

Sensory and consumer science –
what have we achieved? where
are we going?

Hal MacFie
Pangborn 2005

Preface

- Scope of vision
 - FQAP glasses
 - Consult for both companies and government
- Selection of issues – not comprehensive view
 - Statistician
 - Consumer Science
- What we are about
 - Sensory perception
 - Consumer perception and liking
 - Product development and support
 - Consumer decision making (choice) and purchase (role of sensory)

Overview

- Sensory Science
- Consumer Science
- Future

Sensory Science

- Data collection

Data collection in the sensory lab

These packages have revolutionised sensory data collection



COMPUSENSE® World leader in software applications for sensory evaluation

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[Back](#) [Previous](#) [Next](#)

FIZZ Software Solutions for Sensory Analysis and Consumer Tests



Biosystemes

FIZZ is born from a fact: in the eighties, there was no tool available allowing the management of sensory analysis, a growing but demanding new field, based on the statistical computation of the sensory properties of the products. Biosystemes' team, composed of specialists in food technology and software, then launched the development of a powerful tool able to collect and analyze sensory data while providing simple means to realize the long, tedious and various tasks encountered at each phase of the sensory analysis. This gave birth to the first version of **FIZZ** in 1988. Since then, new versions were launched regularly, taking in account new user needs and the technological and scientific advances.

- [Several solutions adapted to the different situations](#)
- [Complete solutions](#)
- [Dependable and versatile solutions](#)

The **FIZZ** solutions cover all needs

FIZZ is available in three versions that allow the management of sensory

Biosystemes

They are important vehicles for transmitting new technologies into practice

Market research

| Test types | Data Collection | Tasting Designs | Analysis | Database |
|-----------------------------|------------------------|------------------------------|---------------------------------|-----------------------------|
| Virtual reality | Interfaces | | Preference mapping | Integrating information |
| Advanced programming | Web-based collection | Advanced designs | Time-Intensity | Queries |
| Time-Intensity, Progressive | Mobile data collection | Products split over tastings | PCA, cluster, discriminant | Results database |
| Combining questions | Pictures, multimedia | Sample labelling | Open question encoding | |
| Conditional tests | Session recovery | Blinding codes generation | Reports | Products / Samples database |
| Comments | Several sessions | Williams Latin Squares | Automation of routine tasks | Automated exportation |
| Standard tests | Paper or computerized | Balanced designs | Basic stats: descriptive, ANOVA | Copy / paste |


Future (Punter OP&P)


- Sensory-on-Demand.
- users do not need any software except a browser and internet connection.
- The logical next step is the analysis and reporting on demand, so that the the client only has to provide place, products and respondents.
- le a 100% internet application.


Welcome to
LOGiC8.com
The logical choice in survey
and document automation

Welcome to Logic8

Logic8 is the first company that offers flexible online survey and reporting software for sensory research. With our products **EyeQuestion** and **EyeQuestion Reporter** companies can have a powerful and simple tool to support their sensory or marketing research. Click [here](#) for an introduction to EyeQuestion.

News
Logic8 and **Compusense®** have agreed to enter into a process of collaborative development to provide the sensory and consumer research community with flexible, web-based, software tools for data collection and analysis.
 **COMPUSENSE®**
[Read more...](#)

EyeQuestion Reporter

The consumer insight division of **IFF International Fragrances & Flavors** located in Hilversum, The Netherlands, uses the EyeQuestion Reporter to generate standard reports of their research data. This tool saves a lot of time in analysing the data and provides a standard corporate way of reporting.
[Read more...](#)

Polls
Do you use sensory software?
 We always use software
 We use paper and software
 We only use paper
 We don't do sensory research
[Vote](#) [Results](#)
 See our online demo!

Who's Online
We have 2 guests online and 1 member online
Login
Username

Password

Training and Performance of Panels

- Computer recording makes review data easier
- Many companies are increasing their monitoring activities
- Is there pressure for cost-cutting?|

Descriptive Profiling - Training

- In FQAP relatively few papers in the last 5 years on training
 - Peyvieux and Dijksterhuis 12(1) Training in TI
- Controversy over Sensory – Instruments versus Sensory – Consumer Perception remains
- Feedback strategies appear to shorten the time to reach good performance but not improve it
 - Findlay and colleagues FQAP – to appear
- Can they be trained into improvement?
- Important area requiring further work.(Beauchamp hypothesis)

Classification of papers in Sensometric Special issues

Surprising in the sensometrics field that so many are on performance

| Topic | No of Papers |
|----------------------------------|--------------|
| Sensory Panel Performance | 15 |
| Relating consumer to sensory | 13 |
| Difference tests | 7 |
| Preference Testing | 6 |
| PCA/PLS | 6 |
| Design | 5 |
| Relating sensory to instrumental | 4 |
| Multivariate Testing | 3 |
| Free choice | 3 |
| Segmentation | 3 |
| Neural Nets | 3 |
| Quality | 2 |
| Choice/ Attitudes | 2 |
| Dispersion Tests | 1 |
| Multidimensional Scaling | 1 |
| Time-Intensity | 1 |

Monitoring Sensory Panel performance

- Repeatability
 - The ability to score the same product consistently for a given attribute (Rossi 2001 quoting NB Standards)
- Reproducibility
 - The ability to score products the same, on average, as the other panel members (Rossi 2001)
- Discrimination
 - The ability to show a significant signal to noise ratio
- Performance criteria are understood and easy to calculate with computer recording
- To my mind the last two are more important than the first two
- Industrial pressure to replace poorly performing assessors

