising if predicted responses to these extra sets, which are generated from the same population of designed profiles as the main study, fit the data similarly well (Louviere, 1994). Prediction of a set of these so-called "holdout" choices was used by Elrod et al (1992) in comparing conjoint and choice models. On this basis there was little difference between the methods.

To ensure content and face validity, the preliminary work in designing conjoint and choice experiments must be comprehensive and rigorous, to ensure that the most relevant and influential variables are identified and included and attribute levels are credible (Batsell & Louviere, 1991; Carson et al, 1994). Use of initial qualitative, exploratory and pilot studies all help to increase the validity of a study. In choice studies, there must also be a realistic set of alternatives and no dominant alternatives (ie appearing to be substantially more attractive across all attributes than other alternatives). Attention should be paid to the choice context and if necessary a particular context specified which applies to the choice task being asked of respondents.

Johnson et al (1989) investigated the overall construct validity of using discrete choice models to model consumer decision making, in response to the widespread confidence in these methods, which assume compensatory strategies (where tradeoffs are made between attractive and unattractive attributes). Non-compensatory strategies, in which the decision making may be simplified and not involve tradeoffs, may be used instead, but the convention has been to use compensatory conjoint models even when the strategies used are not known. Johnson et al (1989) addressed this question by investigating in a simulation study how well compensatory models predict non-compensatory processes; examining the processes actual consumers use when faced with different patterns of attribute correlations, and assessing how actual predictive validity is affected. Overall, it was found that compensatory choice models, when used to model non-compensatory processes, were sensitive to negatively correlated attributes in a choice set. However, individual consumers were less sensitive and did not appear to change strategies with changing attribute correlations. These results suggest that to reduce prediction errors, compensatory models must be correctly specified, adding even more weight to the growing evidence that interactions should be incorporated.

The actual decision processes used was also one factor considered by Oppewal et al (1994) in proposing hierarchical integrated choice experiments for complex decision problems where there may be higher-order decision constructs (Corfman, 1991) which may be more abstract in nature than lower level attributes (Wedel et al, 1998).

3.7.2 Reliability

Assessment of reliability can be absolute, or more commonly, comparative, where the different techniques are compared, the goal being to find the most consistent amongst a variety of methodological variants. Recently there has been a call to identify the most appropriate procedures for different study conditions and contexts (Carson et al, 1994). Reliability issues in conjoint and experimental choice analysis have focused on stimuli presentation and data collection procedures; and sources of error in estimation. While earlier published studies concentrated on the former, most recent empirical research has focused on the latter.

It is generally accepted that as the number of attributes increases over a certain number (there is disagreement over the exact number), reliability decreases (eg Malhotra et al, 1982; Green & Srinivasan, 1990; Huber et al, 1993). Therefore researchers must weigh up the merits of including all attributes thought to influence choice against practical considerations such as task complexity and subject fatigue and possibly less reliable results. Reliability over attribute sets, or structural reliability, refers to the extent to which estimated parameters for an attribute depend on other attributes or levels in the set of stimuli.

Reibstein et al (1988) studied reliability over attributes by interchanging one attribute for a new attribute in a test-retest situation, and the reliability demonstrated over five different products indicated that as long as key attributes are included, the inclusion or omission of other attributes has very little effect on reliability of results. The number of levels (varied from three to five in their study) also had no effect on reliability. Green & Srinivasan (1990) however, questioned the reliability measures used for this study. Steenkamp and Wittink (1994) further discussed the issue of the number of and variation in attribute levels and queried whether some respondents may be more inclined to provide metric responses than other subjects, and what effect this might have.

The question of metric responses is also relevant to the use of rating scales for metric conjoint responses. It has been pointed out in many fields of study that individuals utilise rating scales differently. For one consumer a rating of six out of ten may mean the product is very attractive, while for another it may mean the product is marginally unattractive. While this is avoided in hypothetical discrete choice studies, it should be noted that choices made by respondents may also be cognitively different. One consumer may make a choice without any hesitation while another makes a reluctant choice after much indecision. However this can be equated with real life choices, as in the end the ultimate behaviour of interest is the actual choice made. Individual differences in scale usage are an additional problem in inferring choice behaviour from ratings data.

Order effects in choice set presentations in experimental choice analysis was investigated by Chrzan (1994). Three different effects were studied: choice set order, within the set of choice sets; profile order, within choice sets and attribute order within profiles. Results showed that although choice set order and attribute order had some influence on attribute utilities, there was no predictable pattern. Profile order had more of an influence, but only for brand attributes not generic attributes. While this is encouraging, sequence effects and position effects were not separated out in this study and choice studies should where possible balance all order effects in both sequence and position. For studies involving tasting products, designs for order and carry-over effects should be used to account for sequential and response bias effects.

Recommendations for reducing order effects generally in conjoint and choice studies include having a "warm up task" to familiarise respondents with the attributes and their levels (Huber et al, 1993), having several practice profiles at the start of the evaluation task, not disclosed to respondents (Louviere, 1988), or fully describing attributes and levels in explanatory text, glossaries, pre-evaluation questions or visual representations (Carson et al, 1994).

Conjoint analysis has seen a wide variety of parameter estimation procedures over the years and many empirical studies have assessed these on the basis of prediction under various conditions.. Darmon and Rouzies (1994) specifically investigated the reliability of results under conditions of random or systematic errors in the input data, and reported that least squares regression seems to give the best estimation results.

A number of researchers have recently proposed methods to improve reliability in estimation. Allenby et al (1995) explored ways to incorporate prior knowledge into the analysis of conjoint and choice studies by utilizing Bayesian methods, and demonstrated improvements in part-worth estimates. Research efforts have also been centred on methods of data aggregation to obtain more stable part-worth estimates, as outlined in section 3.6.

Apart from errors due to breaches of the IID and IIA assumptions, previously discussed, the sources of errors which may occur in the estimation of parameters in non-experimental multinomial models are:

i) specification error, which mainly relates to the construction of the study design and variables in the model, and includes omitted relevant variables and irrelevant variables (Bell, 1996; Hensher & Johnson, 1981).

ii) measurement error, which takes into account inaccuracies in obtaining information from participants due either to questionnaire design or imprecise instructions, or participants' incorrect responses due to incomprehension or perceived social desirability.

iii) aggregation bias, which is concerned with errors associated with trying to make aggregate forecasts or predictions with what are essentially models of individual choice (Ben-Akiva & Lerman, 1985).

iv) systematic and random sampling errors. Systematic sampling errors occur through biased sampling techniques, substitutions or non-responses (Bell, 1996). Random sampling errors are a consequence of sample size and proportion variance (Hensher & Johnson, 1981).

Most of these have been covered already and may be interrelated and difficult to separate. Specific issues, such as the effect of small sample sizes on MNL estimation, seem to be largely ignored. Choice experiments have multiple responses and usually have far smaller sample sizes in comparison to revealed preference studies, yet there are few guidelines on appropriate sample sizes. Chen and Anderson (1993) found that the precision of estimated parameters improved as the model's degrees of freedom increased, with the improvement being at a decreasing rate. There is as yet a lack of guidance on reliability issues for researchers using choice models for designed choice experiments. Louviere (1994) however, notes that it is relatively easy to test for sources of error and also to take steps to minimise or take account of such errors in choice models.

There is a need for more research attention to be paid to the reliability of estimation in different circumstances, although in practice there are so many different applications and variations of choice models that it would be difficult to construct practical guidelines. There is also considerable uncertainty regarding the most appropriate way to measure the different types of reliability and validity.

3.8 Summary

In this chapter a review of methodologies suitable for investigating the influence of sensory, cognitive and contextual factors in food choices was presented. Multivariate analysis was essential to uncover relationships between factors and experimental research was appropriate for identifying causal links rather than just statistical associations. Decompositional methods were preferred over compositional methods, as consumers can be unreliable in recognising and reporting the importance of the multiple variables that make up their choice behaviour. Conjoint analysis and the related technique of experimental choice analysis were reviewed to assess their appropriateness for studying food choice.

Conjoint analysis and experimental choice analysis are similar in many respects: they share a common goal of understanding and predicting consumer preferences by requiring respondents to evaluate multiple multiattribute product or service profiles; both rely on experimental designs which combine the attributes, and both estimate similar part-worth utility functions. The use of overall judgements in conjoint and experimental choice analysis are particularly suited to sensory applications. It has been demonstrated in a variety of sensory studies that "hedonic processing is preconscious" (McBride, 1990, p.202), and consumers are unable to isolate which sensory components contribute to their overall liking of a product. The main limitation to their use is in the number of attributes that can be independently varied and the total number of treatment combinations that can be presented to consumers. The methods have the greatest potential in consumer research, where marketing concepts, product information and physical products can be combined in one design. This approach "provides an extraordinarily fertile area for research" (Moskowitz, 1993a, p254).

Conjoint and experimental choice analysis differ in many respects too. They have different theoretical foundations, use different statistical theories and methods of analysis, use different levels of aggregation for estimation of parameters and use different types of responses. Conjoint analysis has strong methodological foundations in terms of measurement and is now well established as a research method. The conceptual foundations in terms of theories of underlying consumer behaviour is much less developed and often largely ignored (Louviere, 1994). Its adoption by marketing researchers as a tool for marketing decisions has placed it apart from more theoretical approaches. Experimental choice analysis combines theory and methods from two main fields and uses the conceptual framework of probabilistic discrete choice theories to model choice behaviour. It is not as well established in the consumer field and has been used mainly in observational econometric applications.

The main distinguishing feature between conjoint and experimental choice analysis is that in conjoint studies respondents rate treatment combinations one at a time whereas in experimental choice analysis respondents make a choice between sets of treatment combinations. Choosing one alternative from a set of alternatives is a different cognitive task from rating each alternative. Scaling methods can be problematic due to consumers' reluctance to use end categories, and inconsistencies of scaling across consumers. Metric conjoint methods also assume that consumers are able to associate an interval level scale of preference with different product profiles so that they meaningfully differentiate between the alternatives. As consumers are faced with making choices between products and services all the time, this is largely the appeal of experimental choice analysis. Its strength is its realism. When consumers go to the supermarket for ice cream, they choose from the alternatives available - they don't give each one points out of ten. In conjoint analysis the task of rating has no link to actual behaviour. Experimental choice analysis therefore explicitly investigates consumer choices by using choice as the response measure.
Another major difference between the methods is that experimental choice analysis is based on probabilistic random utility choice theory which provides a framework for modelling choice behaviour. The utilities estimated are represented by both systematic and random components, so take account of all the unexplainable and unmeasured factors inherent in choice tasks. Estimation is by maximum likelihood rather than the ANOVA or regression techniques used in conjoint analysis. Incorporation of individual explanatory variables directly into aggregated conjoint and choice data can overcome the problem of how to treat heterogeneous consumer responses. In the case of experimental choice analysis this strategy also eliminates one source of violation of the IIA property, which can be a disadvantage of the technique.

Experimental design and analysis requirements impose greater barriers to the use of experimental choice analysis than conjoint analysis, but this is likely to change as experimental choice analysis methodology is used more and computer programs and guidelines become more readily available. Carson et al (1994) noted, however, that while progress had been made on choice designs, no theories on producing "the best" designs for different situations had been produced, and little work had been done on the statistical properties of different design strategies. Several years later, the situation does not appear to have changed much, despite some enlightening work by researchers such as Kuhfeld and co-workers (1994, 1996). No further reviews have appeared in the literature and the complexities of the design process may have discouraged use of the technique for applied research.

In terms of methodology choice, experimental choice analysis was considered to be a more meaningful method for investigating food choices than conjoint analysis. The greater external validity of a method which forces consumers to make a choice, combined with the greater flexibility of the method for investigating a variety of research problems were the main features which led to this conclusion. A limitation of the method is the lack of established guidelines for experimental research. The methodology needs to be further tested and developed for food choice applications. However, experimental choice analysis has much potential for product development applications and for understanding product choices.

Chapter Four

EXPLORATORY STUDIES

4.1 Introduction

The foundation of food choice research is the identification of factors determining choices. Preliminary qualitative research allows consumers themselves to have an influence on the direction of the research rather than using pre-determined measures. This strategy was used in the present research to provide information on consumer perceptions of the product category and a means of examining how the use context contributes to consumers' food choices. Qualitative research guided the design of the experimental choice study, and supported the interpretation of the results. The exploratory studies carried out are described in this chapter.

The reasons for choosing the product category for this research are firstly outlined, with a brief description of the product. The research methodology for two qualitative studies is outlined and results are presented. A use context classification which could be used for general application is then developed and presented, along with a conceptual model of the food choice process.

4.2 Choice of product category

Yoghurt is a cultured food made by fermentation of milk with lactic acid bacteria. It is a nutritious product that has been in existence for centuries. Yoghurt was chosen as an appropriate product category for this series of studies because:

i) it is a product which is still relatively new to New Zealand consumers, even though yoghurt consumption has increased dramatically over the last decade (Cooper, 1994).

ii) it is available in different formulations in terms of ingredients, cultures and processing methods and is also both perceived and promoted as a "healthy" product, which makes it suitable for examining sensory and cognitive determinants of choice.

iii) it is a product which does not have culturally defined use occasions in New Zealand and is therefore suitable for investigating context specific variations in preference.

Flavoured and natural (unflavoured) products form the major division in the market. Natural yoghurts are, as stated, natural unsweetened products, but plain unflavoured yoghurt is also available sweetened. Flavoured yoghurt is by far the most popular and may be fruit flavoured or more usually contain fruit, either as puree or as chunks of fruit. Product variants in the market can also be described along various other dimensions:

a) *Fat content*. In New Zealand there are four categories of products (New Zealand Food Regulations, 1984):
  - non-fat, made from skimmed milk and having a maximum of 0.2% fat
  - reduced fat, made from semi-skimmed milk and having one third less fat than equivalent full-fat products, usually between 0.5% and 3% fat.
  - low fat products, made from semi-skimmed milk, have reduced fat and must have no more than 10% of the energy content coming from the fat.
  - full fat, made from whole milk and usually having a fat content of 3-5%.

  The natural yoghurt market is equally divided among these three classifications, while flavoured yoghurt is mainly reduced-fat.

b) *Stabilisers/preservatives/thickeners*
  The shelf life of yoghurt has been extended in recent years as technology improves, and a shelf life of up to 60 days without preservatives can be achieved. Modified starches and gelatin may be added, which can influence the structure

and texture of the yoghurt.

c) *Culture*

The cultures used to manufacture yoghurt are most commonly a blend of *Lactobacillus bulgaricus* and *Strepococcus thermophilus*, as they produce growth factors that stimulate each other's growth. In recent years "bioactive" or "pro-biotic" cultures have become popular. These so-called beneficial bacteria, *L. acidophilus* and *L.bifidus* are naturally occuring micro-organisms in the human intestine and are claimed to help to maintain a healthy digestive system and contribute to general good health.

Yoghurts on the market usually emphasise on their label one or more ingredient and processing formulations, most commonly fat content, all natural ingredients, organic production or the use of probiotic cultures. These are often accompanied by statements relating to the benefits of the particular formulation. Less often for this product category, label claims are made on the taste of the product, or its sensory properties.

4.3 Identification of choice factors

A review of the literature did not reveal any studies in which consumer generated factors affecting purchase choices in this product group had been identified. In order to identify these factors, an initial qualitative exploratory study was undertaken.

The repertory grid method was chosen to elicit from consumers how they differentiate between products in their purchase decisions. The repertory grid procedure is a partially structured technique that allows participants to generate their own descriptions of determinant characteristics. It is based on a technique developed by a psychologist (Kelly, 1955) to evaluate the personal constructs of individuals. This method has successfully been applied in many studies to investigate the perceived attributes of food products (e.g. Green & Tull, 1978; McEwan & Thomson, 1989; Gains, 1994; Jack et al, 1994).

The strength of the repertory grid method over structured methods is that it generates a list of differentiating characteristics derived from participants themselves and in their own language, rather than in terms chosen by the researcher which may not be meaningful to consumers (McEwan & Thomson, 1989). The method also has several advantages over unstructured methods such as focus groups, where products are often not physically present and where not all attribute dimensions may be captured. There may also be bias due to dominant individuals in the group or to the interviewer. Consumers, whether individually or in groups, when asked in isolation, often find it very difficult to describe why they like particular products and it appears that people can more easily describe why they dislike a product than why they like it. The repertory grid method compensates for these limitations of other methods by forcing people to attend to the ways in which they differentiate between products (Gains, 1994) and the technique is very flexible in terms of the different types of perceptions which may be investigated in this way.

The basic procedure involves presenting triads of products and asking individuals to indicate in what ways two of the products are similar to each other and different from a third product. The result is a list of constructs which describe in the participant's own terms how the objects are perceived. This list of constructs may then be used for identifying relevant attributes for subsequent studies such as conjoint analysis; subjected to further analysis by having participants rate each object on a scale for each of the constructs elicited; or perceptual mapping techniques may be used to chart the main dimensions.

In the present study the procedure used to elicit constructs was based on choice factors rather than similarities/dissimilarities, as choice was the focus of the research not discrimination.

4.3.1 Products

Eighteen cultured and related dairy products were selected to cover the range of products currently available on the market in terms of brands and types, and varied in ingredients, nutritional composition, production methods and product style. The products included were plain, flavoured and fruited varieties of yoghurt, along with related products such as dairy food, dairy dessert and fromage frais. Eight triads were presented. Similar product types were initially grouped in a triad (eg all natural yoghurts) with one product then carried over to the next triad to make a grouping of products with dissimilar attributes.

4.3.2 Participants

Twenty women who had indicated their interest in taking part in consumer studies participated in the repertory grid study. They were all regular yoghurt consumers and primary household food purchasers, and ranged in age from 20 to 70 years old.

4.3.3 Procedure

Participants were interviewed separately in their own homes in March 1996. Real, physically present products were used rather than photographs or written descriptions as this was thought to increase the external validity of the study by making it as realistic a task as possible. The products were arranged into groups of three and each triad placed on a table in front of the participant, who was then asked:

"For what reasons would you buy one of these products but not the other two?"

All responses were recorded, whether phrased as behavioural statements (e.g. "I only ever buy reduced fat yoghurt"), evaluative statements (e.g. "I prefer the one with the chunks of fruit") or factual observations (e.g. "This one has a resealable lid"). When no new responses (constructs) were forthcoming for that triad, a new triad was presented, with one product carried over to the next triad. Each interview took approximately 30-40 minutes.

Products presented to individual participants fell into one of three categories: products previously purchased and consumed; products which the participant was aware of but had not tried; and products the participant was totally unaware of, ie in essence a new product to that individual. Choice factors were thus based on previous product experience, as well as expectations of products gained solely from the package and product information. The repertory grid method also ensured that both favourable and unfavourable factors in purchase choices were elicited from participants. A comprehensive list of reasons potentially influencing purchase decisions was therefore obtained from the participants in their own terms.

4.3.4 Results and Discussion

Participants generated between 28 and 72 responses each, including repetitions within different triads. The list of constructs elicited from participants was grouped and sorted on the basis of verbal labels. In contrast to many previous repertory grid studies where the final list of constructs is a composite list of conceptually different dimensions, the constructs in the present study were grouped to reflect the range of underlying reasons for choice preferences. The reasons for selecting one product version over another may be categorised on many different levels. Rather than imposing one or other theoretical structure on the data to initially categorise the findings, the constructs were firstly grouped according to clear distinctions in choice reasons. The key reasons behind choice preferences were classified as follows:

Intrinsic or sensory factors
User benefits
Factors related to usage
Economic reasons
Practical reasons
Extrinsic product factors

- Intrinsic or sensory factors take into account overall preference of sensory character, plus particular flavour and texture properties.