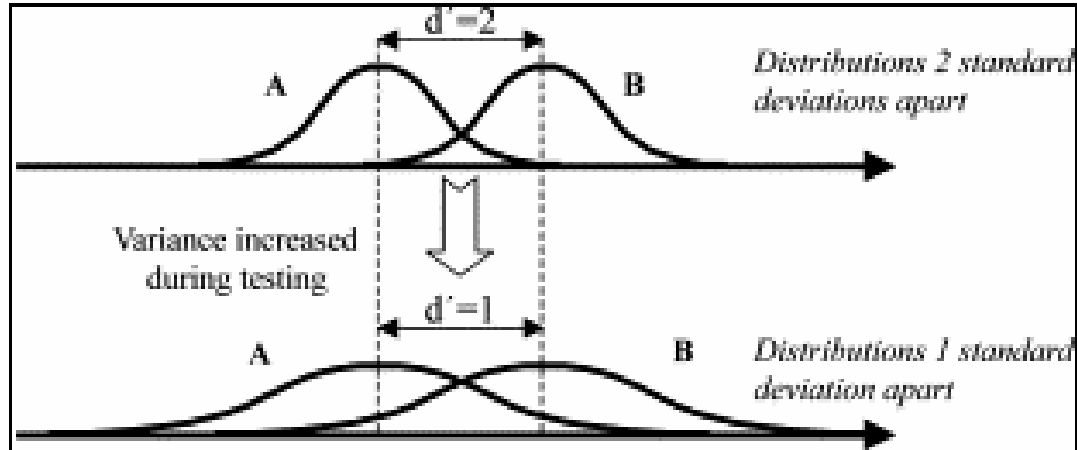
Assessment of Panel Performance Literature

- A useful and comprehensive literature has led to a number of interesting graphical techniques that are possibly unique and may have wider significance.
- O'Mahony and colleagues have started to ask some basic questions:
 - Eg scoring one attribute across all samples versus all attributes simultaneously

Dynamic measurement

Time -Intensity

- Standard techniques – Anova etc
- Overbosch, Liu and MacFie rescaling ideas
- Van beuren – PCA, Dijksterhuis PCA non centred PCA
- Wendin – modelling
- Statis – Guinard and colleagues
- Future – back to basics?



Using the variance as well as the mean of response distributions and some clear thinking has enabled O'Mahony and colleagues to develop a valuable programme of testing that is

Comparing the performance of different testing procedures

Testing the effects of warm up samples, memory, re-tasting etc This programme is producing a series of useful results that resonate with sensory practitioners

Worth pursuing, may yield useful new methods! More workers needed!

Are we doing too many reps?

- Mead: Experimenters who design trials with more than 30 degrees of freedom in the residual should be shot!

$$E(MS_A) = \sigma^2 + n\sigma_{AS}^2 + bn\sigma_A^2$$

$$E(MS_S) = \sigma^2 + n\sigma_{AS}^2 + an \frac{\sum S_j^2}{b-1}$$

$$E(MS_{AS}) = \sigma^2 + n\sigma_{AS}^2$$

$$E(MS_E) = \sigma^2$$

| Source | Degrees of Freedom |
|--------------------|--------------------|
| Assessors | 11 |
| Samples | 9 |
| Assessor by Sample | 99 |
| Residual | 241 |
| Total | 359 |

Are we doing too many reps?

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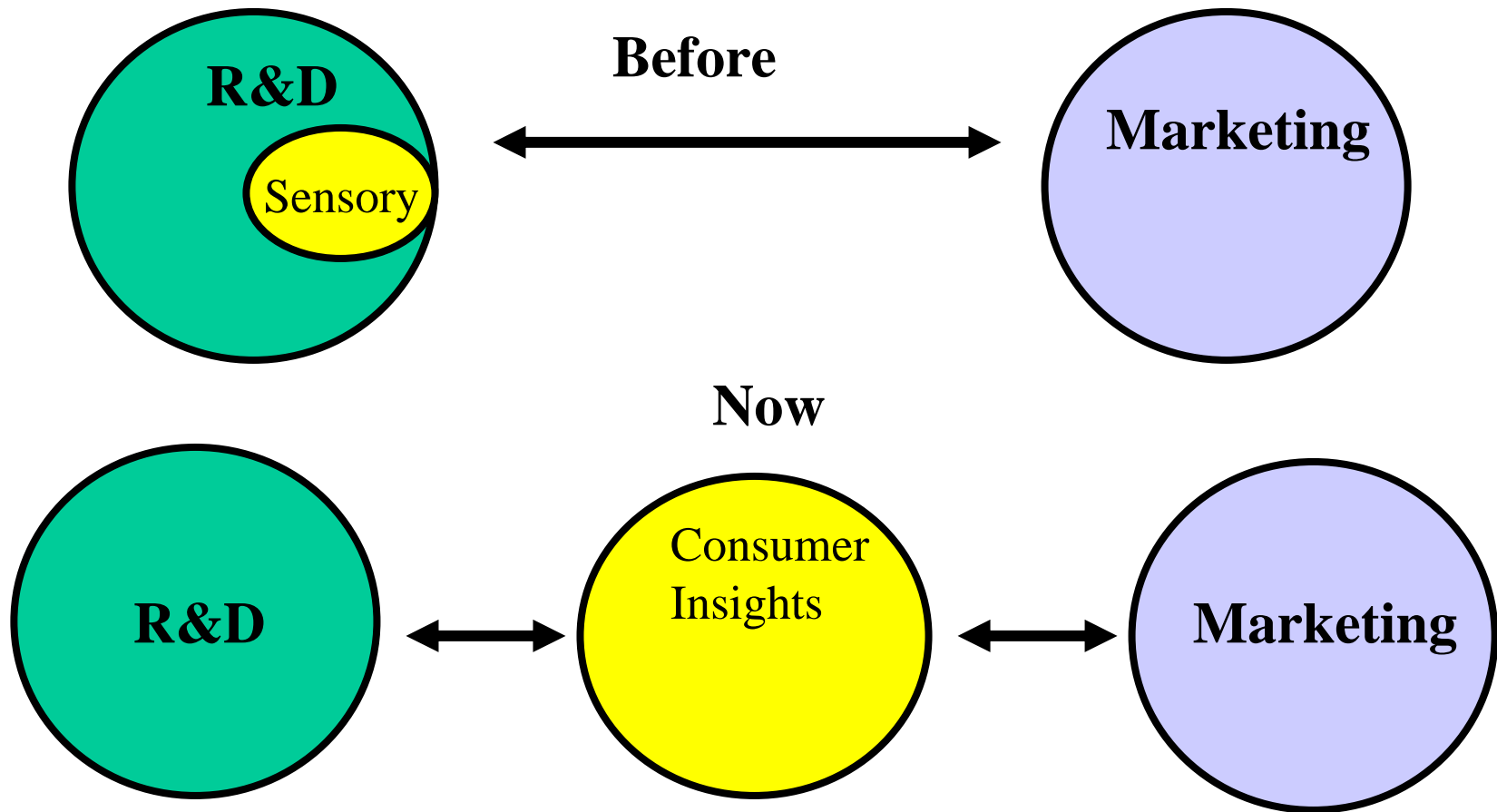
| Source | Degrees of Freedom |
|--------------------|--------------------|
| Assessors | 4 |
| | |
| Samples | 9 |
| | |
| Assessor by Sample | 36 |
| | |
| Residual | 29 |
| | |
| Total | 79 |

| Source | Degrees of Freedom |
|--------------------|--------------------|
| Assessors | 4 |
| | |
| Samples | 9 |
| | |
| Assessor by Sample | 36 |
| | |
| Residual | 0 |
| | |
| Total | 49 |

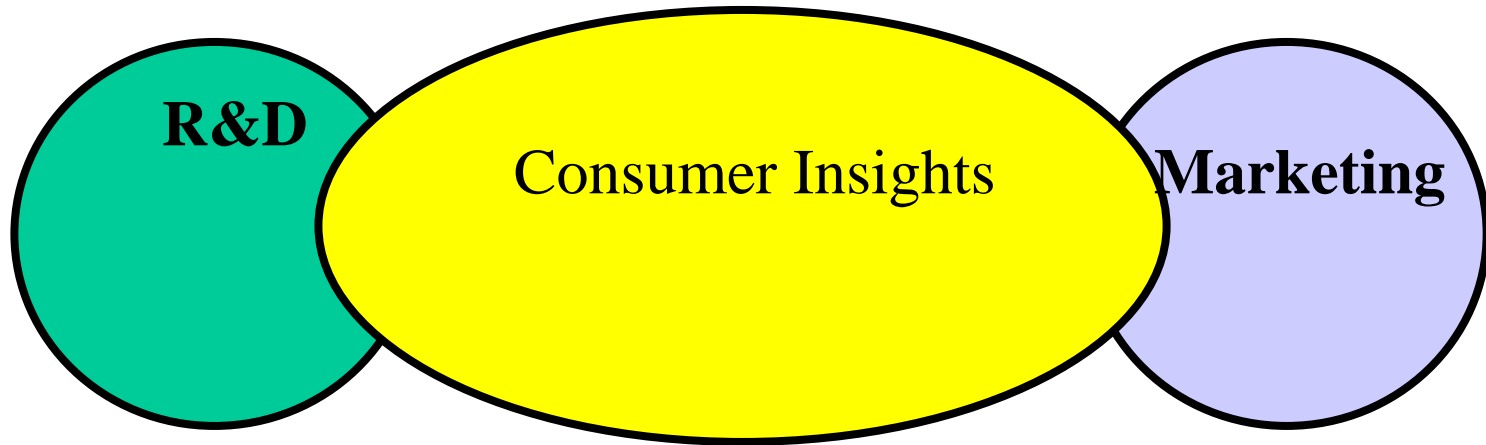
Making sensory relevant in an industrial context

- R-Index
 - estimating the number of discriminators
- Repertory Grid
 - Comparing sensory and consumer language
- Predicting Liking
 - Not needing to go to the consumer for every variant or new product
- Claims support
 - Disproving a competitor's claim, supporting own claim

Change in function?