- User benefits include perceived nutritional or health benefits related to specific product characteristics, composition or production methods.

- Factors related to usage cover appropriateness of the product for the end-user and meal occasion, time-related factors of consumption, accompanying foods in the consumption situation, as well as the perceived appropriateness and quality of performance for the anticipated usage situation.

- Economic reasons are concerned with absolute cost, value for money and outlay of time involved.

- Practical reasons relate to the size, quantity and availability of the product and convenience of the package for opening, storing, using and re-using.

- Extrinsic product factors take into account external characteristics of the marketed product and include brand familiarity or reputation, name of the product, and design of the package including colour, graphic presentation, pictorial representations.

The constructs in each group were reduced by grouping similar terms and then sorted according to how frequently each construct was mentioned, to obtain a comprehensive list of factors specific to this product group (See Table 4.1). Constructs mentioned by only one or two individuals, and which could not easily be fitted into a category were noted but not included in the main list.

Table 4.1 **Constructs elicited from participants in repertory grid choice study** (in order of frequency within groups)

Choice reasons	Constructs
Intrinsic/Sensory factors	Flavour type
	Overall liking
	Familiar/unfamiliar taste
	Presence/absence of fruit pieces
	Flavour intensity
	Firm/runny consistency
	Sweetness
	Lightness/richness
	Tartness (sharp, tangy, sour, bite)
	Creaminess
User benefits	Fat content
	Culture type / benefits to digestive system
	Ingredients
	General health / good for you
	Calories
	Calcium
	Artificial colours / flavours
	Additives
	Sugar / artificial sweeteners
	Food value / goodness
	Organic
Usage factors	Culinary uses
	Particular meal, time of day, time of year
	Regular use / special occasion use
	Appropriateness for person/people
	Suitability for individual circumstances
	Suitability for other foods eaten with it
	As ingredient
Economic reasons	Price
	Value for money
Practical reasons	Convenience of package for opening/ storing/ using
	Size / quantity of product
	Time / convenience / availability factors
	Re-usable container
Extrinsic product factors	Familiarity of brand
	Quality / reputation of brand
	Appearance of package
	Presentation of information
	Description of product
	Name of product

In addition to categorising the factors, the data were examined for relationships between factors, as mentioned directly by participants. The following table (Table 4.2) describes these:

Table 4.2 Relationships between usage and yoghurt choices, as elicited from participants in repertory grid choice study 1

User benefits	USE CONTEXT	Sensory attributes
	Children	* Mild taste
	If eating product by itself	* Sweetened
	If eating with fruit or other accompaniments	* Unsweetened
Low fat	* Regular purchase	
Low fat	* Cooking	
Low fat	* Lunch	
Full fat	* Children	
Acidophilus	* Children	
Acidophilus	* When sick	

* denotes that choices for the particular user benefits or sensory attributes on each line were influenced by the use context noted

In addition, there were relationships between factors such that attribute 'X' was considered to imply attribute 'Y', as shown below (Table 4.3).

Table 4.3 Implied relationships between yoghurt attributes, as elicited from participants in repertory grid choice study 1

Attribute 'X'	Implied attribute 'Y'
Reduced fat	Runny
	Less body
	Less flavour
Full fat	Creamy
	Richer
	More flavour
Acidophilus	Less flavour
Calcium enriched	Less flavour
Thick	Creamy

In this study, participants may or may not have purchased or consumed all the products presented, thus the factors encompassed both experienced attributes and those perceived only on the basis of the label. For this reason the relative frequencies of the factors mentioned may be of limited usefulness. The main objective in this study was to obtain a list of both types of factors to obtain perceptions of non-users as well as users. The results cannot be assumed to apply to other groups of participants or the population as a whole. However, a relatively small number of consumers can be used to identify most (around 90%) of the relevant factors, and many qualitative studies use no more than twenty to thirty people (Griffin and Hauser, 1993).

The repertory grid method was an effective means of examining the differences between products which specifically affect consumer choices. In this study, equivalent products to yoghurt (fromage frais and dairy dessert) were included. It was noted that product attributes and usage occasion were in many cases more important than product type in determining choices. The choice factors mentioned by participants were also answered on an individual basis and on behalf of the household unit. While expected liking can be assumed to be answered on the basis of personal preference, many food purchasing decisions are ordinarily based on buying for the whole household. The choice behaviour of individuals is rarely done independently of the influence of others (Wind, 1976; Dellaert et al, 1998). These findings are relevant to the potential importance of the use context in food choices. Prior to the design of the main choice experiment it was considered necessary to investigate fully the contexts of use for the product.

4.4 Identification of use factors

A second repertory grid study was undertaken to identify consumer relevant contexts of use applicable to yoghurt and the factors affecting perceptions of appropriateness in these contexts. There are two levels of evaluation of products which are relevant in terms of preference. Consumers may be able to give an overall evaluation of a product in terms of their individual preference and consumers may also have preferences or attitudes towards particular product attributes. Both these overall or attribute preferences are dynamic in the sense that they are dependent on context. This may include the context in which the product is to be used, as outlined in section 2.3.

The methodology was based on the approach by Gains (1994), and focused on contextual factors perceived by the consumer as affecting their choices and the relationship of these factors with the sensory attributes of the product alternatives. Repertory grid methods have been used to elicit contexts of use for a variety of foods, including alcoholic beverages (Scriven et al, 1989); meat products (Nantachai et al, 1991/92); and snack foods and fruit (Jack et al, 1997).

4.4.1 Products

A range of 16 commercially available yoghurt and associated products was used. These were selected to cover all the different brands and types of products - plain, flavoured and fruited yoghurt, fromage frais, whipped yoghurt and frozen yoghurt. They varied in product style, production methods, ingredients and nutritional composition.

4.4.2 Participants

Twenty people participated in the study - seventeen women and three men. All were regular yoghurt consumers, aged between 20 and 50, primary household food purchasers and regularly prepared food for others in the household.

4.4.3 Procedure

Participants were interviewed separately. For this study paired presentations were used. As participants were asked to focus on a more specific evaluation, i.e. context, rather than all factors influencing their choice, it was thought that this format would make it easier for participants (McEwan et al, 1989)

Actual products were used, and contexts of use were elicited by asking:

"In what contexts would you use or consume this product but not the other?"

To explain the term "context", the following questions were presented to participants, both verbally and in written form:

When would I eat this?
Where would I eat this?
What would I eat this with?
Who would I serve this to?
On what occasion would I eat this?
What would I use this for?

They were asked to keep these in mind or refer to them when considering their response. All responses were recorded as in the first repertory grid study.

In order to focus attention further on specific attributes and how preferences for these might vary between contexts, a second elicitation process was conducted at the same session, after a short break. In this part, contexts most frequently described in the first choice study were written on cards. These were:

- with breakfast cereal
- for lunch
- for dessert
- for eating by itself
- for eating with fruit
- for children
- for the whole family
- for a treat
- for everyday use
- for use in cooking or baking

Pairs of contexts were presented to participants and they were asked:

"What characteristics would you consider important in a yoghurt for this use but not the other?"

This question was repeated for the other use context in the pair, before going on to the next pair.

4.4.4 Results

Participants generated between 11 and 32 contexts each in the context elicitation phase, including repetitions across pairs. The results, prior to classification according to context type, are presented in Appendix A.

The uses most frequently mentioned were: for dessert, for children, with fruit, for a snack and for a treat or special occasion. The use 'for children' may have been overemphasised for the participants in this group, as all had children and the interview location may have focused attention on this use. The uses 'cooking' and 'ethnic cooking' were separated in this list. If combined, they would come in the top five.

In the attribute elicitation phase, participants generated between 11 and 24 attributes. These related primarily to type (plain/flavoured), fat content, and sweetness type or intensity. Other attributes mentioned were: creaminess, consistency (thick/runny), body, familiarity of taste, no additives, acidophilus, quantity and long life.

Participants found it hard to verbalise interactions between context and product attributes. Most attributes mentioned related to the basic distinctions between yoghurt variants as clearly signalled on the label (type, fat content and sweetness type). It was harder to identify why they liked or disliked other features in relation to their use of the product. This is consistent with the view of most food researchers (e.g. McBride, 1990; Moskowitz, 1995). When asked why they would choose between products, as in the first repertory grid study, participants had no problem identifying attributes and did in fact often relate these to their use of the product, but when asked directly about attributes, they found it much more difficult. It was however clear that fat content and sweetness type were the main features influencing choice for different use contexts.

4.5 Discussion and development of use context classification

The qualitative studies described in this chapter provided a means of examining how the use context contributes to consumers' food choices. The first study identified the most common factors, as expressed by the respondents, in their food choices. The second study evaluated these factors in greater detail, as preparation for the main trial. These two studies obtained a comprehensive picture of an individual's perceptions, verbalised in their own terms.

Foods may have a large number of uses and these vary considerably across contexts. In order to gain a clearer picture of use context variations, some kind of organising structure is helpful. Most studies investigating context (Schutz, 1994; Gains, 1994; Jack et al, 1997) have subjects rating products for each use and use quantitative data in a principal components analysis to group the data and find common dimensions. This is a means of reducing the large amount of data, as a list of 30 or more different uses is hard to work with and interpret. In the present study, the data were qualitatively analysed, by isolating actual patterns and characteristic associations, and a use context classification developed.

In order to gain a more structured categorisation of the use contexts, they were grouped on the basis of underlying dimensions of context. A preliminary classification was developed, applied to the data and then revised until it adequately fitted the data. This approach is similar to the constant comparative method of analysing qualitative data (Miles & Huberman, 1994; Furst et al, 1996).

The final classifications are shown in Table 4.4. These classifications could be used for any food product, with the specific uses in each use context changing according to the particular food under study. This classification structure could be used as a useful organising structure for future qualitative studies. In the first qualitative study in the present research, where the reasons behind choices were identified, many relationships were noted between product attributes and usage factors. These relationships could be more easily classified and interpreted according to the use categories developed. Product preferences were influenced by dimensions related to time (the use occurrence and meal occasion), food (food context and function of use) and person (the end-user and state dependence of the end-user).

While the use classifications described are not particularly new, such groupings have rarely been explicitly used in studies investigating context. Separate consideration of each use context classification may aid clarity and interpretation in many aspects of food context research.

The contexts were used to regroup the raw data from the second study, using this structure. As a means of validation of the classification structure, the data in the context category from the first repertory grid study (in Table 4.1), were regrouped according to these categories. The uses were easily classified and were almost identical in both studies, with only three or four uses specific to each study. The combined classification of use contexts for natural yoghurt is shown in Table 4.5.

The use contexts were suitable to use as measurement variables in the experimental choice study. The overall frequency of mentioned contexts, together with representation from the context classifications were taken into account in the selection of factors.

Table 4.4 Use context classification structure

Dimension	Context	Definition
Time	Meal occasion	Refers to meal name, linked to the time of day the food is eaten
	Use occurrence	Takes into account the relative frequency of use and periods of use
Person	End-user(s)	Takes into account the person or persons actually consuming the food and whether it is eatcn alone or with others
	State dependence	Refers to the physiologcal, psychological or situational state of the individual at the time of purchasing, preparing or consuming the food, and this state is explicitly considered by the individual as a factor in their choice
Place	Meal location	Refers to the place the food is to be eaten
Food	Food context	Refers to whether the food is being consumed by itself or eaten simultaneously with other foods, and what these combinations of foods are
	Function of use	When the food is transformed in some way before being consumed (eg an ingredient in another dish), performs an ancillary function (eg is used to dress up, accompany or be mixed in with another dish), is eaten in a different state (eg frozen), is used as a substitute for another food, or is used for purposes other than consumption.

Table 4.5 Use contexts for yoghurt from two qualitative studies, reclassified according to use context classification structure

Dimension	Use classification	Contexts
Time	Meal occasion	Breakfast Lunch Snack Dessert
	Use occurrence	Regular/everyday Special occasion/treat Occasional use Summer Winter
Place	Meal location	Home Away from home School Work On holiday When travelling
Person	User	Baby Children Adults Whole family / everybody Guests Eating by yourself
	State dependence	When dieting When ill When using antibiotics When in a hurry When hungry When have allergies
Food	Food context	By itself With cereal With fruit With honey or sugar With nuts, choc chips, 100s/1000s, etc With flavouring With desserts Mixed with cream
	Function of use	For general cooking For ethnic cooking For baking As condiment As topping In dressings In dips In sauces and soups In smoothies For thickening As substitute for milk, cream, ice-cream In uncooked desserts For making frozen yoghurt To re-use culture to make yoghurt For skin applications

4.6 Framework for studying consumer choices

A conceptual model of the food choice process, based on the synopsis of the literature and the exploratory studies, is shown in Figure 4.1. It gives a general framework for studying consumer-oriented approaches to food choice, and illustrates the conceptual links between cognitive, sensory and usage factors inherent in consumer choices.

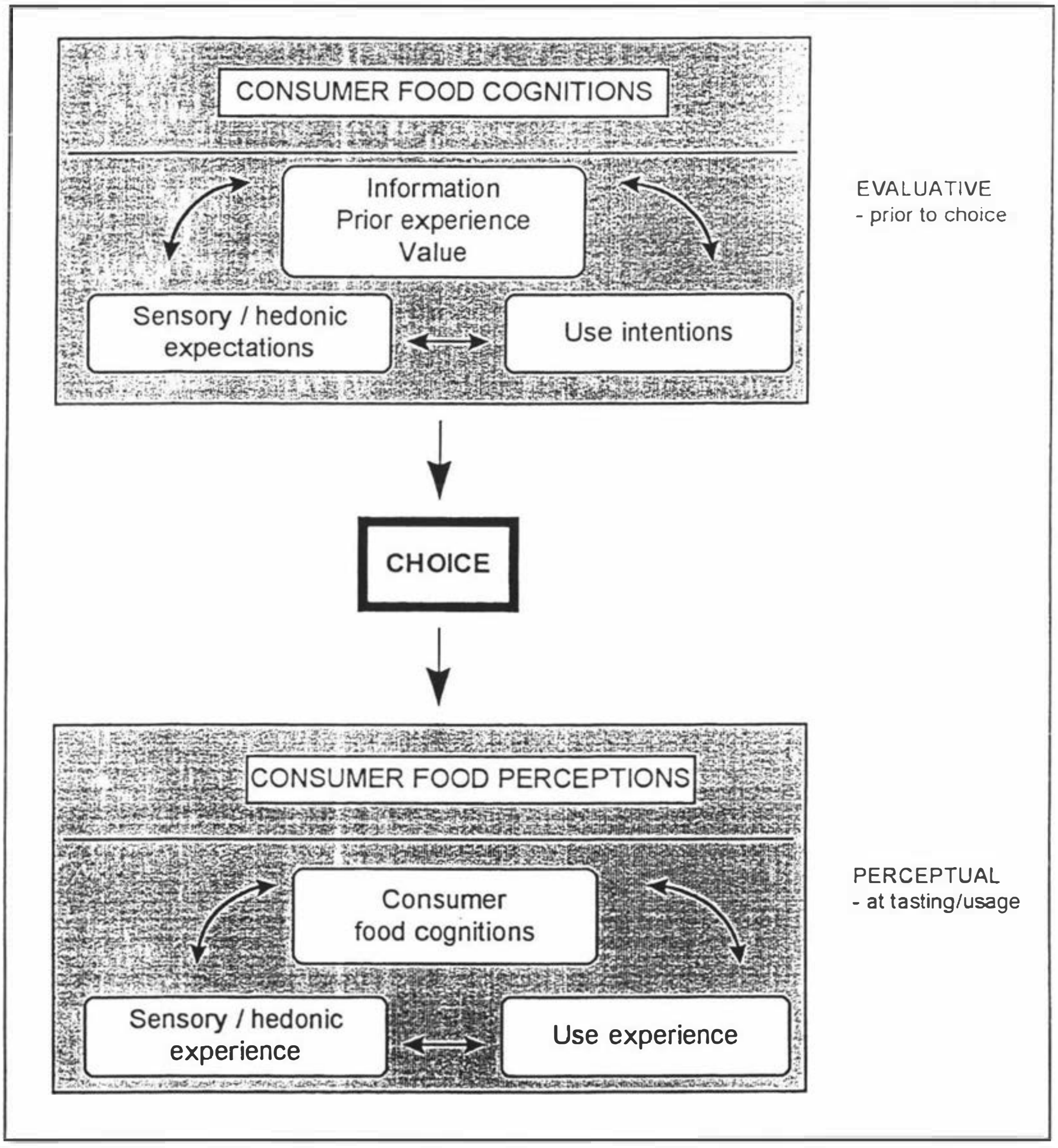

Figure 4.1: Conceptual model of the food choice process

Consumer food cognitions represent how the individual thinks about and conceptualises the food prior to choice. The dimensions which may interact in the mind of the consumer at the evaluative stage include: information, prior experience, perceived value, sensory and hedonic expectations and use intentions.

Information includes product information, advertising, information from other people or knowledge the consumer has gained from whatever source. Prior experience may come from use of the product or similar products. Value may represent actual price and/or the value an individual places on product characteristics or benefits. These would all be expected to interact.

A choice is made from an available choice set. When used or consumed perceptions are integrated with cognitions to form an overall assessment of the product. Both the hedonic experience and the use experience, each of which may or may not include assessments of specific sensory characteristics, combine with the previously held food cognitions. These food cognitions are part of the perception process. Satisfaction or dissatisfaction with the choice may lead to changes in the consumer's food cognitions and the choice may be reinforced or revised for future purchases or selections.

The framework models food choice for an individual, within a particular cultural, social and economic climate. Therefore, important though they undoubtedly are to food choice, indirect cultural and environmental influences over which the person has no control are not included, nor are indirect individual socio-cultural and developmental influences on food choice. Individual characteristics and traits of the consumer, in this framework, are implicit and considered to be antecedent to choice, not independent influences at the time of choice, and may be accounted for as interactions with model components.

The choice event may be purchase occasions such as choices between different types of foods, product categories, product variants and brands of a product, or selection between foods in the house, foods on the menu at a restaurant, or any other food-related choice event.

The model is supported by the research on expectations (Oliver, 1980; Goering, 1985; Cardello, 1994; Deliza & MacFie, 1996) which suggests that when a product is evaluated, prior expectations are compared with the actual experience and the previous expectations may be confirmed or disconfirmed and thus play a significant role in food choices. Expectations in this model may be hedonic, sensory or related to the product's functional qualities for the intended use.

For many regular food purchases, choices may be well established, but even for habitual food choices, use intentions may sometimes change or there may be a further input of information which will impact on the choice process. For example, a consumer may regularly purchase a particular type, brand or variant of product for a particular use, but may decide to purchase a different product if they are using the product in a different way, for a different occasion, or serving it to other people. Or the consumer may receive information on a product feature which previously did not influence their choice but is now thought to be of value to them.

This framework is a means of conceptualising food choices to aid in the design of food choice research.

4.7 Summary

This chapter described two exploratory studies utilising qualitative methodology. Choices for yoghurt were identified in a choice-based repertory grid study and categorised into six main groups: intrinsic or sensory factors, user benefits, factors related to usage, economic factors, practical factors and extrinsic product factors. This was an effective means of examining the differences between products which specifically affect consumer choices. The study showed many examples of interactions between the choice factors, e.g. sweetened products being chosen only if they were low fat; and fat content being used to infer sensory properties. Such effects are not usually incorporated into models of food choice.

A second repertory grid study provided a comprehensive picture of how the consumer's use of yoghurt affected their choices. Based on these results, a use context classification was developed. The contexts were organised by the dimensions *time (*meal occasion, use occurrence), *person* (end-user, state dependence), *place* (meal location), and *food* (food context and function of use). These classifications may offer a helpful approach to assessing usage factors within the broader sphere of food choices. Further validation of these use contexts could be a subject for future research.