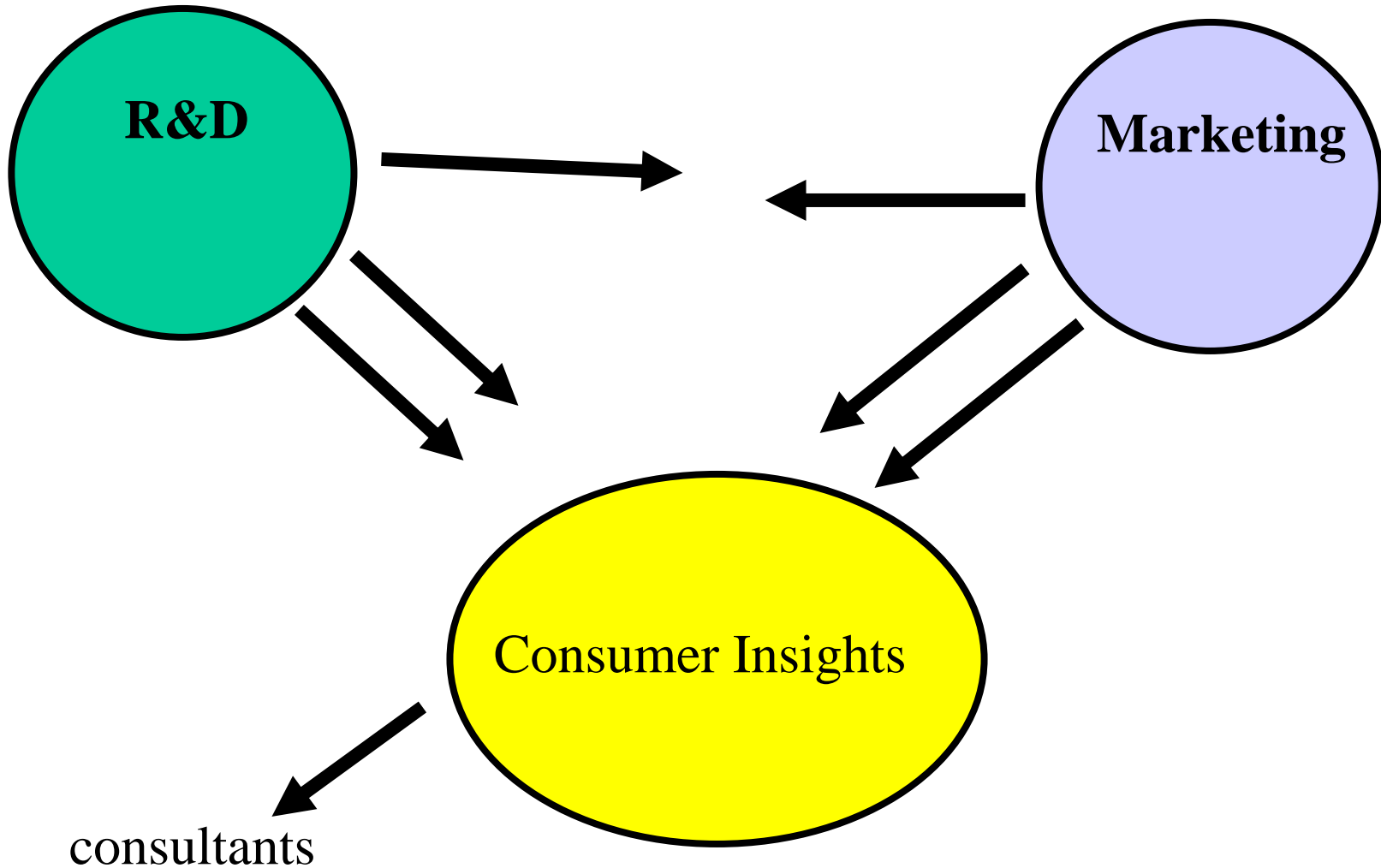


Future



Need for new methods to expand our influence

Who blames who when it goes wrong



How long does it take a respondent to notice a change?

- Mars Snickers story
 - Reduce chocolate on surface
 - Discrimination tests no difference
 - After 6 months sales go down
- How do you predict that?

Consumer Science

- Central Location Testing CLT
- Decision making
- Expectations
- Combined approaches
- Novel ideas

CLT – what have we achieved?

- Established that sensory scientists are uniquely qualified to conduct the tests properly
 - Specialised designs,
 - Food Science background,
 - Statistical analysis framework
- Universally applied in food and non-food area
- Segmentation techniques work well with complete designs
- Results related to sensory profiling and these can be related back to Analytical and compositional data

CLT - problems

- Numbers of subjects
- Question biasing effects
- Segments do not relate to demographic factors
- Incomplete designs
- Blind multiple product testing

Can we find a general value for N?

Number of consumers necessary for sensory acceptability tests

(Hough, Wakeling, Mucci, Chambers IV, Méndez Gallardod and Alvese) Food Quality and Preference to appear

By reviewing the results of many CLT trials the authors arrive at a general value of 0.23 for noise

Table 1. Range of N used in different studies.

| Product | Number of consumers | Reference |
|--------------------------|---------------------|--|
| Meat patty | 43 | Miller & Holben (1999) |
| Fermented eggplant study | 26 | Seseña, Sánchez-Hurtado, González-Viñas & Palop (2001) |
| Lamb meta | 10-20 ^a | Arsenos et al. (2002) |
| Low-fat foods | 10-43 ^b | Devereux, Jones McCormack & Hunter (2003) |
| Cereal bars | 84 | Hall, Hampl, Stanton, & Monte (2003) |
| Instant coffee | 199 | Geel, Kinnear, & de Koch (2005) |
| Cherries | 581 | Crisosto, Crisosto & Metheney (2003) |

a Number of consumers varied from one stage of the experiment to another.

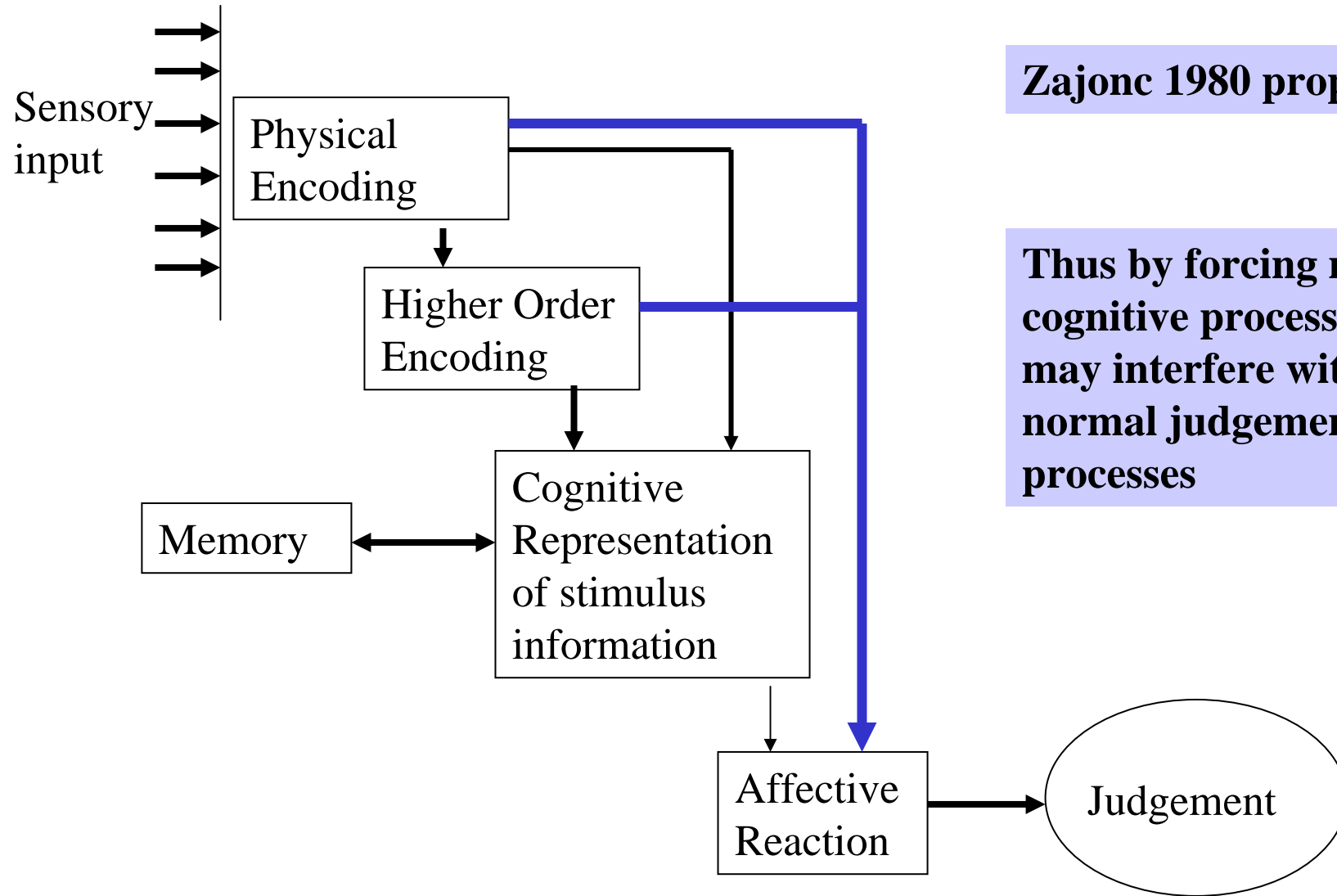
b Number of consumer's availability.