Finally, based on these results and the review of literature presented earlier, a conceptual model of the food choice process is presented to structure the experimental choice study, illustrating where sensory, cognitive and contextual factors fit into the whole food choice process.

Chapter Five

DESIGN OF EXPERIMENTAL CHOICE STUDY

5.1 Introduction

This chapter describes the specific design and methodology used to investigate consumer choices for natural (unflavoured) yoghurt. The framework of the study is introduced and the key features of the approach outlined, followed by a discussion of the selection of variables for the study. The methodology including experimental and presentation designs, participants, stimuli and data collection procedures are then described. Chapter six presents the results of the analysis and chapter seven brings all the sections together in evaluating the methodology and discussing the limitations, practical applications and theoretical issues.

The objectives of the study were to determine product attribute preferences across different use contexts, and to assess how these interact with each other and with the characteristics of the participants. As choices can only be fully understood in the context of the intended use, the primary focus of the study was to determine if the perceived appropriateness of products characterised by different product attributes varied according to use. The experimental choice methodology was extended to incorporate sensory assessment of the products.

Experimental choice analysis is a method which allows the choice to be the central focus of enquiry, and it was conducted in two stages. Firstly, the evaluative stage identified choices based on consumers' food cognitions prior to tasting. Secondly, the perceptual phase identified choices based on sensory assessment of the product together with product information. The key features of the study are set out in Table 5.1.

Table 5.1: The key features of the experimental choice study

Data collection	
■ realistic choice task	
■ context-specific responses	
■ 3-stage data collection procedure	- label information only
	- blind tasting
	- labelled tasting
Model	
■ designed experiment based on factorial design	
■ discrete choice modelling techniques	
■ interactions between attributes modelled	
■ interactions between attributes and participant variables modelled	
Model estimation	
■ random utility theory	
■ multinomial logit model specification	
■ maximum likelihood estimation	

5.2 Study variables

5.2.1 Selection of attributes

The two key features of yoghurt formulation and labelling were sweetness and fat content. These two attributes can imply both sensory and nutritional properties. Despite the large literature on cognitive and sensory responses to low-fat products, there has been practically no research attention paid to the conditions under which use of low-fat products might be thought more appropriate, and how fat content might interact with other product variables in influencing preferences.

Two features which are increasingly important in today's market are the bacterial cultures used (specifically the use of probiotic cultures such as *Lactobacillus acidophilus* and *Lactobacillus bifidus*, and the presence or absence of preservatives, thickeners and stabilisers. These features are promoted on the label mainly as benefits to the consumer and therefore are subject to cognitive judgements. The exploratory studies had indicated that these features may not always be perceived as benefits, and they may have either a positive or negative effect on consumers' choices.

These attributes were therefore chosen for the current study. Sweetness and fat content were manipulated in the experimental products for the tasting phase. The bacterial culture and additives features were used as product information only because they would not easily be discernable to consumers in the actual products.

Other purely sensory features which are not generally communicated to consumers on the label are consistency and acidity or sourness. While these are important for acceptance of yoghurt, they were controlled to be the same for all products in this study as the aim was not to study preference per se.

Although it may be expected that sweetness would be the most important factor in consumers' choices, for the present study the appropriateness of the two different types was expected to vary across use contexts and the interactions between sweetness type and the other attributes were expected to provide more insights than the simple main effect of sweetness.

5.2.2 Selection of response measures

Discrete choices were to be made from sets of experimentally varied alternatives. For this study multiple responses were made for each choice set, corresponding to different use contexts. In the context of choice experiments, irrespective of the theoretical justification, the use of context-specific responses is advocated by Ben-Akiva (1992) to increase reliability and validity, such that "by placing the choice task in a framework that is familiar and meaningful to the respondent, we increase the chance that the decision protocol that would be used in an actual choice situation will also be used in the experimental situation" (p3).

The use contexts chosen were representative of each of the use context classifications presented in Table 4.4. The use contexts covered meal occasion (dessert), end-user (pre school children), food context (on its own), functional use (cooking/baking) and general multipurpose use. Too narrow a situational context may result in participants being unable to identify with the situation. Too broad a context may result in true differences being masked because participants form their own reference contexts.

5.2.3 Participant variables

Participants who were familiar with natural and/or flavoured yoghurt were selected. As the product features may be perceived differently for consumers with prior experience of the product, the effect of participants' previous use of natural yoghurt was studied. Many people who use flavoured yoghurt have never bought or consumed natural yoghurt.

In addition, the effect of participants' food and health related concerns was studied. Previous research has shown that such concerns can affect preference for reduced fat products (Tuorila, 1987; Aaron et al, 1994; Kähkönen et al, 1996; Saba et al, 1998). Several attributes in this study could be judged in terms of health benefits/concerns: fat content, whether the product is sweetened or not, and whether the label describes it as either having no additives or acidophilus culture. Individual differences in the evaluation of these attributes, depending upon individuals' degree of concern about health issues, can easily be incorporated into choice models (Ben-Akiva, 1992).

5.3 Methodology

The stages of the experiment are shown in Table 5.2.

Table 5.2 Stages of experimental choice study

PHASE	STAGE	Task based on:
Phase 1	Label	Information only (8 choice sets)
		⇩
	Tasting	Blind tasting (4 samples)
		⇩
Phase 2	Labelled tasting	Information + tasting Session 1 [4 choice sets]; Session 2 [4 choice sets]
		⇩
	Participant survey	Questionnaire

5.3.1 Experimental design

The experimental design consisted of two parts: the design of the treatment combinations and choice sets, and the design of the presentation orders (Lundahl, 1996).

5.3.1.1 Design of treatment combinations and choice sets

An efficient design for a choice model which would estimate all main effects and two-factor interactions was required. It could not be too large because it could cause sensory fatigue for participants, as the design was to be the same for both pre-tasting (label only) and post-tasting (labelled tasting). For the post-tasting phase, two factors were to be manipulated for both product and label, and one manipulated for the labels only. The major decisions were to select the number of alternatives in each choice set and the number of choice sets.

(i) Number of alternatives in each choice set

The decision to use three alternatives per choice set was made because the same choice sets were to be used for the label only and labelled tasting stages of the study, and sensory constraints had to be considered. Most traditional sensory and consumer research with multiple presentations use two to four products (Stone & Sidel, 1985). In the labelled tasting stage (when samples were tasted and information was presented), a choice between four alternatives was considered too complex. With two or three alternatives, the same number of samples needed to be tasted, but with the three-alternative choice sets, the number of sets is less, making the task appear less onerous. A recent study by MacRae and Falahee (1996) compared three different options for presentation of six substances and concluded that two triads was better in terms of discrimination and assessor effort than three pairs or one set of six. Choice sets of three were therefore thought to be the most appropriate. Presentations of three are common in sensory research (Lawless & Heymann, 1998). There is little research reporting reliability for different numbers of alternatives in choice sets for written and visual stimuli, although Lussier and Olshavsky (1979) provided some support for the use of three alternatives, finding that subjects used compensatory strategies to evaluate the alternatives.

(ii) Number of choice sets

All two-factor interactions were to be estimated, and this limited the design strategies available. Another limiting condition was the asymmetrical design, there being two two-level factors and one three-level factor.

The total number of treatment combinations to be presented to each participant should ideally be divisable by two and three, as there were two and three levels factors in the study. Many of the design strategies also required the number of choice sets to be divisable by two and three. This was more difficult to achieve as six choice sets was shown to be too few to accurately estimate the parameters, and twelve was too many to present to participants in one or two sessions without sensory fatigue, boredom or "information overload" (Jacoby et al, 1974) Alternatively, more sessions could be run, which would have been more difficult to organise for volunteer participants and would run the risk of missing or incomplete data if participants did not complete the whole study.

A computer-generated design was found to be the most appropriate. None of the catalogued choice design strategies was suitable and traditional experimental designs for single presentations either involved too many runs or the blocks were too large. PROC OPTEX in SAS (Kuhfeld, 1996) can generate choice designs to specified requirements. A full factorial design was used for the candidate set of possible combinations and a design requested with three alternatives in each choice set that would estimate all 2-factor interactions in as few runs as possible. Designs with fewer than eight choice sets were not found to be efficient and were not considered further.

The resulting 2^2x3/3/8 design generated by PROC OPTEX, shown in Table 5.3, was such that each of the twelve label profiles appeared twice in the design. For the actual product profiles within this design, there were two choice sets of each of the four possible triad combinations, four presentations of each of the six pairs of treatments within choice sets, and six presentations of each of the four different product formulations over the whole design. The D-efficiency for the design (a function which can be thought of as maximising the volume of the design space; Kuhfeld et al, 1994) was 89.9045 and the average prediction standard error was 0.9509.

Table 5.3. : Experimental design - treatment combinations and choice sets

Obs	X1	X2	X3	C/set
1	1	0	0	1
2	0	1	0	1
3	0	0	1	1
4	1	1	1	2
5	1	0	0	2
6	0	1	0	2
7	1	1	2	3
8	1	0	1	3
9	0	0	2	3
10	1	0	1	4
11	0	1	1	4
12	0	0	0	4
13	1	1	1	5
14	0	1	2	5
15	0	0	1	5
16	1	1	0	6
17	1	0	2	6
18	0	1	2	6
19	1	1	0	7
20	1	0	2	7
21	0	0	0	7
22	1	1	2	8
23	0	1	1	8
24	0	0	2	8

KEY:
obs = treatment combinations
X1 = level of attribute 1
X2 = level of attribute 2
X3 = level of attribute 3
C/set = choice set
Levels of attributes:
0 = level 1
1 = level 2
2 = level 3

5.3.1.2 Presentation design

There are two main types of response bias for both "pencil and paper" evaluation tasks and sensory tasks. These include the order in which treatment combinations are presented (Mead & Gay, 1995; Earthy et al, 1997), and sequential effects where one position may be rated higher or chosen more often than other positions (referred to as position error, time-order error or first sample effect, Mead & Gay, 1995).

Choice experiments have three possible label order effects (Chrzn, 1994):

i) order of attributes in description of alternatives
ii) presentation order of alternatives within choice sets
iii) choice set order

As attributes were depicted graphically in the form of labels, attribute order was not an issue in the current study. There were few attributes and the benefits of varying their placement on the label did not outweigh the potential for confusing participants.

As the same treatment profiles were to be presented for both the pre-tasting and post-tasting phases, carry-over effects in tasting order had to be taken into account in addition to order effects of presentation. First-order carry-over effects refer to the effect that a previous sample can have on the evaluation of the next sample. Simple randomisation of treatments or Latin Square designs are not sufficient to eliminate these effects, as there may still be an imbalance in the number of times a sample appears in each position (Schlich, 1993).

The order of choice sets was created by generating a balanced set of 60 orders according to the strategy outlined by MacFie et al (1989), derived from Williams (1949). For an even number of treatments (t), a Latin Square begins with the row:

$$0, 1, t\text{-}1, 2, t\text{-}2, 3, t\text{-}3, t/2 .....$$

and successive rows are generated by adding 1 to each element of the preceding row. Any treatment (k) greater than (t-1) is replaced by k-t. For 8 treatment combinations t=8, k=1. The design is shown in Appendix B1.

The resulting set of treatment orders was then randomised, which did not change the design properties but eliminated any potential bias due to the systematic generation of the design.

The experimental design for the order of samples and labels within choice sets was a balanced block design (Stone & Sidel, 1985) and is presented in Appendix B1. There were six possible orders of presentation, so for every six consumers each sample appeared equally often in each of the three serving positions and also preceded and followed every other product equally often. As testing was conducted over a week, any time dependent effects were also balanced and maintained.

The same designs were used for both pre-tasting and tasting phases. For the label phase (pre-tasting), the design for the choice set order of presentation was first randomised and then matched with the design for order of alternatives within each choice set. For the tasting phase a different randomisation was generated and matched with the alternative order design, with the serving order moved forward one place. Therefore each individual had a different combination of orders for choice sets and alternatives within choice sets for each phase. This was completely balanced over the whole design and was suitable for breaking the tasting phase into two or three sessions while still keeping the balance.

It must be noted that the presentation designs used in the sensory literature generally assume blind tasting, often for a set of unrelated products, and an ANOVA analysis. The adequacy of translating these designs into a choice study is uncertain because there are no guidelines. In the current study the presentation design had to be chosen according to the label design as this information was being presented to participants along with the actual samples. Adoption of these sensory presentation designs was thought to be the best strategy to take account of possible order and carry-over effects for both label and product.

Presentation design for blind tasting

For the blind tasting phase, the four product formulations were first rated separately for liking without a reference context. This was then followed by a separate presentation of a choice set of four, to obtain one choice for each of the five use contexts. The four sample choice presentation is larger than in most sensory presentations, but is sometimes used in dual-standard tests (Peryam & Schwartz, 1950) and larger sets may be used in preference ranking consumer tests (Lawless & Heymann, 1998).

Four products were to be evaluated by 60 people. As there were 24 possible serving orders for four products, a perfectly balanced design was not possible. Two sets of the 24 combinations were used, and SAS PROC OPTEX was used to find a nearly optimal set. The resulting design was nearly balanced (Ball, 1997), as two products appear equally often in each position and two come close. Ball (1997) argued that efficient designs that are nearly balanced are just as good as balanced designs and present no problems. The resulting 60 combinations (Appendix B2) were randomised twice for the rating and choice phases of the blind tasting.

5.3.2 Participants

Sixty-two adults were recruited on the basis of interest and availability from a community organisation. All were the major food purchaser for their households.

The study received approval from the Massey University Human Ethics Committee. Participants were fully informed about the study and were advised that they had the right to ask any questions about the study at any time, to withdraw from the study at any time, and to refuse to answer any particular questions or taste any particular products. Confidentiality of personal information was assured and participants signed a consent form before the study commenced.

Participants were asked questions on personal and household usage of flavoured and natural yoghurt, composition of household, gender and age, and were asked to complete a questionnaire on food and health issues (see section 5.3.4).

5.3.3 Stimuli

Labels

Visual representation in the form of labels was used in preference to written paragraphs or lists of attributes. Support for the label format is provided by empirical evidence that an increase in realism has a positive effect on the validity of evaluations (Loosschilder

& Ortt, 1994). Visual stimuli are thought to reduce the information load on participants (Green & Srinivasan, 1978) and make a more interesting task. For choice studies, the more the task resembles actual marketplace behaviour, the more valid it is likely to be, as participants are more likely to respond in a manner consistent with their normal purchasing habits (Ben-Akiva & Gershenfeld, 1997).

Because of the randomisation of orders, it was impractical to prepare all the treatment combinations (120) in a totally realistic label format. Choice set profiles were therefore prepared on white A4 paper in landscape orientation and photocopied in black and white. The three alternative labels appeared side by side, and label statements appeared in fixed positions on all labels (see Appendix C). Label statements are shown in Table 5.4.

Table 5.4 Label statements

Label statements			
Attribute	***Level one - 0***	***Level two - 1***	***Level three - 2***
X1 - Sweet	Unsweetened	Sweetened	
X2 - Fat	LIGHT Non Fat (0.1% fat)	STANDARD Full-cream (4.0% fat)	
X3 - Label Message	Absent	Contains no artificial ingredients, thickeners or stabilisers	With the health-giving properties of acidophilus culture

Selection of the actual label statements was made on the basis of current products in the marketplace. The inclusion of three components in the fat content statement was to communicate the fat content in a manner which covered the different aspects emphasised by existing products, and to avoid any confusion on the part of participants. Acidophilus is generally promoted as a health benefit and the inclusion of "with the health giving benefits of .." was to communicate this and inform those to whom the term 'acidophilus' meant nothing. Additional ingredients often fulfil several functions and while some products may proclaim just 'no artificial ingredients', others state that there are no stabilisers or no thickeners (one often implies the other). Although the terms in the label statement in the present study may be confounded (there is no way to determine which component influences participants) this was not considered detrimental to the objectives of the current research, whereas realism was important. All label statements were clearly outlined to consumers in a separate explanation sheet (Appendix E). 'Natural yoghurt' appeared on all labels in addition to the manipulated label statements, as this is used on most commercial sweetened and unsweetened varieties.

Products

The products used in this study were natural unflavoured yoghurts. Product formulations were factorially varied, with two levels of dairy fat: 0.1% (referred to as non-fat) and 4.0% (referred to as full-fat); and two levels of sucrose: 0% (referred to as unsweetened) and 6.5% (referred to as sweetened). (See Table 5.5). The level of sweetness chosen was based on an analysis of commercially available sweetened yoghurts in New Zealand (Visser et al, 1991). All the products contained the cultures *L.acidophilus, L.bulgaricus* and *L. thermophilus.*

Products were formulated for this study by reconstituting commercial yoghurt powders and adding standard sucrose to half the samples. The four formulations were prepared simultaneously under identical conditions. Products were reconstituted in water at 30°C using a Heidolph overhead stirrer and a stainless steel bucket, covered with tinfoil and incubated at 30°C. Products were monitored as they approached pH4.6, then removed to the cool room and stored at 4°C until testing, up to a maximum of 8 days.

Two batches were required to complete the trials, and while this may have introduced a source of variation, the length of the trials meant that they could not be completed using one batch. The pH values achieved for the two batches are shown in Table 5.5 . It was difficult to achieve identical pH values. However, product orders from low to high pH were maintained across batches and there did not seem to be any pattern across product formulations. A previous study (Barnes et al, 1991) did not find any correlation between pH and overall consumer liking. All participants tasted the products within 8 days of manufacture.

Table 5.5: Natural yoghurt product formulations for experimental study

Sample	Fat	Sugar	Final pH - batch 1	Final pH - batch 2
A	0.1%	0%	4.21	4.27
B	0.1%	6.5%	4.22	4.28
C	4.0%	0%	4.15	4.23
D	4.0%	6.5%	4.14	3.91

5.3.4 Procedures

The data were collected in two phases as shown in Table 5.2. The first phase consisted of the label-only choice study followed by the blind tasting. Phase two consisted of the labelled tasting, conducted in two sessions of four choice sets each, followed by the usage questionnaire. Despite the common practice in consumer studies of conducting the blind tasting first, in this study it was deliberately placed after the label only phase.

All testing was conducted at central community locations in groups of 5-10 participants. Both phases were completed within 36 hours for all participants, with most being completed in two sessions on the same day. Sessions were arranged to be at least one hour after meals, but the time of day at which groups of participants tasted the products varied for practical reasons. This was a potential problem, as time of day has been shown to influence preference (Birch et al, 1984). To minimise any effects, participants in the present study were asked to make choices for specific usage situations and not overall preference where they may use their own reference use context.

PHASE 1

Participants read the information sheet about the study (Appendix D), after which they had an opportunity to ask any questions. They then signed a consent form. To familiarise participants with attribute labelling and levels, an explanation sheet (Appendix E) was given which outlined the label attributes. Participants read through the use context questions and were asked if they needed any clarification on any of the contexts (they did not). They then completed the eight choice sets in their own time. Each alternative was labelled with a 3-digit code. These codes were the same for all participants, although each participant had a different order of alternatives and choice sets.