Hough et al propose 112 as a generally useful number

So if you have a 1-9 point hedonic scale and want to detect a difference of 0.8 on this scale, then the d value with which to enter Table 3 would be this difference divided by the scale length: $0.8/8 = 0.1$. Thus with RMSL= 0.23, $\alpha = 5\%$, $\beta = 10\%$ and $d = 0.1$; the number of consumers necessary to perform the test would be $N = 112$.

| RMSL ^a | $\alpha\%$ ^b | d^c | $\beta\%$ ^d | | |
|-------------------|-------------------------|-------|------------------------|------|------|
| | | | 20 | 10 | 5 |
| 0.14 | 10 | 0.2 | 7 | 9 | 11 |
| | 5 | 0.2 | 8 | 11 | 14 |
| | 1 | 0.2 | 12 | 15 | 18 |
| | 10 | 0.1 | 25 | 34 | 43 |
| | 5 | 0.1 | 32 | 42 | 52 |
| | 1 | 0.1 | 47 | 59 | 71 |
| | 10 | 0.05 | 98 | 135 | 170 |
| | 5 | 0.05 | 124 | 166 | 205 |
| | 1 | 0.05 | 184 | 234 | 280 |
| 0.23 | 10 | 0.2 | 17 | 23 | 29 |
| | 5 | 0.2 | 22 | 29 | 35 |
| | 1 | 0.2 | 32 | 40 | 48 |
| | 10 | 0.1 | 66 | 91 | 115 |
| | 5 | 0.1 | 84 | 112 | 138 |
| | 1 | 0.1 | 124 | 158 | 189 |
| | 10 | 0.05 | 262 | 363 | 459 |
| | 5 | 0.05 | 333 | 445 | 551 |
| | 1 | 0.05 | 495 | 631 | 755 |
| 0.30 | 10 | 0.2 | 29 | 39 | 49 |
| | 5 | 0.2 | 36 | 48 | 59 |
| | 1 | 0.2 | 53 | 68 | 81 |
| | 10 | 0.1 | 112 | 155 | 196 |
| | 5 | 0.1 | 142 | 190 | 235 |
| | 1 | 0.1 | 211 | 269 | 322 |
| | 10 | 0.05 | 446 | 617 | 780 |
| | 5 | 0.05 | 566 | 757 | 936 |
| | 1 | 0.05 | 842 | 1072 | 1284 |

Typical information-processing model of affect



Zajonc 1980 proposes

Thus by forcing more cognitive processing we may interfere with normal judgement processes

The effects of asking questions on liking

Product 4 is significantly higher than the other 4 products when just Overall Liking or Overall Liking plus intensities are asked but not when JARS are present

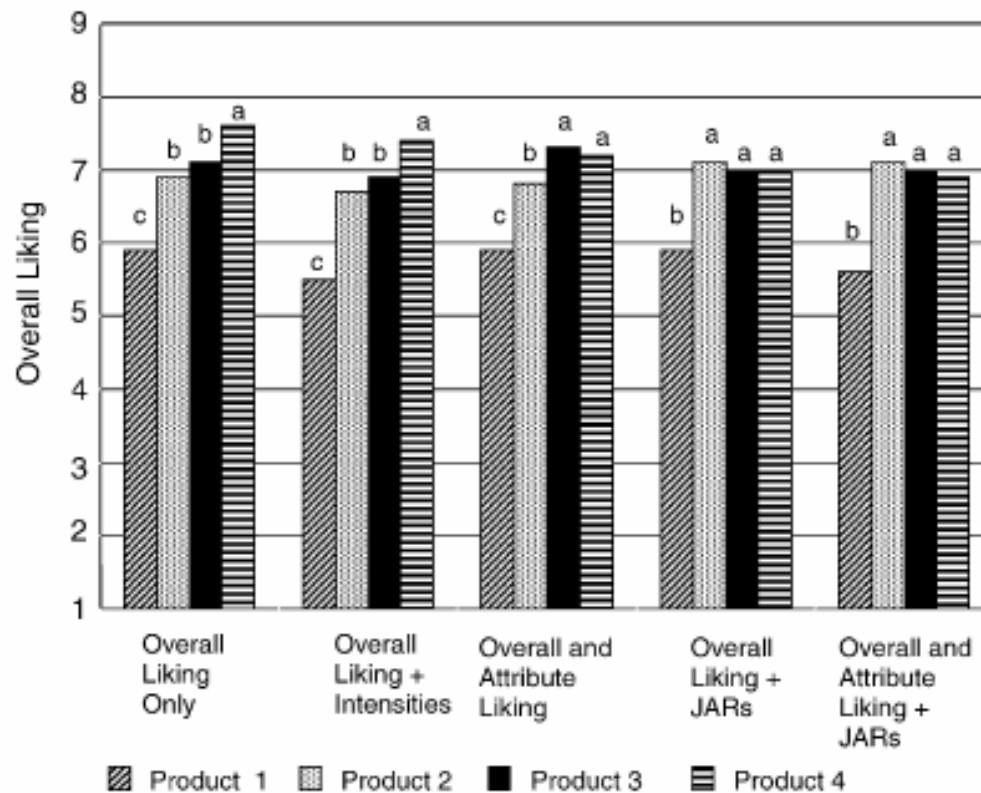


Fig. 1. Mean overall liking ratings for the products by questionnaire condition (JAR = just-about-right). Within a questionnaire condition, the overall liking means that share a common letter do not differ significantly from one another ($p < 0.05$).

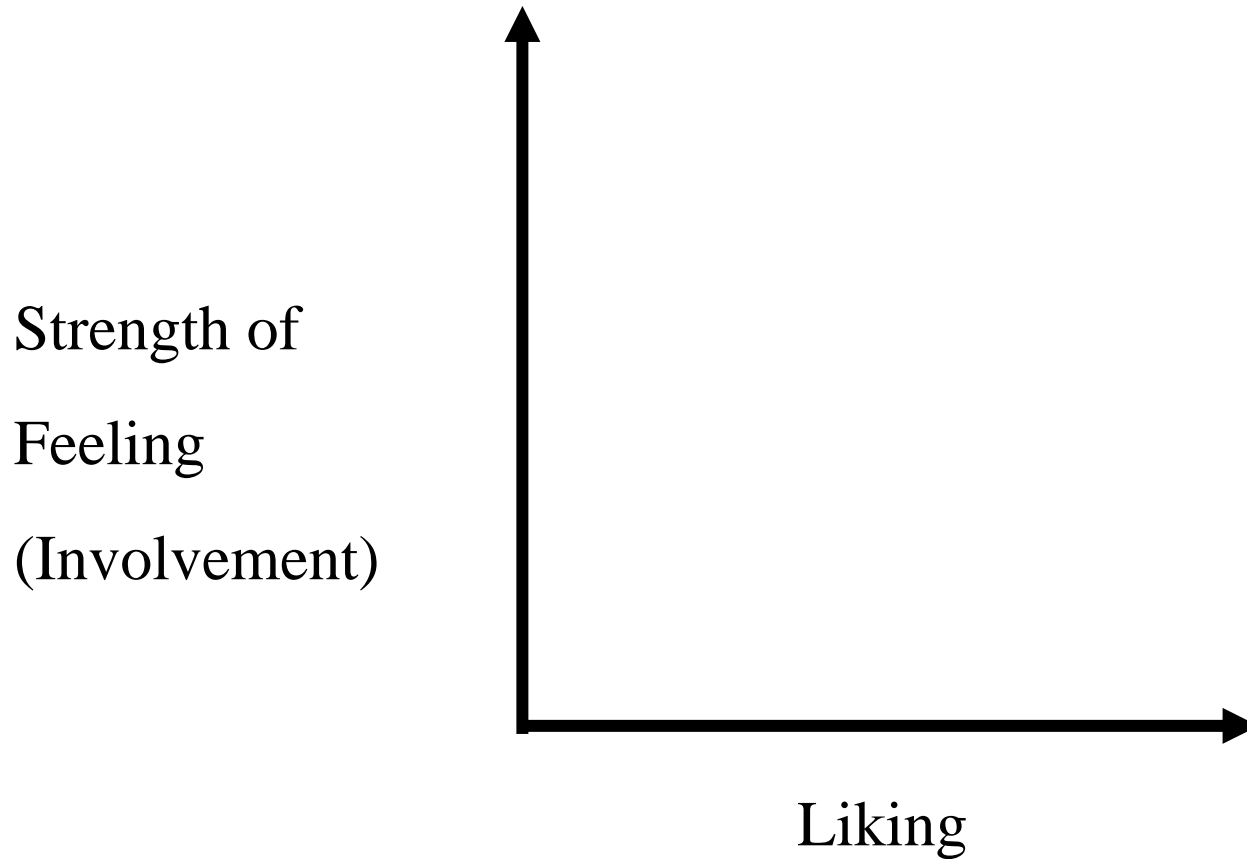
Popper, Rosenstock, Schraidt, Kroll (2004) The effect of asking questions on attribute ratings. Food Quality and Preference, 15,853-858

A provoking proposal

- FQAP should not accept papers where sensory attributes or just about right attributes are asked before or simultaneously with liking
- Watered down proposal
 - Liking
 - Intensity modulated liking
 - JAR modulated liking

Postscript – accelerated testing

Affect is one or two-dimensional?



This work of Pieter Desmet is fascinating

Cross cultural

Non verbal

Derived for
design objects

PrEmo_demo

PrEmo DEMONSTRATION version 8.0

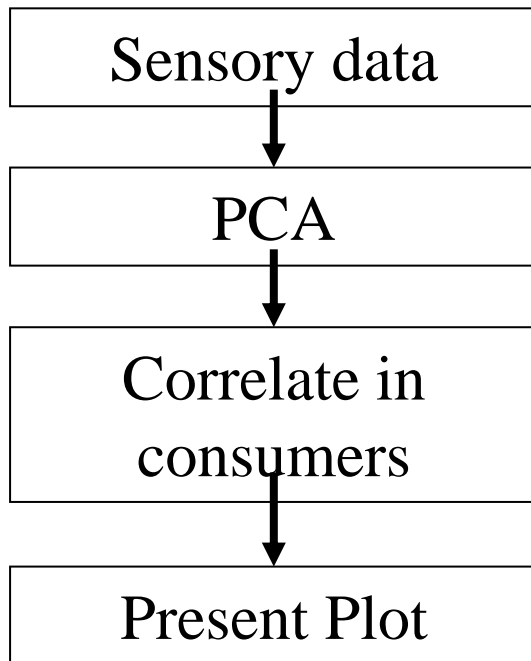
You can now rate each character by clicking on it. Please use the coloured scales to report to what degree the feelings expressed by the characters correspond with your own feelings.