The choice questions for the label phase were as follows:

1) *Which one of these yoghurts would you expect to like the most if you were to eat it on its own (without any additions or accompaniments)?*

2) *Which one of these yoghurts do you think would be most appropriate as an ingredient for general cooking and baking purposes?*

3) *Which one of these yoghurts do you think would be most appropriate for serving to pre-school children?*

4) *Which one of these yoghurts do you think would be most appropriate for dessert?*

5) *Which one of these yoghurts do you think would be most appropriate for multi-purpose use (all the possible occasions you and your family might want to use it for)?*

Participants were then presented with a tray with four coded samples. They were instructed to taste the samples in order from left to right and rate their liking of each sample on a 9-point hedonic scale (Peryam & Girardot, 1952), with categorical responses ranging from "Dislike extremely" to "Like extremely". A second set of samples was then presented and participants asked to taste all four and choose one sample for each of the use contexts.

Samples were placed in serving containers up to one hour before the experiment, lids put on and chilled at 4°C until 5-10 minutes before serving. Approx 20ml of each sample was presented in 30g clear plastic serving cups on a clear tray. Each sample was tasted with a separate white plastic spoon. Cold water was provided to clear the mouth between samples.

PHASE 2

The samples were prepared and presented as in the blind tasting, and the label format and response measures corresponded to the label only phase. Three samples were presented, with the corresponding labels, with instructions to taste the samples and read the labels from left to right. Three digit codes were used to label the yoghurts, which matched the codes for the labels. A break of at least 15 minutes was allowed between the two sessions of four choice sets.

For the labelled tasting, questions two to five of the choice questions were the same, and question one was amended to read: *"Which one of these yoghurts do you prefer for eating on its own (without any additions or accompaniments)?"*. It was asked first as some empirical research has shown that there may be biases involved when asking for general preference questions in conjunction with specific type questions (Mela, 1989; Earthy et al, 1997). Although that research concerned sensory attribute questions and overall preference, it may be applicable to the present investigation. It therefore seemed wise to ask for personal sensory preference first, specific questions next and appropriateness for overall household use last, as participants by then had a basis on which to formulate their response.

After completing the labelled tasting, participants filled out a background questionnaire on yoghurt usage and how much they were concerned with food and health related issues (See Appendix G). Frequency of yoghurt use was measured on a 7-point scale. On the basis of this, participants were split into 'Regular users' (who used natural yoghurt "several times a month" or more) and 'Non users' (who used natural yoghurt "a few times a year" or less). Two classifications of yoghurt use were calculated: one based on respondent's personal use of yoghurt (for analysis of use context one) and one on household use of natural yoghurt (for analysis of use contexts two to five). It should be noted that non-users were still familiar with the product category and may be classified as regular users of flavoured yoghurt.

Participants were asked to indicate the occasions they had used yoghurt within the last month and which brands they regularly purchased. Participants were also invited to make "any comments about the products used in this study", to uncover any perceptions about the products used or suspicions about mislabelling, and to identify participants who may be familiar with the reconstituted powdered yoghurt used in the study.

Finally, participants were asked to indicate how much they were concerned about ten food and health related issues (based on Kähkönen et al, 1996, and Kähkönen et al, 1997). The statements dealt with concerns about food composition and ingredients, food processing and production methods and dietary related potential health consequences (See Appendix G). Responses were made on a 7-point scale (1=strongly disagree 4=neither agree or disagree 7=strongly agree). Individual means were used to classify the participants as having either high health concern or low health concern.

Chapter six

ANALYSIS

In this chapter the choice analysis is described. This includes a general overview of the analysis of choice data, followed by the findings for label, blind tasting and labelled tasting studies.

6.1 Introduction to the analysis of experimental choice data

The multinomial analyses were performed using the SAS System for Windows, Release 6.12 (SAS Institute Inc., Cary, NC, 1989). Guidelines were available (So & Kuhfeld, 1995; Kuhfeld, 1996) to help in the design of the experiment, collecting, processing and analysing of the choice data. The PHREG procedure was used to fit the conditional multinomial logit model (Kuhfeld, 1996). The Cox proportional hazards regression model was used, as the likelihood function in multinomial logit analysis has the same mathematical form as the Breslow likelihood in survival analysis. The choice each individual made for each choice set was used as an artificial time variable and censoring variable in the PHREG procedure.

As outlined in section 3.4, the explanatory variables in the conditional multinomial logit model are the attributes making up each alternative. The impact of each variable on choice is determined by its difference across alternatives. The data consist of the choices made by each individual for each choice set, and the set of alternatives (both chosen and unchosen) from which it was chosen.

The overall fit of the model to the data is shown by the log likelihood. Whether the model represents a significant improvement over a 'null' model where attributes have no effect, can be judged by comparing the log likelihood of the null model ('Without Covariates') to the model ('With Covariates'). If the improvement is significant, then the difference should be greater than the critical point of a chi-square distribution with

degrees of freedom equal to the degrees of freedom of the model.
Maximum likelihood parameter estimates are given in a table, along with the corresponding standard errors and probability values, which are equivalent to the t-test statistic in linear regression. The maximum likelihood estimates of the parameters indicate whether the profile evaluations for each of the use contexts were influenced by the attributes. The parameter estimate is the difference between the two levels of the attribute.

In the following analyses, increasingly complex models are estimated: a main effects model, followed by models incorporating interactions. The models were statistically compared using the likelihood ratio test. The difference between the -2 log likelihoods for the two models has a Chi square distribution and this difference was checked for significance in Chi square tables using the difference in degrees of freedom between the two models for the test.

The experimental design was entered separately and merged with the stratified choice data when the data set was read for each subject. Prior to analysis of the results, the entered data were screened to ensure accuracy and to verify that they were arrayed correctly. This was done in PHREG by viewing the summary statistics which set out each subject and choice set combination with the chosen and unchosen observations.

6.2 Results - Phase 1: Label effects

6.2.1 Participants

Sixty-two participants took part in the label study, all of whom were familiar with yoghurt. Twenty-four were classed as regular users of natural yoghurt and thirty eight were classed as non-users. Five percent of the participants were in the age range 16-24, 50% were 25-34, 37% were 35-44 and 5% were 45+ (3% had missing responses for age). 87% currently had children living at home. Fifty-nine of the participants were women and three were men.

6.2.2 Context-specific effects

The use contexts measured are presented in Table 6.1. In order to test whether there were in fact context specific differences in attribute parameters, the data for all uses were combined and two models were estimated. Model one estimated attribute parameters for the combined data. Model two estimated context specific effects in which interactions between product attributes and use contexts were modelled. In model two, the attributes were coded separately for each of the five contexts. In this analysis the coefficient for use context five was zero, and acted as the reference level. Coefficients for contexts one to four had values relative to use five, multipurpose use.

Table 6.1 Contexts used as response measures in experimental choice studies

Context	Use
Use 1	For eating by itself (expected liking)
Use 2	For cooking & baking
Use 3	For children
Use 4	For dessert
Use 5	For multipurpose household use

Model two accounts for significantly more variance. The coefficients in the model are dissimilar across contexts, suggesting that the more complex model is a better representation of the data. The difference in -2-log likelihood between model 2 and model 1 was 447.236 (model 2) - 69.469 (model 1) = 377.767, distributed χ^2 with 20 - 8 = 12 df ($p < .0001$), indicating that the attributes do vary across contexts and this supports the separate analyses by use context.

6.2.3 Analysis by attributes

Main effects model

The impact of product attributes on label evaluations for each of the use contexts was firstly assessed using a main effects model. Analysis of the pooled data is based on 496 observations (62 participants x 8 choice sets). The log likelihood tests for the main effects models were all significant ($p < .0001$ for uses one to four; $p < .01$ for use five).

Table 6.2 Attributes and levels manipulated in choice experiment

Level	Sweet	Fat	Message 1 (no additives)	Message 2 (Acidophilus)
0	Unsweetened	Non-fat	Absent	Absent
1	Sweetened	Full-fat	Present	Present

Sweetness had the greatest impact on preferences. Sweetened yoghurt was thought more appropriate for eating by itself, for dessert and for children, and unsweetened thought more appropriate for cooking and multipurpose use. However, the magnitude of the preferences differed across contexts, as seen from Table 6.3.

Table 6.3 Relationship between attributes and uses of yoghurt from Label main effects model analysis

	Parameter estimates (± standard error)			
Use	Sweet	Fat	Message1	Message2
1 By itself	1.40 (0.11) ***	0.29 (0.10) **	0.04 (0.15)	0.12 (0.15)
2 Cooking	- 1.34 (0.11) ***	- 0.06 (0.10)	0.12 (0.14)	0.13 (0.16)
3 Children	0.49 (0.10) ***	1.16 (0.10) ***	0.01 (0.14)	0.15 (0.15)
4 Dessert	1.01 (0.10) ***	- 0.04 (0.10)	0.01 (0.14)	- 0.03 (0.15)
5 Multipurpose	- 0.24 (0.10) **	0.06 (0.10)	0.14 (0.13)	0.42 (0.15) **

** $p < .01$
*** $p < .001$

Full fat yoghurt was preferred for eating by itself and for children, where it had a greater impact on choices than sweetness. None of the parameters for the 'no additives' message (mess1) were significant, and acidophilus was significantly preferred only for multipurpose use.

These main effects however could not provide any information on whether the effects depended on the presence of other factors.

Attribute interaction model

An expanded model including attribute interactions was fitted to see if the interactive terms added significantly to the main effects model. For the log likelihood ratio test, the difference in -2 log likelihoods between the two models with an extra five degrees of freedom would have to exceed 11.07 for significance at $p < .05$. Only for use by children did the extra terms add significantly to the base model. The difference between the models (165.442 - 149.785 = 15.657) was significant at $p < .01$. Examination of the parameters showed a significant ($p < .001$) interaction between sweet and fat. Full fat products were preferred over non-fat products overall, but for sweetened products there was less difference in preferences between full fat and non fat than for unsweetened products.

For multipurpose use (use five) there was also a sweet*fat interaction ($p < .05$). There was no difference in choices between unsweetened and sweetened for non-fat products but for full-fat products, unsweetened was much preferred to sweetened.

The non-significance of many of the effects in the main and interaction models could have been the result of a lack of consensus amongst participants with respect to the perceived appropriateness of attributes. To investigate the possibility that variations in choices were partly explained by interactions between product attributes and participant characteristics, models including these interactions were estimated.

Interactions between attributes and participant variables

The appropriateness of different product features may conceivably be perceived differently for consumers with prior experience of the particular product. To investigate this further, analyses were conducted including participant usage variables. Participants who regularly used natural yoghurt (a few times a month or more) were classed as "users", and participants who very rarely or never used natural yoghurt (a few times a year or less) were classed as "non-users". For use one (eating by itself), participants were grouped on the basis of their personal consumption of natural yoghurt. For uses two to five they were grouped on the basis of their household use of natural yoghurt. Some consumers regularly bought yoghurt products but did not directly consume it themselves - it was purchased for other household members or used for cooking or other purposes. Data on the final numbers in each group are given in Table 6.5. In the analysis, new variables were created for participant usage, one for each attribute (Usweet = user*sweet; Ufat = user*fat; Umess1 = user*no additives; Umess2 = user*acidophilus).

For expected liking for eating yoghurt by itself, the likelihood ratio test showed that there was a significant improvement over the basic main effects model, 209.360 - 192.244 = 17.116 with 8 - 4 = 4 df, $p < .005$. For functional cooking uses, there was no improvement over the base model, suggesting that consumers, whether familiar with the product or not, have similar perceptions of appropriateness for cooking and baking purposes. Use three (for children) had significant attribute interactions, and user interactions further improved the base model (182.539 - 165.442 = 17.097, with 18-9 = 9 df, $p < .05$. The use four (dessert) and use five (multipurpose) user interaction models also explained more variance over the main effects model, (use 4: 139.039 - 102.998 = 36.041, with 8-4 = 4 df, $p < .001$; use 5: 60.416 - 15.609 = 44.807, with 8-4 = 4 df, $p < .001$). The nature of these user interactions is described in conjunction with the final model results.

Effect of health concern

Data for participants' health concerns were obtained from ratings on a 7-point ten-item scale on food and health related issues. This scale is presented in Table 6.4. Internal consistency (Cronbach's alpha) for the scale was 0.92.

The overall mean for the total scale was 48.79 with a standard deviation of 10.5, and a range between 21 and 69. Thirty-three participants were classed as having high health concern (those scoring 49 and over) and twenty-nine were classed as having low health concern (those scoring 48 and under). Cross tabulations of the data for user status and health concern are presented in Table 6.5.

Table 6.4: Health concern scale

	Item mean	s.d.	Item-total correlation	Alpha if item deleted
The amount of salt in my diet	4.27	1.93	0.67	0.91
The amount of fat in my diet	5.47	1.51	0.62	0.91
Artificial colourings & flavourings	5.03	1.76	0.84	0.90
The amount of cholesterol in my diet	4.98	1.60	0.57	0.91
Organically produced food	4.21	1.83	0.59	0.91
Getting enough vitamins and minerals	5.40	1.54	0.71	0.91
The amount of sugar in my diet	4.97	1.76	0.78	0.90
Preservatives in my food	4.97	1.69	0.84	0.90
The risk of dietary related diseases	4.81	1.71	0.84	0.90
Gaining weight	5.69	1.67	0.45	0.92

s.d. = standard deviation

Table 6.5: Participant numbers for personal & household usage of yoghurt and classification of participants' health concerns

Personal Usage				Household Usage			
Health Concern	**Non-user**	**User**	**Total**	**Health Concern**	**Non-user**	**User**	**Total**
Low	19	10	**29**	**Low**	19	10	**29**
High	20	13	**33**	**High**	19	14	**33**
Total	**39**	**23**	**62**	**Total**	**38**	**24**	**62**

In order to examine interactions between attributes, participants usage of the product and their general health concerns, all variables and interactions were entered into the model. A backwards elimination process was then conducted to find the best fitting model, by selecting effects that contributed to improvements in log likelihood. The models were tested against the previous models for improvement in log-likelihood and non significant terms deleted. A significance value of $p < .05$ was the basis of decisions on whether terms were to be retained in the model, and all main effects were automatically included in all subsequent models.

Final model

The final model, along with main effects, attribute interaction and user interaction models for each use context is shown in Table 6.6.

For cooking, the more complex models did not explain significantly greater variation in preferences. There was however a small interaction effect ($p < .05$) of sweetness and the no additives message which differed between users and non-users. For unsweetened products there was no difference in preferences between users and non-users when there was no message. But when the no additives message appeared on sweetened products this improved preferences for non-users but decreased preferences for users.

For all other use contexts, the user interaction models explained significantly more variance. Health concern effects were complex in that they interacted with user and attribute interactions to influence choices. The health concern and usage effects can be better understood by examining the total utilities (overall value to the consumer) for each of the groupings for different attribute "bundles". This is done by adding up the part-worths for each of the attributes in each alternative, taking into account any interactions in the final model, for the appropriate participant groupings.

For use one, eating by itself, there was a user-health concern interaction with sweetness, illustrated in Figure 6.1. It is clear that there are major differences between sweetened and unsweetened yoghurts for both user groups. Both preferred sweetened yoghurt.

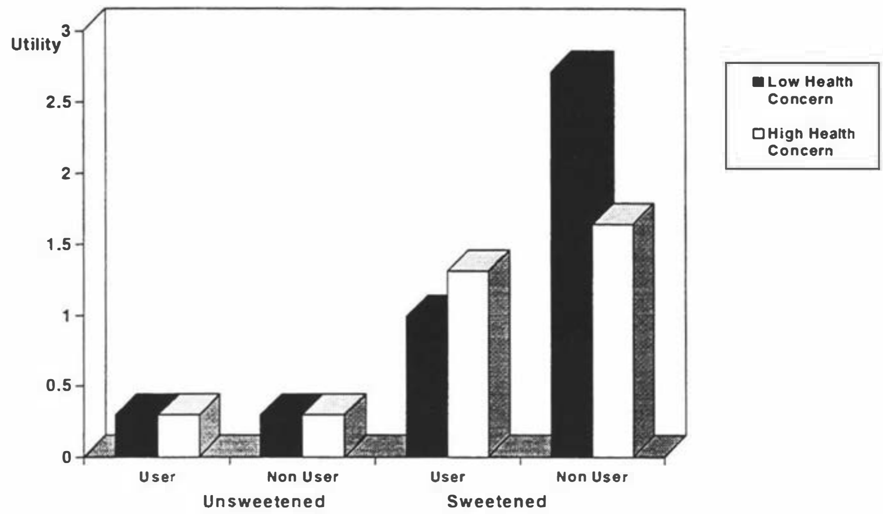

Figure 6.1: Utilities for Label use context 1 (eating by itself) - Sweetness type *user group interaction for full-fat products

However, whereas all participants scored the same for unsweetened yoghurt, the non-users showed a much greater positive response to sweetened yoghurt compared to users.

On the basis of the total utilities (u), non-users with low health concern had a much wider gap between preferences for sweetened and unsweetened full-fat products, sweetened (utility = 2.71) being preferred over unsweetened (utility = 0.29). For users with low health concern this gap is much smaller, although sweetened (utility = 0.99) is still preferred over unsweetened (utility = 0.29). For non-fat products the pattern is the same. A full set of results from the PHREG analysis for the use one final model is attached in Appendix I.

Use context three, for children, showed a difference in preferences for fat content according to usage and health concern. Users had a higher utility for unsweetened full fat products than for sweetened full fat. There was a much greater gap in preferences for full-fat sweetened products between users (u = 0.41) and non-users (u = 2.05) having low health concern. While non-fat unsweetened was uniformly thought not appropriate for children, non-users had a higher utility for non-fat sweetened products than users, irrespective of their health concern grouping.

For dessert use, users were significantly more likely to choose unsweetened and full-fat products than non-users. There was a significant sweet-fat interaction by user ($p < .05$). This is illustrated in Figure 6.2.

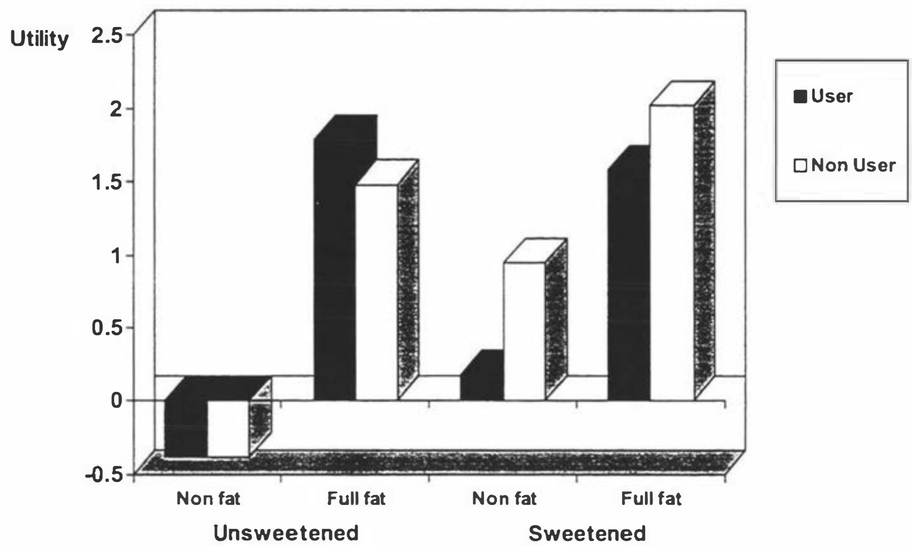

Figure 6.2: Utilities for Label use context 4 (dessert): Sweet*fat interaction by user group

Users prefer unsweetened full-fat (u = 1.79) over sweetened full-fat (u = 1.58), whereas non-users prefer sweetened full-fat (u = 2.02) over unsweetened full-fat (u = 1.48). Both users and non-users prefer sweetened non-fat over unsweetened non-fat (u = -0.38 for both groups), although this preference is much stronger for non-users (u = 0.95) than users (u = 0.18).

For multipurpose household use (use five), sweetened yoghurt was preferred overall (0.70, $p < .001$), although users thought unsweetened more appropriate (-1.25, p <

.001), and those participants with high health concern were also more likely to choose unsweetened (-0.89, $p < .001$).

There was a significant preference for yoghurt labelled 'acidophilus' (0.47, $p < .01$) for household use, and there was a significant interaction of fat content with user by health concern. Non-fat was preferred over full-fat for sweetened yoghurts for all groups except non-users with low health concern.

.0001), and those participants with high health concern were also more likely to choose unsweetened (-0.89, $p < .0001$).

There was a significant preference for yoghurt labelled ‘acidophilus’ (0.47, $p <.01$) for household use, and there was a significant interaction of fat content with user by health concern. Non-fat was preferred over full-fat for sweetened yoghurts for all groups except non-users with low health concern.

Table 6.6 Analysis of Label effects for the five use contexts: Parameter estimates for main effects, attribute interaction, user interaction and final models

Model	Main effects model	Attribute interaction model	User interaction model	Final model
Use 1 (eating by itself)				
Sweetness	1.40***	1.49***	1.80***	1.72***
Fat	0.29 **	ns	0.44 **	0.29 **
User*sweetness			- 0.94***	-1.02***
User*HC*sweetness			ns	0.69 **
Likelihood ratio test		ns	20.116***	7.192 **
Use 2 (cooking)				
Sweetness	-1.34***	-1.37***	-1.21***	-1.35***
Fat		ns	-0.51 *	ns
User*Sweetness*M1			ns	- 0.91 *
Likelihood ratio test		ns	ns	ns
Use 3 (children)				
Sweetness	0.49***	0.96***	1.25***	0.97***
Fat	1.16***	1.25***	1.29***	0.70 **
Sweetness*fat		- 0.36 **	- 0.32 *	- 0.38 **
User*sweetness			ns	- 0.81***
User*HC*fat			ns	0.80 ***
Likelihood ratio test		15.657 **	17.097 *	ns
Use 4 (dessert)				
Sweetness	1.01***	1.27***	1.52***	1.56***
Fat		ns	- 0.29 *	- 0.39 *
User*sweetness			- 1.12***	- 1.14***
User*fat			0.55 **	0.68 **
User*Sweetness*Fat			- 0.51 *	ns
Likelihood ratio test		ns	36.041***	4.675 *
Use 5 (multipurpose)				
Sweetness	- 0.24 *	ns	0.24 *	0.70***
Acidophilus	0.42 **	ns	ns	0.47 **
Sweetness*fat		- 0.22 *	ns	ns
User*sweetness			-1.27***	-1.25***
HC*sweetness				- 0.89***
User*HC*fat				0.69 ***
Likelihood ratio test		ns	44.807***	30.305***

* p < .05
** p < .01
*** p < .001
ns = not significant

HC = health concern
M1 = Label message 1: no additives

6.3 Results -Blind tasting

To ascertain whether there were context specific effects, the data for all five contexts were combined, and two models estimated, one with the pooled data and one with separate attribute-context interactions. A likelihood ratio test (69.363 (model 2) - 29.821 (model 1) = 39.542, 4 df, $p < .0001$), confirmed there were differences in parameters over contexts.

The use contexts were then analysed separately. The main effects for the five use categories are shown in Table 6.7.

Table 6.7: The relationship between main effects and the five use categories for blind tasted yoghurt samples

	Parameter Estimates & standard errors				
	Use 1 Eating by itself	Use 2 Cooking	Use 3 Children	Use 4 Dessert	Use 5 Multipurpose
Sweetness	1.27 (.30)***	- 0.90 (.28)***	1.41 (.32)***	1.43 (.32)***	0.13 (.25)
Fat	- 0.19 (.25)	0.07 (.28)	- 0.10 (.25)	- 0.60 (.27) *	- 0.26 (.26)

* p < .05
*** p < .001

Sweetness had the most significant influence on choices for all uses in the blind taste testing. Fat had a significant effect only for use four (dessert). There were no significant sweet*fat interactions.

User and health concern variables were then introduced into the model and results are presented in Table 6.8.

Table 6.8: Attribute and user effects for the five use categories for blind tasted yoghurt samples - final model

Effect	Use 1 Eating by itself	Use 2 Cooking	Use 3 Children	Use 4 Dessert	Use 5
Multipurpose					
Sweetness	1.27 (.30) ***	- 0.90 (.28) ***	3.50 (0.91) ***	2.11 (.53) ***	0.86 (.36) *
Fat				- 0.60 (.26) *	
User*sweetness			- 1.82 (.76) *	- 1.36 (.68) *	- 1.80 (.57)**
HC*sweetness			- 1.70 (.86) *		
HC*fat	- 1.29 (.53) *				

*   p < .05
**   p < .01
*** p < .001
HC = Health concern

For uses three, four and five, regular users were more likely than non-users to choose unsweetened products. Participants with high health concern were also more likely to choose unsweetened products for children.

There was an interaction between health concern and fat content in use one. Participants with high health concerns were more likely ($p < .05$) to prefer low fat products than participants with low health concern. For unsweetened products, the total utility for non-fat was 0.00 for both groups. The utility increased to 0.46 for full-fat products for those with low health concern and decreased to -0.83 for participants with high health concern. For sweetened products the utility for non-fat for both groups was 1.27. For full-fat products the utility increased to 1.73 for those with low health concern, while it was just 0.44 for those with high health concern This is illustrated in Figure 6.3.

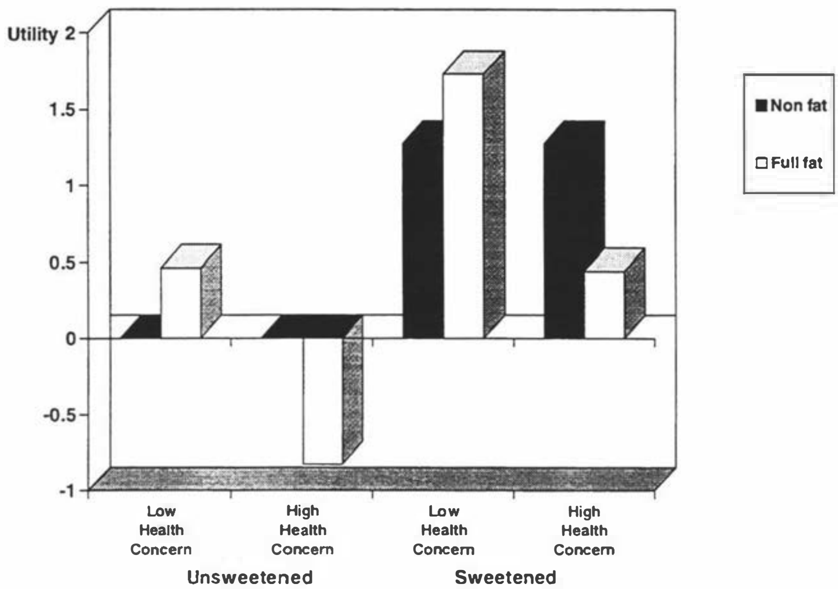

Figure 6.3: Utilities illustrating fat*health concern interactions for blind tasted yoghurts

Ratings for blind tasted yoghurts

Ratings of liking for each of the four samples were also made on a 9-point labelled hedonic scale, from dislike extremely to like extremely, without a reference context, before the choice evaluations were made. An ANOVA was performed on ratings, which were significantly different, $F = 2.54$ (64,183), $p < .0001$. The mean ratings are given in Table 6.9. The sweetened yoghurts were liked more than unsweetened and there was no significant preference for full-fat or non-fat products.

Table 6.9 Blind tasting - sample means of yoghurts rated

Product	Mean Rating (n=62)	
Sweetened non-fat	7.05[a]	
Sweetened full-fat		6.63[a]
Unsweetened non-fat	4.73[b]	
Unsweetened full-fat	4.13[b]	

[a,b] Numbers with letter superscripts in common do not differ (LSD, p < .05)

6.4 Results of Phase 2 - Labelled tasting (tasting + information)

6.4.1 Participants

The same participants took part in the labelled tasting phase which was conducted in a separate session after the label and blind tasting phases. The data from five participants were eliminated from the tasting phase because of a labelling error in the second batch of samples which led to non-fat and full-fat products being mislabelled. There were also four participants who had incomplete tasting data, but their data were retained in the analysis.

6.4.2 Context specific effects

In order to test whether there were context specific differences in attribute parameters, the data for all uses were combined and two models estimated; for model one, attribute parameters were estimated for combined data, and for model two context specific effects were estimated.

Model two accounted for significantly more variance than model 1, with the difference in -2 log likelihood being 454.978 (model 2) - 125.927 (model 1) = 329.051, with 20-8 = 12 df, $p < .0001$. This indicated that the attributes varied across contexts, so separate analyses for each use context were conducted.

6.4.3 Analysis by attributes

Main effects

As in the label phase, the impact of product attributes on evaluations for each of the use contexts were firstly assessed using a main effects model. Analysis of the pooled data was based on 435 observations. The -2-log likelihood test for the main effects models for all uses was highly significant ($p < .0001$), indicating a strong relationship between choices and the attributes. The results of the main effects analysis are shown in Table 6.10.

Table 6.10 Relationship between attributes and uses of yoghurt from Labelled tasting - main effects model analysis

	Parameter estimates (± standard error)			
Use	**Sweetness**	**Fat**	**No additives**	**Acidophilus**
1 Eating by itself	1.25 (0.12) ***	-0.38 (0.11) ***	-0.10 (0.15)	0.14 (0.16)
2 Cooking	-1.47 (0.12) ***	-0.28 (0.11) **	-0.01 (0.15)	0.26 (0.18)
3 Children	1.18 (0.12) ***	0.44 (0.11) ***	0.18 (0.15)	0.37 (0.16) *
4 Dessert	1.26 (0.12) ***	-0.20 (0.11)	-0.04 (0.15)	0.21 (0.16)
5 Multipurpose	0.18 (0.10)	-0.31 (0.10)**	0.03 (0.14)	0.44 (0.16) **

* $p < .05$
** $p < .01$
*** $p < .001$

Attribute interaction model

An expanded model including attribute interaction terms did not add significantly to the base model for any of the use contexts when tested with the likelihood ratio test. There were however significant sweet-fat interactions for use two (-0.37, $p < .01$), use three (-0.32, $p < .05$) and use five (-0.26, $p < .05$), indicating that there were differences between preferences for full-fat and non-fat according to sweetness type (See Table 6.11).

Interactions between attributes and participant variables

For all contexts, user interactions added significantly to the basic main effects model. Where there were sweet-fat interactions, these were also added into the model. For use one, eating by itself, the likelihood ratio test, 160.864 - 143.529 = 17.335, with 8-4=4 df, was significant at $p < .005$. For use two, cooking, it was just significant at $p < .05$, (200.709 - 186.268 = 14.441, with 8-4=f df). For use three, for children, 223.098 - 133.898 = 89.200, with 9-4=5 df, $p < .001$. For use four, dessert, 180.693 - 139.646 = 41.047, with 8-4=4 df, $p < .001$, and for use five, multipurpose, 58.706 - 23.505 = 35.201, with 9-4=5 df, $p < .001$). Health concern interactions were then entered into the model and a final model fitted (See Table 6.11).

Table 6.11: Analysis of Labelled Tasting effects for the five use contexts : parameter estimates for main effects, attribute interaction, user interaction and final models

Model	Main effects	Attribute interactions	User interactions	Final model
Use 1				
Eating by itself				
Sweetness	1.25 ***	1.08 ***	1.61 ***	2.32 ***
Fat	0.38 ***	-0.65 **	-0.31 *	-0.39 ***
User*sweetness			-0.90 ***	-0.87 ***
HC*sweetness			ns	-1.15 ***
Likelihood ratio test		ns	17.335 **	18.543 ***
Use 2				
Cooking				
Sweetness	-1.47 ***	-1.63 ***	-1.31 ***	-1.34 ***
Fat	-0.28 *	-0.57 *	-0.42 **	-0.46 ***
Sweetness*Fat		-0.37 **	-0.38 **	-0.37 **
User*sweetness			-0.66 *	-0.57 *
Likelihood ratio test		ns	14.441 *	ns
Use 3				
Children				
Sweetness	1.18 ***	1.47 ***	2.19 ***	2.59 ***
Fat	0.44 ***	0.55 *	ns	0.59 ***
Acidophilus	0.37 *	ns	ns	ns
Sweetness* fat		-0.32 *	ns	-0.34 **
User*sweetness			-1.98 ***	-2.00 ***
User*fat			0.49 *	ns
User*acidophilus			0.65 *	0.55 *
HC*sweetness				- 0.60 *
Likelihood ratio test		ns	89.200 ***	ns
Use 4				
Dessert				
Sweetness	1.26 ***	1.06 ***	1.97 ***	2.62 ***
Fat	ns	-0.45 *	ns	ns
User*sweetness			-1.51 ***	-1.42 ***
HC*sweetness			-1.24 *	-1.09 ***
Likelihood ratio test		ns	41.047 ***	19.017 **
Use 5				
Multipurpose				
Sweetness	ns	ns	0.63 ***	1.35 ***
Fat	-0.31 **	-0.43 *	-0.36 **	- 0.33 **
Acidophilus	0.44 **	ns	ns	0.37 *
Sweetness*fat		-0.26 *	-0.25 *	- 0.28 *
User*sweetness			-1.16 ***	- 1.02 ***
HC*sweetness			-1.88 ***	- 1.36 ***
Likelihood ratio test		ns	35.201 ***	37.670 ***

* p < .05 ns = not significant
** p < .01 HC = health concern
*** p < .001

Final model

The final model is presented in Table 6.11. User interactions explained significantly more variance for all use contexts over the base model, and the addition of health concern interactions again improved the model for all uses except for cooking and for children.

Sweetness and fat content strongly influenced choices for eating yoghurt by itself, with sweetened being preferred ($p < .001$), although users ($p < .0003$) and those with high health concern ($p < .0001$) were more likely to prefer unsweetened. Non-fat was preferred over full-fat (p .001).

Unsweetened yoghurt was preferred for cooking and baking, ($p < .0001$) and this effect was stronger for users ($p < .05$). Non-fat ($p < .0005$) was preferred over full-fat, although this depended on sweetness type. There was little difference in fat content preferences for unsweetened, but a greater preference for non-fat over full-fat for sweetened yoghurts.

For serving to children, there was a strong preference for sweetened yoghurt ($p < .0001$), although users were more likely to choose unsweetened ($p < .0001$). Full fat was preferred over non-fat but an interaction between fat content and sweetness type showed that this was stronger for unsweetened than sweetened yoghurts. There was a positive effect of the acidophilus label on users ($p < .05$). The total utility for unsweetened full-fat was 0.59 for both users and non-users, but when an acidophilus label appeared, the utility increased to 1.22 for users but remained similar at 0.67 for non-users.

The results for dessert use were similar to use one in that there was an overall preference for sweetened yoghurt ($p < .0001$), but users and those with high health concern were more likely to choose unsweetened ($p < .0001$).

For multipurpose use, sweetened ($p < .0001$), non-fat ($p < .005$) and acidophilus ($p < .05$), were preferred, but again users and those with high health concern were more likely to choose unsweetened ($p < .001$). There was a greater tendency for non-fat to be chosen over full-fat for sweetened yoghurt, but little difference in fat content preferences for unsweetened ($p < .05$).

The inclusion of a question on appropriateness for multipurpose use gave an opportunity to gauge the results that might have been expected if a single choice question on likelihood of purchase had been given. There was far greater variance in choices in the main effects model for use five than for the more specific use contexts. However, when usage and health concern variables were included in the model, much more of the variance was explained. Preferences for sweetened yoghurt were much less pronounced for use five than for the other uses. There was also a significant main effect of the acidophilus label which was not apparent in the final models for the other four uses. This suggests that sensory preference is not the only consideration in choosing a yoghurt for household use and that there are significant individual differences according to the health concerns and product experience of the participants.

6.5 Discussion of results

Label study

In the label study, sweetness type had the most influence on perceived appropriateness. This is in common with studies of many other food products where the key sensory attribute is sweetness (Lahteenmaki & Tuorila, 1997; Drewnowski et al, 1998), even though natural yoghurt is traditionally unsweetened. Sweetened products were preferred overall for all but functional uses, although consumers with prior experience of the product were far more inclined to choose unsweetened products for all uses. As the non-user group had prior experience mainly with flavoured yoghurts which are sweeter, it is more likely that they would be inclined to choose sweetened natural yoghurts. It could be speculated that with increased familiarity with the product this preference may gradually evolve towards unsweetened products. The fact that sweetness type had less effect on overall choices for multipurpose household use indicated that other practical benefits may have more influence for general use. If yoghurt is used for culinary purposes as well as eating, it may be that consumers compromise and choose a product which can be used for both purposes, rather than buying two different products. Information on actual purchasing behaviour may shed light on this, but past research has suggested that flexibility plays a role in purchasing behaviour (Walsh, 1995), and the qualitative research also indicated that some consumers add their own sweetening or accompanying foods to natural unsweetened yoghurt when consuming them at home.

Overall, fat content had less effect on choices than sweetness type, based on information only. As suggested by Kähkönen et al (1997) yoghurt is widely perceived as a healthy food, so information on fat content may not be relevant to consumers for this product. Fat content was however a significant attribute for expected liking for eating by itself and for serving to pre-school children, where full-fat was preferred. For dessert use non-fat was preferred. There was also a sweet*fat interaction for use in serving to children such that full fat was far more likely to be chosen than non fat for unsweetened products only. The ordering of total utilities for each of the attribute combinations for uses one and three showed that unsweetened non-fat products were least preferred by all user groupings. As previous studies have shown that consumers expect to like regular fat products more than low-fat products (Tuorila et al, 1994) it could be that lower sensory expectations of the combination of unsweetened and non fat override any perceived benefits of each of these levels.

The label messages had little direct effect on choices, and only for multipurpose use did the acidophilus label influence choices in the label phase. In the more specific use contexts attention may have been focused on the sensory cues, while for the household use context purchasing considerations may have widened to include other factors. These features might also be expected to appeal to some consumers more than others. One explanation for the relative lack of significant participant/label message interaction effects is that preferences for these features were not adequately captured by the usage and health concern groupings. Another explanation may be that whereas consumers might state that these features are important to them (as in the qualitative studies), when they are forced to make a choice, these features are only considered after sweetness and fat content preferences. For children, the label message ' no additives' might have been expected to have more influence. Shepherd and Raats (1996) however, also found that nutritional issues (sweetness and fat content) were more a focus of concern to mothers overall than additives.

Blind tasting

In the blind tasting, there were context specific variations as in the label phase. The parameter estimates were similar in magnitude and direction to the choices based on label only, including comparable participant effects for uses three, four and five. The only context in which there was a significant preference for non-fat yoghurt was as a dessert, which was the same as choices based on label only. Effects apparent in the blind tasting but not the label only phase were a sensory preference for low fat products for participants with high health concern in use one, and a preference for unsweetened products for serving to children by those with high health concern.

The results for ratings and choices for expected liking were very similar, with sweetened preferred over unsweetened. It should be noted that sensory preferences for the four products were not of primary interest in this research and factors other than the manipulated attributes may have influenced the sensory quality of the samples in this study. It might have been interesting however to have conducted discrimination tests with an independent sample to assess whether differences could be detected between the regular and non-fat products.

Tasting

Sweetness type was more important than fat content in the labelled tasting phase. This result is similar to that of Lähtenmäki and Tuorila (1997), who found that fat content had very little effect on appropriateness ratings of milk drinks in comparison to sweetness, which was a dominant feature. Consumers slightly preferred non-fat products in the labelled tasting, with non-fat preferred for all uses except for children, where full-fat was still thought more appropriate.