I feel this strongly
I feel this somewhat
I do not feel this

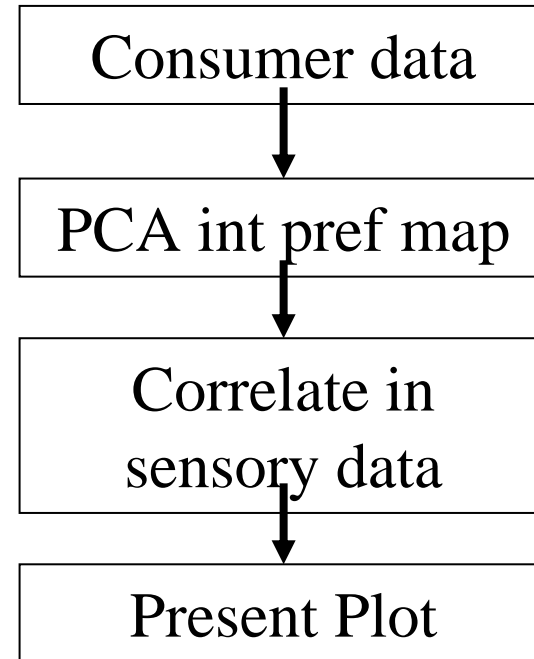
next

Internal versus External Preference mapping

External Preference
mapping
Vector model



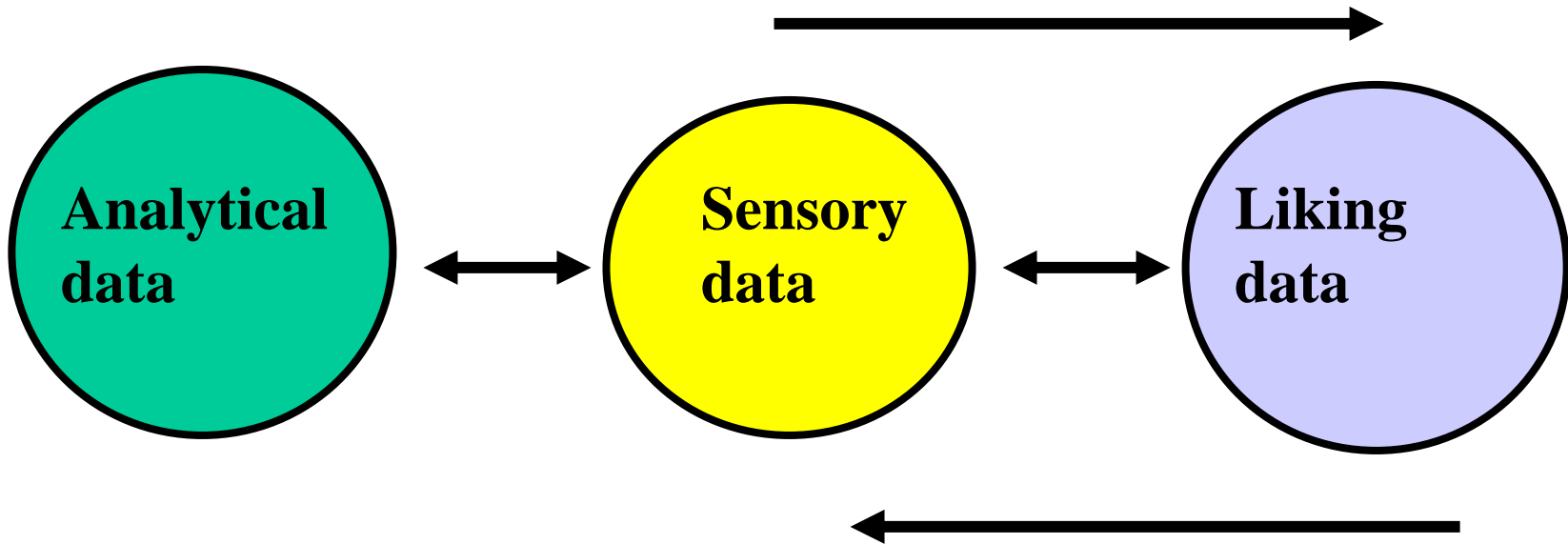
Internal Preference
mapping



Van Trijp and colleagues in paper to appear in FQAP point out that different food specialisms prefer internal or external and that the innovation arising from each approach may vary