Few previous studies have investigated interactions between fat content and other product attributes. In some cases it may be that consumer evaluations of fat content are dependent on other product attributes or features. In the present study there were interactions between sweetness type and fat content for uses two, three and five, which highlights the importance of allowing for interactions to be modelled.

Although sweetened products had a higher utility overall than unsweetened products, regular users of natural yoghurt were less likely to choose sweetened products for all uses. Those participants with high health concern were also less likely to choose sweetened for all uses except cooking, where unsweetened was preferred by participants overall. The acidophilus label influenced choices for household use and for regular users serving natural yoghurt to children.

Linking the phases

The results for the labelled tasting are based on 57 participants not 62 as in the label only and blind tasting. An analysis of the label only and blind tasting results with just the 57 participants who completed the study gave similar results to those based on all 62 participants, and the full data set was retained for the first two phases. The label phase can also be evaluated as a complete study in itself.

When examining the ordering of preferences from the total utilities for each combination of attributes for use one prior to tasting, both users and non-users preferred full-fat sweetened, followed by non-fat sweetened, full-fat unsweetened and non-fat unsweetened. These orderings generally changed after the labelled tasting so that non-fat was preferred over full-fat within both sweetness types. There was a preference for non-fat in the blind tasting by participants with high health concern and it may be that they have a greater familiarity with the taste of low fat foods. However, the preference for non fat after tasting was evident for all participant groupings. It could be that within each sweetness type both samples were almost equally liked by those with low health concern (as shown in the blind tasting), so these participants opted for non-fat products in the labelled tasting, despite their lower general health concerns. In the label only phase there was no strong preference for non-fat, which may indicate that the benefits are considered only after it is established that their sensory quality is acceptable in comparison to full-fat products.

Utilities changed very little across the three phases for cooking. As taste is less likely to be as important for functional uses, choices are more likely to be made from the label only. For pre-school children, sweetened yoghurt became more important after tasting than before tasting for non-users. However, for all groups the most appropriate and least appropriate alternatives remained the same across all phases.

It might be expected that non-users would demonstrate more differences between label and labelled tasting due to their exposure to the product during the course of the study. However this was not the case. Users with high health concern showed the greatest change from label only to labelled tasting in uses one and four, where sensory factors would be expected to be more important. For general household use, participants with high health concern demonstrated the least change across phases, irrespective of their usage status. This suggests that for consumers with high health concern appropriateness for household use is based more on cognitive judgements than purely sensory preferences, whereas other consumers may balance out sensory and non-sensory factors in making their purchase decisions.

Previous studies have shown that overall liking influences appropriateness ratings, such that subjects who find foods pleasant also assess them to be more appropriate in almost all use contexts (Lähtenmäki & Tuorila, 1997). Asking participants to make choices for different use contexts may be a more sensitive measure than ratings of appropriateness, as people are forced to make a decision between products. While inappropriateness is clearly defined and distinct from liking (Cardello & Schutz, 1996), it is more difficult to distinguish between degrees of appropriateness. A measure which is more clearly linked to actual buying behaviour may therefore be more suitable for uncovering perceived differences in appropriateness within product categories than ratings on a 7-point scale.

Further general discussion of the findings is provided in chapter seven, in which the experimental choice methodology is evaluated, limitations of the study outlined and theoretical considerations pertinent to the research are presented.

Chapter seven

DISCUSSION AND CONCLUSIONS

7.1 Introduction

In this final chapter, an evaluation of the experimental choice methodology is presented, followed by a discussion of the more general limitations of the studies. Theoretical issues arising from the research as a whole are then outlined, and practical applications proposed.

7.2 Evaluation of methodology

Experimental choice analysis is a method of modelling consumer choices which closely parallels actual behaviour and therefore has greater validity for consumers than classical rating methods. The objective is to estimate how the probability that a particular alternative is chosen, varies with changes in the level of the attributes characterising that alternative. This methodology was evaluated and applied in this thesis.

Use of experimental choice analysis, also referred to as choice-based conjoint analysis, is still very new and for this reason the strengths and weaknesses of the method are not well documented. Substantially more work has been published on revealed preference discrete choice analysis but these do not easily translate to experimental studies, and more research is needed on the statistical properties and model structures used in experimental choice studies. There is some lack of consensus about the most appropriate methods of design and analysis and many of the issues are unresolved (Batsell & Louviere, 1991; Carson et al, 1994). However, the method's basis in random utility theory provides both a behavioural theory and a statistical theory for analysing choices, which is the same no matter what the source of the data (Louviere, 1994).

Design theories for experimental choice designs are still very new and a comprehensive set of designs has yet to be developed. Because both alternatives and choice sets rely on experimental design, the design process is more complicated than conjoint analysis, and most of the recent work in constructing choice designs has been for branded products. As the elements of any choice experiment are many and varied, it is often not possible to construct "the best" experimental design. As illustrated in the present research design, there have to be trade-offs between data collection limitations, realistic choice scenarios, model specifications, level of analysis required and statistical efficiency (Carson et al, 1994). Further work on efficient design strategies would be welcomed.

Analysis using PHREG is straightforward and easy to interpret, although the data manipulation required can be complex. The MNL model estimated using PHREG allows for repeated measurements, which departs from the normal assumptions of independent observations in other traditional methodologies. This may mean that the estimates do not fully account for the correlation in responses within individuals but the parameter estimates appear to be consistent and this has not been a problem in practice (Batsell & Louviere, 1991; Kuhfeld, 1996). More research on estimation efficiency would be of benefit in this area.

A traditional method of classifying consumers on the basis of their actual choices is discriminant analysis, which attempts to interpret the pattern of differences. Discriminant analysis is closely allied to multinomial logit analysis, but MNL doesn't require the simplifying assumptions of discriminant analysis and is therefore more robust, and is more suitable for experimental data.

The Independence of Irrelevant Attributes (IIA) property has sometimes been a limitation in experimental choice analysis. In the present study there was no reason to believe that there would be any IIA violations other than heterogeneity of data as there were distinct alternatives and no branding effects. Participant variables were included in the design and this would have helped eliminate any IIA violations due to heterogeneous subject preferences (Louviere et al, 1992, cited in Louviere, 1994). This method allows for a number of individual difference variables to be incorporated. Probabilities of choice and/or utilities can be calculated for different combinations of participant variables, which can be useful for segmentation purposes as well as giving insights into choice behaviour. This method of incorporating individual differences was thought to be more suitable in the present research than post hoc segmentation methods. For marketing purposes there may be merit in finding consumer segments. This can still be achieved in experimental choice analysis by methods such as multiple correspondence analysis of choices, followed by cluster analysis.

There are many uncertainties about appropriate aggregation and segmentation methods in conjoint and choice analysis. Although there are various modelling approaches to heterogeneity, there is an absence of research about the conditions under which heterogeneity may occur (Brascamp, 1996) and the most appropriate way to deal with it. In the current study, the results suggest that responses are less variable for some use contexts than they are for others and this may prove a sound basis for relevant future research.

Experimental choice analysis, as an extension of conjoint measurement, has much appeal. As the method relies on qualitative responses, the realism of the task is greater than metric scaled evaluations, and the quality of information obtained is arguably better than for conjoint analysis. The method is well suited to investigating consumer oriented approaches to food choice, as represented in the framework presented in chapter four.

The present study extended previous research by modelling attribute interactions. The vast majority of conjoint and choice studies use main effects designs and do not include any interactions (Batsell & Louviere, 1991; Louviere, 1994). Unless interactions are modelled, the possibility of higher effects cannot be ruled out. In food choice research where complex product attributes are involved, errors in model specification may lead to erroneous conclusions and ultimately wrong product decisions. Product features which seem to have little influence on consumer choices may have an effect only in conjunction with other attributes, or may have totally different effects for different levels of another attribute. In the present research, the main effects results indicated that the dominant attribute was sweetness. However, there were interactions between sweetness and fat which gave greater insights into consumer choice patterns. The inclusion of interactions may provide important information on the joint effect of sensory and non sensory factors. This may have substantial implications for product design and/or promotional strategies.

Extension of the method to research including a sensory component involves some special issues over and above standard pencil and paper choice problems. There are severe limitations in the number of choice sets which can be presented to consumers, restricting the number of attributes which can be incorporated. Possible solutions are splitting the data collection over several sessions, or using incomplete designs where not all subjects evaluate all choice sets. These strategies may however cause problems related to the practical difficulties of sample consistency, participant recruitment and motivation. These are often limitations in traditional sensory research, but solutions to these problems in sensory research using panels are often not appropriate or feasible for consumer research. The nature of the product to be evaluated may also not lend itself to the choice set presentation format (eg wine or highly seasoned foods), and sensory fatigue must also be considered. The data collection is subject to some complex sensory effects but in the current study the design was balanced for carry-over and presentation order effects to minimise these.

Much more research needs to be conducted to be able to evaluate the potential application of multinomial choice models to consumer research including sensory evaluation. The work in the current study was a preliminary attempt to assess the feasibility of such a technique for extending to such research. This has highlighted the practical aspects of designing a choice study and some of the problems in analysing such data. The methodology is flexible enough to adapt to the varying needs of consumer studies, but further investigations are needed to compare the merits of experimental choice analysis with traditional research methods. However, given its foundations in psychophysics, the applicability of probabilistic choice models to sensory consumer research is promising.

Caution must be exercised in comparing data from the different phases in the present research. There have been very few guidelines on how to deal with within-person correlation of responses both within and across data sets in experimental choice studies (Ben-Akiva et al, 1994), and there was no allowance in the analysis of the current study to deal with carry-over effects due to the interrelatedness of the data. Whether evaluations from the three phases can be thought of as structurally the same is a consideration for sequential choice studies such as these. One method of assessing this might have been to have participants rate the importance of the attributes after the different phases to assess whether rescaling might be required. There are several complications with this. Consumers tend to rate every product feature as very or somewhat important, and this is a problem with survey data which asks consumers to rate the relative importance of product features, as there is no need to "trade off" one attribute against another. A more severe limitation is that because interactions between factors were expected, the importance ratings would not have given useful information. Just as a main effects design may misrepresent the estimates of factors where there are interactions because the main effect estimate may include part of the interaction estimate, self rated importance ratings may also misrepresent the consumer's actual reponses. Combinations of factors may have been presented but this would have added substantially to the tasks asked of participants which were already considerable.

A combined model was considered for the present research, using a joint design to manipulate labels and product formulations. There were several problems with this. Firstly, the face validity of the design was paramount as the choice tasks had to be realistic and logical for participants. There was also the question of whether the data from the different choice tasks may have different levels of uncertainty and bias due to the different methods of data collection. In addition, it was thought, considering the exploratory nature of the research methodology used, that a simpler three-stage model would give more information.

As there is a growing trend towards integrating sensory research with market research, further exploration of conjoint and choice analysis methodologies in which sensory assessment is a part, will be important to assess the trade-offs between cognitive and sensory attributes (MacFie, 1996). There are however a number of statistical issues which warrant further investigation in the application of experimental choice analysis before there may be full confidence in the appropriateness of the technique for studies including consumer sensory evaluation of products.

Qualitative work prior to the design of the study is essential for the development of valid experimental choice studies (Batsell & Louviere, 1991). An adaptation of the repertory grid procedure was very effective in the present research, as it focused specifically on the factors that influence choices. This was complementary to the experimental choice study and allowed a thorough assessment of the factors underlying food choices. The choice based repertory grid procedure was found to be effective in eliciting contexts of use and attributes influencing appropriateness for different uses, as it allowed the relevant contexts of use to be elicited in a natural and non-directive way. Whereas the inclusion of realistic choice contexts is recommended for choice studies, the present studies investigated in more depth differences in the appropriateness of the products for different use contexts. This approach offers researchers a way of more fully understanding consumer perceptions of products.

7.3 General limitations

The limitations associated with this research have been emphasized in the summary of results in chapter six and throughout the evaluation of methodology in the previous section. These mainly relate to the lack of knowledge of experimental applications of the multinomial choice model in investigating consumer choice behaviour.

More specific limitations in the current study must be mentioned. A simple application of experimental choice analysis was described in this thesis and the specific details of the results are less important than the general approach. As a small non-representative sample was used, the results cannot represent the general yoghurt consumer population, as this was a very limited demographic group. The small number of participants may have had substantial implications on estimation, and a much larger sample would be recommended for future studies. The sample size for discrete choice modelling depends on the values of the unknown parameters in contrast to standard linear regression (Ben-Akiva & Lerman, 1985), and sequential studies which build on previous results should be used as a basis for ongoing research.

Another limitation was in the selection of variables for the study, and interpretation of results should be made with due consideration of the potential influence of other factors not included. However, this was predominantly an illustrative study. It was decided to include only intrinsic product attributes and not attributes of the marketed product. There is no doubt, from previous research and the qualitative studies in the current research, that brand name, package design and price are influential for consumer choices, but these were outside the scope of this experimental study. These could be studied in a discrete choice study of actual purchases, but it would not be possible in such a study to manipulate attribute levels and there would be correlations between attributes. As both types of studies can contribute valuable information, a more inclusive picture of consumer choices could be obtained by synthesising observed and hypothetical preferences in a single combined model.

A limited number of attributes could be studied in the current research and this may also be a constraint in similar research efforts. For large numbers of attributes the task very rapidly becomes unmanageable. One way of handling a larger number of attributes than can be accommodated in a single design is to design several sub-experiments, each consisting of sets of attributes which may logically be grouped together (Oppewal et al, 1994). The sub-experiments are analysed separately, but a single choice model can also be estimated by combining the separate experiments.

For some choices there are factors influencing choices which are fundamentally different in character to other factors (Wedel et al, 1998). Some of these factors may be more abstract in nature. For example, "thirst-quenching" or "refreshing" (McEwan & Colwill, 1996) are different in character to the sensory attributes "sweet" and "fruity". There may be an interrelated hierarchy of choice (Ben-Akiva & Lerman, 1985), and the more abstract factors may be evaluated in a separate phase prior to attribute profiles.

In the present research, a hierarchical structure may have more adequately modelled the choice task. As the label statement attributes had little effect on choices compared to the sensory attributes in both phases, it may be that sensory attributes such as sweetness type and fat content could be evaluated in a separate experiment, followed by label attributes such as acidophilus, no additives, organic and calcium-enriched. The two experiments could then be concatenated to estimate an overall choice model. This would also allow more conceptual attributes to be modelled along with a few key sensory attributes. One reservation with this is that these models to date have been demonstrated using main effects models (Oppewal et al, 1994), and as indicated by the present research the modelling of interactions may be critical. The strategy does permit the inclusion of selected interactions but this would need to be tested more fully. There are still many empirical issues to resolve in the application of these hierarchical models, but they could provide a worthwhile approach, especially in the context of sensory consumer research problems.

The findings indicated that there were variations in perceived appropriateness across use contexts. These effects may have been inflated because of the way the data were collected, as participants were asked to evaluate each choice set for each of the five use contexts at one time. However, the results were consistent with prior studies and there was no reason to believe that participants would not make similar choices if the data for each use context were collected separately.

Additional methodological and theoretical implications are discussed in the following section.

7.4 Theoretical issues

The present research concentrated on the choices made by consumers. The cognitive processes by which consumers arrived at these choices were not investigated. There were however theoretical considerations which arose particularly during the design stages and this section provides a discussion of these.

One of the problems in the design of food choice studies is that prior experience and information have a substantial influence on both food choices and the sensory evaluation of foods. As demonstrated by the results in the present study, differences in experience with the specific product under investigation need to be incorporated, or at least acknowledged. However, as pointed out by Alba and Hutchinson (1987), there are different dimensions of consumer experience. Consumers may have familiarity with the product, defined as "the number of product related experiences that have been accumulated by the consumer", but product expertise is also important. Product expertise refers to the ability of the consumer to "perform" product related tasks, such as differentiate between products, analyse information, remember information and elaborate on that information. These are all likely to increase as product familiarity increases, but this is not always the case. Product use has generally been measured in food studies as frequency of purchase or use. However, frequent users may habitually buy one particular product and not compare different products or be knowledgeable about the product features. Therefore they have high familiarity but low expertise. On the other hand, non users may have engaged in an information search on the product and be knowledgeable about it, so they may have low familiarity but high expertise.

The methodological implications of this are that measures of consumer usage may not accurately measure the extent to which knowledge influences choices, leading to unexpected results. In the present study this was very relevant, as all participants had some experience with the product category, but it is possible that "non-users" of natural yoghurt had more expertise about the features than "users" through their experience with flavoured yoghurt. There were three ways of dealing with this in the research design. Measurement of health concern was a way of considering alternative user effects, although this too may not have fully captured the complexity of consumer knowledge. An explanation sheet was also given to all participants before the study commenced, which outlined the attributes and explained the levels and terminology. Finally, because product experience may also be intertwined with consumer usage, information on product usage was gained separately for personal and household use so that the groupings reflected more of the participants' product experience relevant to each use context. If consumers search out different product variants for different uses, their knowledge is likely to be greater than consumers who use one product for all uses.

In the present study, the choice model captured choices at one point in time. However, consumer evaluations are made in the context of an individual's existing food cognitions, built up over a lifetime, and as previous experience and information (and interpretation of that information) builds at each choice event, the choice can also be viewed as part of a dynamic choice process for each individual (Kaul & Rao, 1995). Consumption of the product or a similar product on a previous occasion, or information gained by direct or indirect means may all have an effect on a consumer's perceptions or preferences for product attributes and subsequently the choice made, as depicted in the framework in figure 4.1 in chapter four. In future research, longitudinal studies of new products or new users may shed more light on the temporal processes and possible individual differences involved in repeated product choices.

Fundamental to the above discussion is the point that food choices are made partly on the basis of remembered sensations and anticipated sensations, as pointed out by Rozin & Tuorila (1993) . Memory of the sensory properties of a food will affect future expectations. While a great deal of work has been done on food expectations (Cardello, 1994; Deliza & MacFie, 1996), very little work has been done on the role of memory in food choices. Similarly, very little research has been done on temporal hedonic processes, such as the prediction of future preferences (Rozin & Tuorila, 1993) Hedonic beliefs may be interconnected with usage factors, and the importance of product features may differ between immediate consumption and future uses. While some general work on temporal effects in the area of hedonic decision making has been conducted by Kahneman and Snell (1992) which could well have applications to food choice research, the whole area of hedonic psychology has been somewhat ignored. As McBride (1990) points out, it is an area of research which "does not fit neatly into established research categories" and is "not well accommodated" by either psychology or food science. What therefore is the best way to deal with temporal cognitive effects? In the current study there was no intention to explicitly investigate cognitive processes such as expectation and memory effects, but they were considered in the design. Consumer choices were therefore assessed firstly on the basis of existing food cognitions by presenting information only before any tasting occurred, to correspond with the design framework in figure 4.1.

It is unclear to what extent the decision-making protocol used by participants to evaluate the hypothetical choice sets might differ from that used in a real choice situation because of the oversimplification of the choice experiment compared to real choice contexts (Ben-Akiva & Morikawa, 1990), but the form of response in the present study, i.e. appropriateness for different use contexts, may have been more likely to generate realistic responses than a preference evaluation.

The importance of context was emphasized in this research because it is essential to understand the meaning of any given choice event. In much of the research literature the role of context is acknowledged yet it is rarely defined and described, and even less incorporated in the research design in any form. Context can be thought of as primarily cognitive in nature or primarily physical in nature (Achterberg, 1988), and there are likely to be many different levels of context all interacting. It is not an easy concept to come to grips with. However, as suggested by Achterberg (1988), context can work functionally as a cue or as a controlling or governing factor, and this may be a useful first step in narrowing down the dimensions of interest for a particular study. The incorporation of multiple use contexts to measure choices in the current study was such an attempt. This can help to differentiate the importance of context in consumer choices between product variants.

Relevant use contexts in the present research were elicited in a series of qualitative studies and a use context classification developed (Table 4.3). This classification structure can be applied to other food items and could be used to investigate further the relationship between food choices and use contexts. Several of these dimensions may be relevant in any food purchase situation or a series of interrelated context decisions may operate. The challenge in future research is to investigate the structure of use context criteria hierarchies.

In the present study choices for some use contexts were made on the basis of household use. The choice made by an individual on behalf of the household may be the result of interactions among household members, and each of these household members may have a different objective for choosing different product variants. Family members may also have misperceptions of other family members' preferences (Dellaert et al, 1998). Previous research has suggested that mothers are more influenced by nutritional concerns than other family members but that in practically all households children had some input as to which foods were purchased (Guinard & Marty, 1997). So there may be conflicts in purchase objectives. The results of the present study may help to give some insight into this. As evaluations were based on appropriateness, parents may have given more weight to their own objectives than what they thought their children would prefer. Overall, sweetened full fat products were thought more appropriate for children on the basis of label only, with regular users being less inclined towards sweetened product than non-users. Whether this is influenced by their children's acceptance of unsweetened products or whether it is just that regular users feel more strongly that these would be more appropriate for children is unclear. After tasting, this pattern was considerably strengthened, with even more positive overall estimates for sweetened, while users were even more strongly inclined towards unsweetened. A further study combining perceived appropriateness of hypothetical choice sets combined with actual choices made would be a logical extension to this work, and as previously suggested extended longitudinal studies would be of value.

7.5 Practical research applications

The scope of experimental choice analysis is broad in terms of practical applications. There is a great deal of flexibility in the types of models that can be estimated and the type of information that can be gained from one experimental study. The method can accommodate unequal numbers of attributes in choice alternatives, variable numbers of alternatives in choice sets, allocation of multiple choices among sets of alternatives, incorporation of different product types and many other variations (Carson et al, 1994).

There is the potential to enrich and extend results by modelling probabilities or utilities for new product alternatives with different combinations of product attributes. This is a strength of the method. Experimental choice data can also be compared with actual choices and there is continuing work towards developing a unifed framework for estimating combined models incorporating observed choices and experimental choices (Ben-Akiva et al, 1994).

Some work has been done on "menu" choice modelling techniques which may have particular relevance to food choice research. In this approach, choices are not presented in specific choice sets but as a menu, where people are asked to choose from a list of individual items and/or pre-designed "bundles" of items (Ben-Akiva & Gershenfeld, 1997). This type of research problem is common: consumers choosing individual items on an a-la-carte menu in a restaurant where there may also be a special package such as soup, main course and dessert at a discounted price; or choices where a pre-packaged bundle (eg a 6-pack) of different flavoured items may be available in addition to individual products.

The simplicity of product evaluation means that experimenal choice analysis is a useful alternative to hedonic scaling for measuring consumer preferences. It would be particularly suitable for obtaining preference evaluations from children.

Use of experimental choice analysis may also be useful for sensory studies in developing countries. As some consumers in these countries may be semi-literate, choice tasks may be more suitable than rating methods as they are easy to understand and administer. Coetzee and Taylor (1996) demonstrated an adaptation of the paired-comparison method for determining preferences of semi-literate and illiterate consumers in South Africa. They found that choice methods could be used quite successfully by using symbols, and multinomial choice analysis may be able to be used to gather more information than the paired comparison method which cannot be extended to multiple choice sets. The method may also overcome some difficulties in cross-cultural research, as choosing between alternatives avoids possible differences between cultures in the use of rating scales (Yeh et al, 1998).

Experimental choice analysis is ideally suited for many practical applications in the food industry. It could be used at early stages to establish areas in which to focus research efforts or to evaluate product concepts. It can guide product development by determining preferences for individual product features and identifying which combinations of features are important for consumer choices. It can also be used to evaluate new or alternative versions of a product or for optimising products and concepts. It can help to determine effective marketing and promotional strategies, by assessing what information is important for consumers' selection of products, both at the purchase and consumption stages and deciding which attributes to promote. This could guide packaging design, product information and advertising strategies.

7.6 Concluding remarks

In this thesis an experimental version of discrete choice analysis, in conjunction with qualitative analysis, was used to investigate consumer choices for yoghurt. It was argued that more integrated approaches to food choice research may offer food researchers practical insights into consumer choice behaviour.

The ultimate measure of a product's success is whether a consumer will choose it or not. Experimental choice analysis is a technique which deserves to be more widely applied, as consumers' overall choices can be linked directly back to the attributes comprising each product alternative. When used in conjunction with response measures which take into account the context in which the consumer is to use the product, a comprehensive picture of consumer choices can be obtained. This eliminates the need for consumers to judge product features individually and takes account of the fact that consumer preferences are not always rational and may vary according to different purchase and usage situations.

The flexibility of experimental choice analysis for modelling different consumer choice problems may attract greater interest in the technique. It is ideally suited for assessing both sensory and cognitive factors in food choices as it can accommodate attributes that are not easily quantified in other techniques. Another aspect which should be highlighted is the ease of the task for consumers. This may have practical application for cross-cultural research. However there are limitations for its use, namely the lack of literature on design strategies, and the lack of specialised statistical packages which incorporate its use. While the methodology has been shown to be highly suitable for assessing consumer choices based on information only, it needs to be applied in other areas of food research to allow it to be further tested and developed.

In terms of the methodology used in this study, two main features have implications for future consumer research. Firstly, the design allowed for interactions to be estimated, which showed the joint effects of product attributes on product choices. This gave insights which could not be gained from a main effects design, even for the limited number of interactions found in the present research. This suggests that consumers do not assess the product features independently, and indicates that researchers should incorporate as many interaction effects as possible into their research designs, rather than estimating only the individual effect of attributes. Of course this means a necessarily larger design with a greater number of consumer evaluations, and a resulting increase in cost. It may also severely limit the number and levels of attributes which can be included. However, the increased complexity of the design is justified by the greater depth of understanding that can be gained. Smaller qualitative or preliminary studies can be of value in determining likely interaction effects so that the most parsimonious design can be arrived at. The advantage of experimental choice analysis is that several smaller experiments can be conducted, while the ability to estimate an overall choice model is retained.

Secondly, the use of context-specific measures was a feature of the present study. The results were encouraging in that consumer choices did vary across use contexts and this did not add substantially to the complexity of the study. This approach will be product-dependent and may not be appropriate for all food choices. However, there are theoretical implications associated with the use of context-specific measures. It was clear that for many consumer choices, the intended use of the product serves as a cue to highlight the relevant choice factors in that context. The criteria for choosing products for multipurpose household use appear to be different from those used to choose products for more specific uses. This illustrates that the response measures must be carefully chosen to suit the research question, as choices are rarely made independently of influences from other household members. Analyses of food choices based on context are likely to produce more homogeneous results than aggregated preferences where no reference context is used. As the contexts should be generated from the consumers themselves, as in the present qualitative studies, the potential insights are greater. Complementary qualitative studies add to the value of the research. Although contexts of use are traditionally considered for positioning products in the marketplace, explicit consideration of how specific product attributes may influence consumer choices for different contexts may be of advantage for many other product decisions.

The application of experimental choice analysis in this research may contribute towards the continuing development of research techniques which integrate sensory and marketing approaches to food choice, and may contribute to improved product development in the food industry.

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APPENDICES

APPENDIX A

Contexts of use elicited in second repertory grid study, in order of frequency

Elicited use factors

	For dessert
	For children
	With fruit
	For a snack
	For a treat/special occasion
	With cereal
	For general cooking
	To eat by itself
{	For baking
{	At school
{	Ethnic cooking
{	For lunch
{	Everyday/regular use
{	For breakfast
{	As a condiment or topping
{	In dressings
{	For adults
{	For everyone
{	Substitute for milk, cream or ice cream
{	In dips
{	With own flavours
{	In sauces
{	Away from home
{	For baby
{	When dieting
{	When ill
{	In smoothies
{	With honey
{	With combination of additions
{	When travelling
{	At work
{	When on antibiotics
{	To sour milk
{	With nuts
{	With choc chips/jelly beans
{	With biscuits
{	When have allergies

APPENDIX B1

PRESENTATION ORDER OF CHOICE SET LABELS

LABELS ONLY

Subject	*Alt Order	Set Order
1	a	4 5 3 6 2 7 1 8
2	b	6 7 5 8 4 1 3 2
3	c	2 3 1 4 8 5 7 6
4	d	4 5 3 6 2 7 1 8
5	e	3 4 2 5 1 6 8 7
6	f	8 1 7 2 6 3 5 4
7	b	2 3 1 4 8 5 7 6
8	c	8 1 7 2 6 3 5 4
9	d	3 4 2 5 1 6 8 7
10	e	5 6 4 7 3 8 2 1
11	f	6 7 5 8 4 1 3 2
12	a	1 2 8 3 7 4 6 5
13	c	5 6 4 7 3 8 2 1
14	d	1 2 8 3 7 4 6 5
15	e	5 6 4 7 3 8 2 1
16	f	2 3 1 4 8 5 7 6
17	a	4 5 3 6 2 7 1 8
18	b	7 8 6 1 5 2 4 3
19	d	2 3 1 4 8 5 7 6
20	e	3 4 2 5 1 6 8 7
21	f	1 2 8 3 7 4 6 5
22	a	3 4 2 5 1 6 8 7
23	b	6 7 5 8 4 1 3 2
24	c	6 7 5 8 4 1 3 2
25	e	7 8 6 1 5 2 4 3
26	f	7 8 6 1 5 2 4 3
27	a	1 2 8 3 7 4 6 5
28	b	8 1 7 2 6 3 5 4
29	c	4 5 3 6 2 7 1 8
30	d	5 6 4 7 3 8 2 1
31	f	3 4 2 5 1 6 8 7
32	a	4 5 3 6 2 7 1 8
33	b	1 2 8 3 7 4 6 5
34	c	1 2 8 3 7 4 6 5
35	d	5 6 4 7 3 8 2 1
36	e	2 3 1 4 8 5 7 6
37	a	8 1 7 2 6 3 5 4
38	b	1 2 8 3 7 4 6 5
39	c	7 8 6 1 5 2 4 3
40	d	4 5 3 6 2 7 1 8
41	e	2 3 1 4 8 5 7 6
42	f	7 8 6 1 5 2 4 3
43	b	2 3 1 4 8 5 7 6
44	c	8 1 7 2 6 3 5 4
45	d	8 1 7 2 6 3 5 4
46	e	7 8 6 1 5 2 4 3
47	f	5 6 4 7 3 8 2 1
48	a	2 3 1 4 8 5 7 6
49	c	4 5 3 6 2 7 1 8
50	d	4 5 3 6 2 7 1 8
51	e	1 2 8 3 7 4 6 5
52	f	7 8 6 1 5 2 4 3
53	a	6 7 5 8 4 1 3 2
54	b	3 4 2 5 1 6 8 7
55	d	3 4 2 5 1 6 8 7
56	e	5 6 4 7 3 8 2 1
57	f	3 4 2 5 1 6 8 7
58	a	6 7 5 8 4 1 3 2
59	b	6 7 5 8 4 1 3 2
60	c	8 1 7 2 6 3 5 4
61	e	4 5 3 6 2 7 1 8
62	f	6 7 5 8 4 1 3 2

LABELLED TASTING

Subject	*Alt Order	Set Order
1	b	2 3 1 4 8 5 7 6
2	c	4 5 3 6 2 7 1 8
3	d	8 1 7 2 6 3 5 4
4	e	2 3 1 4 8 5 7 6
5	f	3 4 2 5 1 6 8 7
6	a	2 3 1 4 8 5 7 6
7	c	8 1 7 2 6 3 5 4
8	d	3 4 2 5 1 6 8 7
9	e	3 4 2 5 1 6 8 7
10	f	1 2 8 3 7 4 6 5
11	a	1 2 8 3 7 4 6 5
12	b	4 5 3 6 2 7 1 8
13	d	6 7 5 8 4 1 3 2
14	e	1 2 8 3 7 4 6 5
15	f	3 4 2 5 1 6 8 7
16	a	4 5 3 6 2 7 1 8
17	b	7 8 6 1 5 2 4 3
18	c	8 1 7 2 6 3 5 4
19	e	7 8 6 1 5 2 4 3
20	f	6 7 5 8 4 1 3 2
21	a	5 6 4 7 3 8 2 1
22	b	6 7 5 8 4 1 3 2
23	c	5 6 4 7 3 8 2 1
24	d	2 3 1 4 8 5 7 6
25	f	6 7 5 8 4 1 3 2
26	a	5 6 4 7 3 8 2 1
27	b	4 5 3 6 2 7 1 8
28	c	7 8 6 1 5 2 4 3
29	d	5 6 4 7 3 8 2 1
30	e	1 2 8 3 7 4 6 5
31	a	1 2 8 3 7 4 6 5
32	b	7 8 6 1 5 2 4 3
33	c	8 1 7 2 6 3 5 4
34	d	2 3 1 4 8 5 7 6
35	e	1 2 8 3 7 4 6 5
36	f	3 4 2 5 1 6 8 7
37	b	8 1 7 2 6 3 5 4
38	c	5 6 4 7 3 8 2 1
39	d	4 5 3 6 2 7 1 8
40	e	3 4 2 5 1 6 8 7
41	f	1 2 8 3 7 4 6 5
42	a	8 1 7 2 6 3 5 4
43	c	7 8 6 1 5 2 4 3
44	d	7 8 6 1 5 2 4 3
45	e	4 5 3 6 2 7 1 8
46	f	2 3 1 4 8 5 7 6
47	a	3 4 2 5 1 6 8 7
48	b	5 6 4 7 3 8 2 1
49	d	6 7 5 8 4 1 3 2
50	e	5 6 4 7 3 8 2 1
51	f	1 2 8 3 7 4 6 5
52	a	6 7 5 8 4 1 3 2
53	b	2 3 1 4 8 5 7 6
54	c	4 5 3 6 2 7 1 8
55	e	6 7 5 8 4 1 3 2
56	f	7 8 6 1 5 2 4 3
57	a	2 3 1 4 8 5 7 6
58	b	4 5 3 6 2 7 1 8
59	c	8 1 7 2 6 3 5 4
60	d	3 4 2 5 1 6 8 7
61	f	2 3 1 4 8 5 7 6
62	a	4 5 3 6 2 7 1 8

*** ALTERNATIVE ORDER- Balanced block design**

A	123
B	231
C	312
D	132
E	213
F	321

APPENDIX B2
Order of presentation for blind tasting

RATING

Subj	Order			
01	C	D	A	B
02	A	C	B	D
03	B	D	A	C
04	C	D	A	B
05	A	C	D	B
06	C	D	B	A
07	D	B	C	A
08	C	D	B	A
09	D	C	B	A
10	D	C	A	B
11	A	D	B	C
12	D	B	A	C
13	B	C	A	D
14	C	B	D	A
15	C	A	B	D
16	A	C	B	D
17	B	A	D	C
18	B	D	C	A
19	C	A	B	D
20	D	A	B	C
21	B	A	D	C
22	A	D	B	C
23	C	B	A	D
24	D	B	C	A
25	C	B	A	D
26	B	A	C	D
27	A	D	C	B
28	A	D	C	B
29	C	D	B	A
30	D	A	C	B
31	D	B	A	C
32	C	B	A	D
33	B	D	A	C
34	B	C	D	A
35	C	A	D	B
36	B	D	C	A
37	B	A	C	D
38	A	C	B	D
39	D	B	A	C
40	B	C	D	A
41	D	A	B	C
42	A	B	D	C
43	A	C	D	B
44	C	B	D	A
45	C	D	A	B
46	B	C	A	D
47	D	A	B	C
48	A	B	C	D
49	C	A	D	B
50	A	B	D	C
51	B	D	C	A
52	C	A	D	B
53	A	B	C	D
54	B	A	C	D
55	B	C	D	A
56	A	B	D	C
57	A	C	D	B
58	D	A	C	B
59	D	C	A	B
60	D	C	B	A
61	D	A	C	B
62	A	D	B	C

CHOICE

Subj	Order			
01	D	C	B	A
02	C	D	A	B
03	C	A	D	B
04	D	A	B	C
05	D	B	A	C
06	C	D	A	B
07	D	A	B	C
08	B	D	A	C
09	C	D	B	A
10	D	C	B	A
11	B	A	C	D
12	A	C	B	D
13	A	D	B	C
14	C	A	D	B
15	D	B	C	A
16	B	D	A	C
17	C	B	A	D
18	A	B	D	C
19	B	C	A	D
20	D	C	A	B
21	D	A	C	B
22	C	B	D	A
23	A	C	D	B
24	D	A	C	B
25	B	C	D	A
26	B	D	C	A
27	B	A	D	C
28	A	D	C	B
29	C	D	B	A
30	D	B	C	A
31	A	B	D	C
32	B	C	A	D
33	C	B	A	D
34	C	D	A	B
35	D	C	A	B
36	B	D	C	A
37	C	D	B	A
38	D	B	A	C
39	B	A	C	D
40	A	B	C	D
41	B	A	C	D
42	B	C	D	A
43	A	B	C	D
44	C	B	D	A
45	D	A	B	C
46	D	B	A	C
47	B	A	D	C
48	A	D	B	C
49	B	C	D	A
50	A	C	B	D
51	A	C	D	B
52	C	A	B	D
53	A	B	D	C
54	C	A	B	D
55	C	A	D	B
56	B	D	C	A
57	A	C	B	D
58	A	C	D	B
59	A	D	C	B
60	C	B	A	D
61	B	A	D	C
62	D	A	C	B

APPENDIX C

EXAMPLE OF YOGHURT LABEL

861

SWEETENED

NATURAL

YOGHURT

STANDARD
Full-cream
(4.0% fat)

With the health-giving properties of acidophilus culture

828

UNSWEETENED

NATURAL

YOGHURT

STANDARD
Full-cream
(4.0% fat)

Contains no artificial ingredients, thickeners or stabilisers

813

UNSWEETENED

NATURAL

YOGHURT

LIGHT
Non Fat
(0.1% fat)

With the health-giving properties of acidophilus culture

APPENDIX D

MASSEY UNIVERSITY

NATURAL YOGHURT STUDY

INFORMATION SHEET

What is this study about?
The aim of this study is to investigate consumer perceptions and preferences for natural yoghurt. The study is being conducted by Maxine Clark, a postgraduate student in Food Technology at Massey University and supervised by Professor Ken Kirkpatrick. You are invited to take part in this study to provide information which will be useful for continuing research and development in this area.

Who can take part?
Two groups of people are needed. If you are a regular user of natural (plain) yoghurt, or if you normally eat flavoured yoghurt but would be willing to taste and evaluate some natural yoghurt, we would like you to take part. If you are on any restricted diet or believe you may have any food allergies, you should not participate.

What would I have to do?
If you agree to take part, you would be asked to attend two sessions. At the first session, lasting no more than half an hour, you would firstly be asked to look at some sets of labels describing different types of yoghurts and choose the ones you think would be most appropriate for different uses. You would then taste small amounts of different natural yoghurts and rate your preference for each one and also indicate after tasting them which ones you think would be appropriate for different uses. At the next session, lasting around 40 minutes, you would again be presented with sets of three yoghurts, asked to taste them and choose between them as before. There will be a break between evaluating groups of yoghurt and water will be provided to sip between samples . You will also be asked some general questions, mainly on your use of yoghurt, for classification purposes.

The yoghurts you will be tasting are of high quality and meet all standards set out in the Food Regulations 1984 regarding the manufacture, storage and serving of the products.

What can I expect from the researcher?
If you agree to take part in the study, you have the right to:

- ask any further questions about the study that occur to you during your participation
- withdraw from the study at any time
- to refuse to answer any particular questions or taste any particular products
- to provide information to the researcher on the understanding that your name and the information you provide will not be used for any purpose other than this research and that your name will not be passed on to any other organisation or person
- to be given access to a summary of the findings of the study when it is concluded

You are welcome to talk to Maxine at any point in the study or afterwards if you have any concerns or questions, or to telephone the supervisor of this research, Professor Ken Kirkpatrick at Massey University, ph. (06) 350 5516.

THANK YOU!

APPENDIX E

EXPLANATION OF THE DIFFERENT TYPES OF YOGHURTS USED IN THIS STUDY

Natural yoghurts may vary in the ingredients used to manufacture them, and in the processing methods used.

The following is an explanation of the different types of yoghurts you are asked to choose between.

SWEETNESS:

Unsweetened:	Natural unsweetened yoghurt, containing no sugar
Sweetened:	Natural sweetened yoghurt, with added sugar

FAT CONTENT:

Light:	Non-fat yoghurt, made from skimmed milk. Contains 0.1% fat.
Standard:	Full-cream yoghurt, made from whole milk. Contains 4.0% fat.

Contains no artificial ingredients, thickeners or stabilisers:	Where this label appears, the yoghurt is made totally from natural ingredients and has no other artificial ingredients, stabilisers or thickeners added.
With the health-giving properties of acidophilus culture:	Where this label appears, the culture used to produce this yoghurt is acidophilus, which is a naturally occuring micro-organism in the human intestine. It is thought that eating acidophilus yoghurt maintains a healthy digestive system and may help promote general health.

APPENDIX F1
RESPONSE SHEET FOR LABEL PHASE

MASSEY UNIVERSITY

YOGHURT CHOICE STUDY

This study is to help understand consumer perceptions and preferences for yoghurt.

You will be shown sets of three yoghurt labels representing different types of yoghurts that might be available in the supermarket, varying in ingredients and processing methods.

As yoghurt is eaten and used in many different ways, we have asked you to choose between the yoghurts according to each specific use that yoghurt might be purchased for.

You have been given eight different sets of labels and eight question sheets. The codes on the labels should match the codes on your question sheet.

- For each set, please choose the ONE yoghurt out of the choice set of three which you think would be most appropriate for the use occasion described.

- Indicate your choice on your question sheet by circling the number of the label which corresponds to your choice. You must make a choice for each question.

- When you have completed all questions, turn to the next choice set of labels and the corresponding question sheet.

PLEASE ENSURE YOU WRITE YOUR NAME ON EACH PAGE

APPENDIX F1

Name: ______________________________ ________

1 **Which ONE of these yoghurts would you EXPECT TO LIKE the most if you were to eat it on its own (without any additions or accompaniments)?**

861 828 813

2 **Which ONE of these yoghurts do you think would be most appropriate as an ingredient for general cooking or baking purposes?**

861 828 813

3 **Which ONE of these yoghurts do you think would be most appropriate for serving to pre-school children?**

861 828 813

4 **Which ONE of these yoghurts do you think would be most appropriate for dessert?**

861 828 813

5 **Which ONE of these yoghurts do you think would be most appropriate to buy for multi-purpose use (all the possible occasions you and your family might want to use it for)?**

861 828 813

APPENDIX F2

MASSEY UNIVERSITY

YOGHURT BLIND TASTING

Instructions

You will be given 4 coded samples of yoghurt.

- Taste the samples in order from left to right.
- After tasting each sample, please rate it on the scale on **page 2** according to how much you like each yoghurt.
- Water is provided to rinse your mouth between samples.

You will then be given another 4 coded samples of yoghurt.

- After tasting all the samples, you are asked to choose which yoghurt you think would be the most appropriate for each of the 5 different use occasions described on **page 3.**
- Choose one yoghurt for each of the use occasions by circling the code number corresponding to that sample.
- You may retaste the samples as often as you wish.
- Water is provided to rinse your mouth between samples.

BEFORE STARTING, PLEASE WRITE YOUR NAME ON EACH PAGE

Name: ______________________________ ______

Please rate your liking of each of the four samples presented (tick one box):

SAMPLE ______

- Like extremely ☐
- Like very much ☐
- Like moderately ☐
- Like slightly ☐
- Neither like nor dislike ☐
- Dislike slightly ☐
- Dislike moderately ☐
- Dislike very much ☐
- Dislike extremely ☐

SAMPLE ______

- Like extremely ☐
- Like very much ☐
- Like moderately ☐
- Like slightly ☐
- Neither like nor dislike ☐
- Dislike slightly ☐
- Dislike moderately ☐
- Dislike very much ☐
- Dislike extremely ☐

SAMPLE ______

- Like extremely ☐
- Like very much ☐
- Like moderately ☐
- Like slightly ☐
- Neither like nor dislike ☐
- Dislike slightly ☐
- Dislike moderately ☐
- Dislike very much ☐
- Dislike extremely ☐

SAMPLE ______

- Like extremely ☐
- Like very much ☐
- Like moderately ☐
- Like slightly ☐
- Neither like nor dislike ☐
- Dislike slightly ☐
- Dislike moderately ☐
- Dislike very much ☐
- Dislike extremely ☐

YOGHURT BLIND TASTING

Name: ______________________________ __________

1 **Which ONE of these yoghurts do you prefer for eating on its own (without any additions or accompaniments)?** (circle one)

663 759 374 218

2 **Which ONE of these yoghurts do you think would be most appropriate as an ingredient for general cooking or baking purposes?** (circle one)

663 759 374 218

3 **Which ONE of these yoghurts do you think would be most appropriate for serving to pre-school children?** (circle one)

663 759 374 218

4 **Which ONE of these yoghurts do you think would be most appropriate for dessert?** (circle one)

663 759 374 218

5 **Which ONE of these yoghurts do you think would be most appropriate to buy for multi-purpose use (all the possible occasions you and your family might want to use it for)?** (circle one)

663 759 374 218

APPENDIX F3

MASSEY UNIVERSITY

YOGHURT CHOICE STUDY

This study is to help understand consumer perceptions and preferences for yoghurt.

You will be given sets of three coded samples of yoghurt and three corresponding coded labels.

- Please check that the number on the label matches the number on the yoghurt sample.

As yoghurt is eaten and used in many different ways, we have asked you to choose between the yoghurts according to each specific use that yoghurt might be purchased for.

- For each set, read the label and taste the corresponding sample in order from left to right.
- For each question, please choose the ONE yoghurt out of the set of three which you think would be most appropriate for the use occasion described.
- Indicate your choice by CIRCLING the number of the sample which corresponds to your choice. You must make a choice for each question.
- You may retaste the samples as often as you wish. Water is available to rinse your mouth between samples and between sets.
- When you have completed all questions, please turn to the next page on your question sheet and wait for the next set of samples.

PLEASE ENSURE YOU WRITE YOUR NAME ON EACH PAGE

TASTING

Name: ______________________________

____

1 **Which ONE of these yoghurts do you prefer for eating on its own (without any additions or accompaniments)?**

794 727 753

2 **Which ONE of these yoghurts do you think would be most appropriate as an ingredient for general cooking or baking purposes?**

794 727 753

3 **Which ONE of these yoghurts do you think would be most appropriate for serving to pre-school children?**

794 727 753

4 **Which ONE of these yoghurts do you think would be most appropriate for dessert?**

794 727 753

5 **Which ONE of these yoghurts do you think would be most appropriate to buy for multi-purpose use (all the possible occasions you and your family might want to use it for)?**

794 727 753

APPENDIX G

FOOD USE QUESTIONNAIRE

Name:____

How often do you use natural (unflavoured) yoghurt in your household? (Tick one box)

Do not use	
Hardly ever	
A few times a year	
A few times a month	
A few times a week	
Almost daily	
Daily	

How often do you use flavoured or fruit yoghurt in your household? (Tick one box)

Do not use	
Hardly ever	
A few times a year	
A few times a month	
A few times a week	
Almost daily	
Daily	

How often do **you personally** eat yoghurt?
(Tick one box for each yoghurt type)

	Natural	**Flavoured**
Do not eat		
Hardly ever		
A few times a year		
A few times a month		
A few times a week		
Almost daily		
Daily		

Please indicate how and when you or your family have eaten or used yoghurt over the last month:
(tick as many as applicable)

Breakfast	
Lunch	
Dessert	
Snack between meals	
Cooking or baking	
Other	

Please indicate which of the following brands you regularly purchase (more than once per month):
(tick as many as applicable)

Fresh'n'Fruity		Ski	
Swiss Maid		Yoplait	
Meadow Fresh		De Winkel	
Metchnikoff		Cyclops	
Quality Farm Naturalea		NZ Fresh	
BioFarm		Baby & Toddler	
Easiyo		Hansells	
Other:			

How many people in your household eat yoghurt (more than once a month):

_______ adults

_______ children Ages: ________________________

Could you please indicate your age group:

16-24	
25-34	
35-44	
45-54	
55+	

Do you have you any comments about the products used in this study?

The following statements are related to food and health issues. Could you please indicate your agreement or disagreement with each statement by circling the number on the scale which most closely describes your reaction:

	Strongly agree 1	2	3	Neither agree nor disagree 4	5	6	Strongly disagree 7
I am concerned about the amount of salt in my diet	1	2	3	4	5	6	7
I am concerned about the amount of fat in my diet	1	2	3	4	5	6	7
I am concerned about artificial colourings and flavourings in my food	1	2	3	4	5	6	7
I am concerned about the amount of cholesterol in my diet	1	2	3	4	5	6	7
I prefer to buy organically produced food	1	2	3	4	5	6	7
I am concerned about getting enough vitamins and minerals in my diet	1	2	3	4	5	6	7
I am concerned about the amount of sugar in my diet	1	2	3	4	5	6	7
I am concerned about preservatives in my food	1	2	3	4	5	6	7
I am concerned about the risk of dietary related illnesses or diseases	1	2	3	4	5	6	7
I am concerned about gaining weight	1	2	3	4	5	6	7

THANK YOU VERY MUCH FOR YOUR PARTICIPATION!!

APPENDIX H

Data & SAS Commands for Label Use 1 Final Model

```
Title 'FINAL MODEL - label choice use 1';


data labuse1;
  input subj (choice1-choice8) (1.) @@;
  datalines;
01 23122313 02 12212221 03 23122322 04 11111111 05 12211221 06 12211221
07 31232223 08 22121111 09 21111111 10 13321312 11 12213223 12 21221322
13 11111311 14 13231222 15 21122212 16 11111111 17 12213223 18 32312221
19 12211111 20 11111211 21 11211111 22 12122222 23 32222122 24 11111111
25 12111221 26 33333233 27 11111111 28 11113111 29 12211221 30 12211132
31 33332333 32 21122311 33 21111111 34 11211112 35 11111211 36 21111111
37 23122311 38 11111111 39 12211221 40 11111221 41 23122332 42 12211211
43 11111111 44 11211111 45 12121111 46 11111121 47 11111111 48 11111121
49 12213222 50 32313332 51 11111111 52 11221131 53 11111111 54 32233233
55 12211223 56 12132111 57 31112221 58 12113121 59 11111111 60 11211111
61 11211221 62 12111221
;

data labuse1b;
set labuse1;
array vars {8} choice1-choice8;
  do set=1 to 8;
    choiceno=vars {set};
    output;
    end;
    run;

data labuse1c;
set labuse1b;
  do alt=1 to 3;
  output;
  end;
  run;

data labuse1c;
  set labuse1c;
  c = 2 - (choiceno = alt);
  run;

proc sort data=labuse1c;
  by set alt;
  run;

data merged1;
  merge labuse1c design;
  by set alt;
  run;

proc sort data=merged1;
  by subj set alt;
  run;
```

```
data merged1;
set merged1;
user=subj IN (1,2,3,5,7,8,9,11,12,16,18,21,23,26,29,32,33,34,35,50,51,54,55);
HC=subj IN (1,5,8,9,10,11,13,21,22,24,26,28,29,31,32,33,34,36,37,39,40,41,42,
        43,46,49,50,51,52,57,59,60,61);
UHC=(user=HC);
Usweet=user*sweet;
Ufat=user*fat;
HCsweet=HC*sweet;
HCfat=HC*fat;
UHCsweet=UHC*sweet;
UHCfat=UHC*fat;
run;

proc phreg data=merged1 outest=betas;
  model c*c(2)=sweet fat mess1 mess2 Usweet HCsweet
        UHCsweet / ties=breslow;
  strata subj set;
  run;

Data design2;
set design;
do user=0 to 1;
do hc=0 to 1;
UHC=(USER=HC);
Usweet=user*sweet;
Ufat=user*fat;
HCsweet=hc*sweet;
HCfat=hc*fat;
UHC=(user=hc);
UHCsweet=uhc*sweet;
UHCfat=uhc*fat;
output;
end;
end;
run;

/* calculate utilities */
data pwsum;
set design2 end=eof;
if _n_=1 then
 set betas (rename=(sweet=b1 fat=b2 mess1=b3 mess2=b4 usweet=b5
 hcsweet=b6 uhcsweet=b7));
array x [7] sweet fat mess1 mess2 usweet hcsweet uhcsweet;
array b [7] b1--b7;
sum=0;
do j=1 to 7;
  sum=sum + x[j]*b[j];
end;

proc sort data=pwsum nodupkeys;
by user hc sweet fat mess;
run;

proc sort data=pwsum;
by descending sum;
run;
```

```
proc print data=pwsum;
 var sweet fat mess user hc sum;
  run;
```

APPENDIX I

Full set of results for Label Use 1 Final Model

FINAL MODEL - label choice use 1

The PHREG Procedure

Data Set: WORK.MERGED1
Dependent Variable: C
Censoring Variable: C
Censoring Value(s): 2
Ties Handling: BRESLOW

Summary of the Number of Event and Censored Values

Stratum	SUBJ	SET	Total	Event	Censored	Percent Censored
1	1	1	3	1	2	66.67
2	1	2	3	1	2	66.67
3	1	3	3	1	2	66.67
4	1	4	3	1	2	66.67
5	1	5	3	1	2	66.67
6	1	6	3	1	2	66.67
7	1	7	3	1	2	66.67
8	1	8	3	1	2	66.67
9	2	1	3	1	2	66.67
10	2	2	3	1	2	66.67
11	2	3	3	1	2	66.67
12	2	4	3	1	2	66.67
13	2	5	3	1	2	66.67
14	2	6	3	1	2	66.67
15	2	7	3	1	2	66.67
16	2	8	3	1	2	66.67
17	3	1	3	1	2	66.67
18	3	2	3	1	2	66.67
19	3	3	3	1	2	66.67
20	3	4	3	1	2	66.67
21	3	5	3	1	2	66.67
22	3	6	3	1	2	66.67
23	3	7	3	1	2	66.67
24	3	8	3	1	2	66.67
25	4	1	3	1	2	66.67
26	4	2	3	1	2	66.67
27	4	3	3	1	2	66.67
28	4	4	3	1	2	66.67
29	4	5	3	1	2	66.67
30	4	6	3	1	2	66.67
31	4	7	3	1	2	66.67
32	4	8	3	1	2	66.67
..						
..						
	..					
	..					
473	60	1	3	1	2	66.67
474	60	2	3	1	2	66.67
475	60	3	3	1	2	66.67

476	60	4	3	1	2	66.67
477	60	5	3	1	2	66.67
478	60	6	3	1	2	66.67
479	60	7	3	1	2	66.67
480	60	8	3	1	2	66.67
481	61	1	3	1	2	66.67
482	61	2	3	1	2	66.67
483	61	3	3	1	2	66.67
484	61	4	3	1	2	66.67
485	61	5	3	1	2	66.67
486	61	6	3	1	2	66.67
487	61	7	3	1	2	66.67
488	61	8	3	1	2	66.67
489	62	1	3	1	2	66.67
490	62	2	3	1	2	66.67
491	62	3	3	1	2	66.67
492	62	4	3	1	2	66.67
493	62	5	3	1	2	66.67
494	62	6	3	1	2	66.67
495	62	7	3	1	2	66.67
496	62	8	3	1	2	66.67
Total			1488	496	992	66.67

FINAL MODEL - label choice use 1

The PHREG Procedure

Testing Global Null Hypothesis: BETA=0

Criterion	Without Covariates	With Covariates	Model Chi-Square
-2 LOG L	1089.823	873.271	216.552 with 7 DF (p=0.0001)
Score	.	.	197.874 with 7 DF (p=0.0001)
Wald	.	.	154.313 with 7 DF (p=0.0001)

Analysis of Maximum Likelihood Estimates

Variable	DF	Parameter Estimate	Standard Error	Wald Chi-Square	Pr > Chi-Square	Risk Ratio
SWEET	1	1.720393	0.23911	51.76826	0.0001	5.587
FAT	1	0.293877	0.10587	7.70481	0.0055	1.342
MESS1	1	0.048463	0.14776	0.10757	0.7429	1.050
MESS2	1	0.121112	0.15023	0.64993	0.4201	1.129
USWEET	1	-1.019655	0.23880	18.23269	0.0001	0.361
HCSWEET	1	-0.378179	0.23875	2.50902	0.1132	0.685
UHCSWEET	1	0.693207	0.23877	8.42898	0.0037	2.000

UTILITIES

OBS	SWEET	FAT	MESS	USER	HC	SUM
1	1	1	2	0	0	2.82859
2	1	1	1	0	0	2.75594
3	1	1	0	0	0	2.70748
4	1	0	2	0	0	2.53471

5	1	0	1	0	0	2.46206
6	1	0	0	0	0	2.41360
7	1	1	2	0	1	1.75720
8	1	1	1	0	1	1.68455
9	1	1	0	0	1	1.63609
10	1	0	2	0	1	1.46333
11	1	1	2	1	1	1.43075
12	1	0	1	0	1	1.39068
13	1	1	1	1	1	1.35811
14	1	0	0	0	1	1.34221
15	1	1	0	1	1	1.30964
16	1	0	2	1	1	1.13688
17	1	1	2	1	0	1.11573
18	1	0	1	1	1	1.06423
19	1	1	1	1	0	1.04308
20	1	0	0	1	1	1.01577
21	1	1	0	1	0	0.99461
22	1	0	2	1	0	0.82185
23	1	0	1	1	0	0.74920
24	1	0	0	1	0	0.70074
25	0	1	2	0	0	0.41499
26	0	1	2	0	1	0.41499
27	0	1	2	1	0	0.41499
28	0	1	2	1	1	0.41499
29	0	1	1	0	0	0.34234
30	0	1	1	0	1	0.34234
31	0	1	1	1	0	0.34234
32	0	1	1	1	1	0.34234
33	0	1	0	0	0	0.29388
34	0	1	0	0	1	0.29388
35	0	1	0	1	0	0.29388
36	0	1	0	1	1	0.29388
37	0	0	2	0	0	0.12111
38	0	0	2	0	1	0.12111
39	0	0	2	1	0	0.12111
40	0	0	2	1	1	0.12111
41	0	0	1	0	0	0.04846
42	0	0	1	0	1	0.04846
43	0	0	1	1	0	0.04846
44	0	0	1	1	1	0.04846
45	0	0	0	0	0	0.00000
46	0	0	0	0	1	0.00000
47	0	0	0	1	0	0.00000
48	0	0	0	1	1	0.00000