Mapping Issues

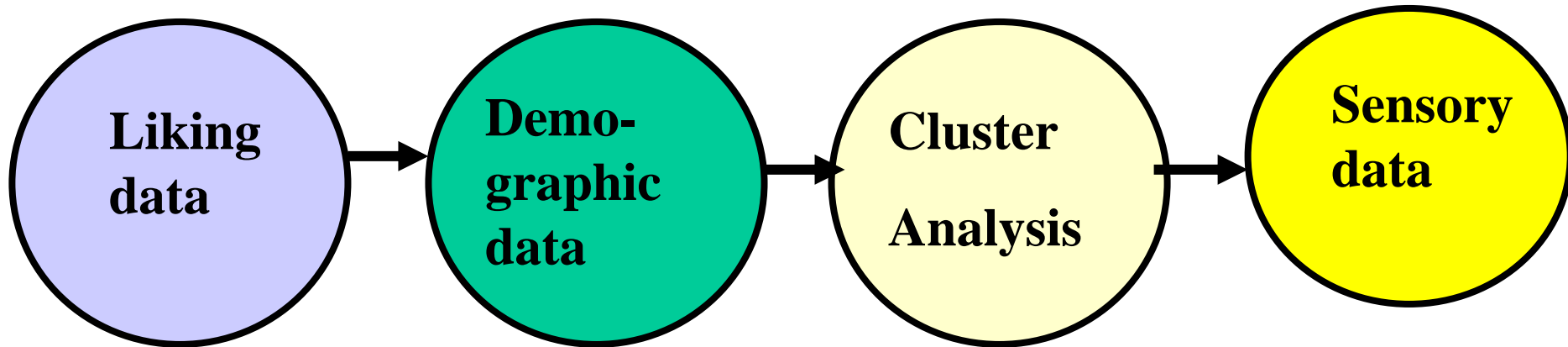
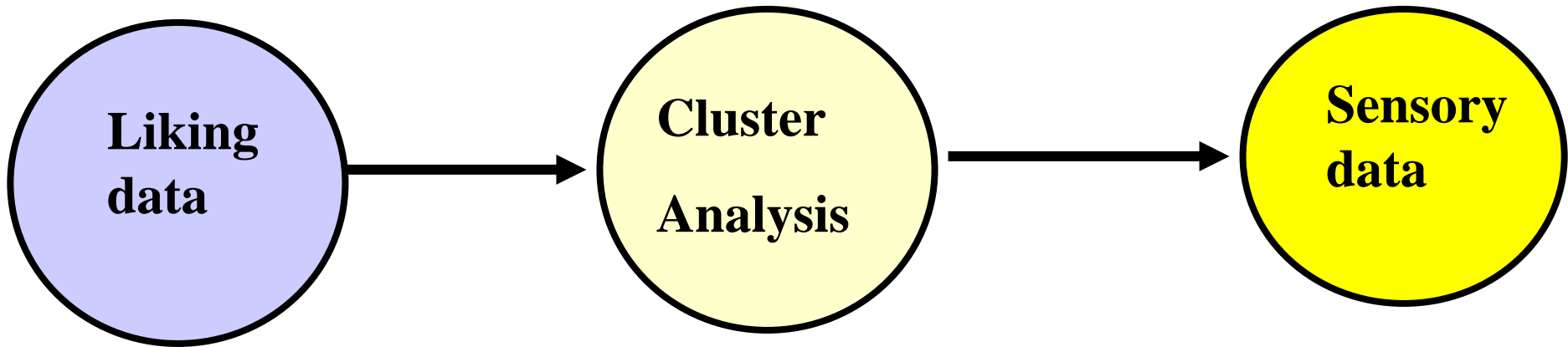
Need to project new sensory samples into liking space



Need to estimate the sensory properties of a potential new product in the liking space

Mapping Issues

Are we too quick to use clustering?

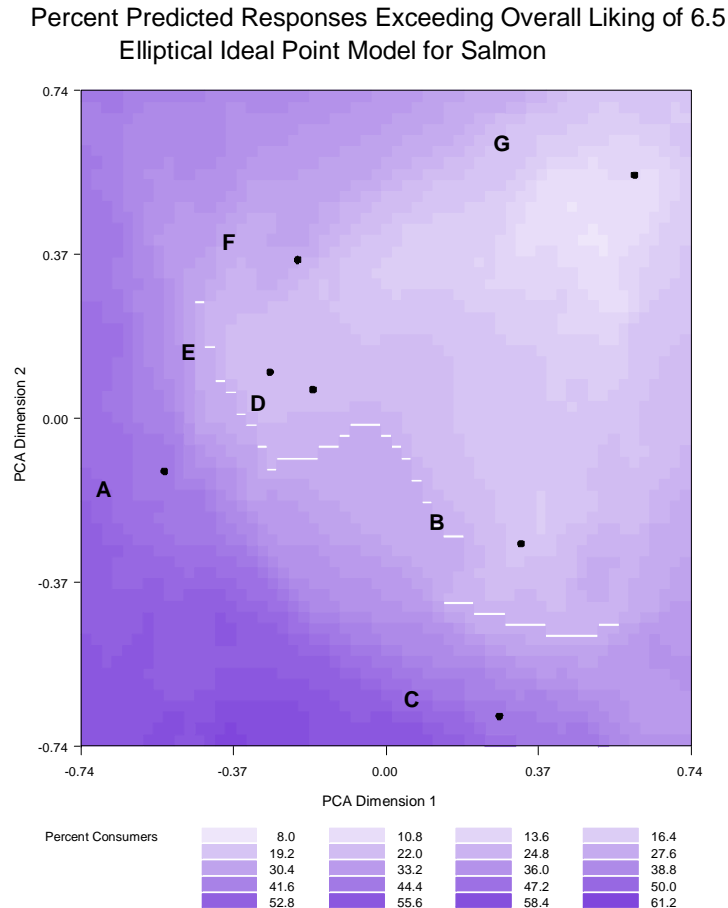


Psychographic measures may be more useful

Psychographic measures that could characterise liking and choice patterns

- Variety seeking scale (Van Trijp)
- Food Involvement scale (Bell and Marshall))
- Food Lifestyle scale (Grunert et al)
- Restrained eating scale (Van Strien)
- Private Body Consciousness (Stevens)
- Neophobia scale (Pliner and Hobden)
- Need for cognition scale (Cacioppo and Petty)

Making products that will satisfy many segments



This contour plotting idea, derived by Danzart, is now widely used and is available in FIZZ and elsewhere

Introducing the idea of a cut –off limit for a category is useful to give product developers more freedom.

Future: Mapping

- More attention to question bias
- Latent class – probabilistic modelling
- Structural equation modelling (more later)
- Psychographic measures
- Cut-off modelling

Decision making

- Conjoint Analysis widely used in concept testing
- Internet testing reduces costs and speeds up tests but questions remain
- Many interesting innovations
 - Eg each respondent is given a fixed time and the model fits based on the data given (HM)
 - Self authoring conjoint (HM)

Shelf-Facing Display Presentation

The CBC/Web Advanced Design Module supports “shelf-facing” presentation, as shown below (this feature is not supported in CBC for Windows). This graphic has been sized to fit within this document—it is bigger and clearer on a PC monitor.



This image from the SAWTOOTH Program literature indicates the shelf display option and conceptually, offers large numbers of choices to respondent in a realistic setting

Hierarchical Bayes

- A recent addition that improves on Multinomial Logit fitting
- If an individual is fitted well by the procedure his individual model is used for prediction
- If not fitted then the global model is used.

Hierarchical Bayes Approach

Richard Johnson: Sawtooth Software Research Paper Series

- 6 conjoint attributes with a total of 17 levels.
- Each respondent answered 18 customized choice questions with 5 alternatives plus a further 9 hold out choice questions, also with 5 alternatives.
- Part worths were fitted using HB based on 18, 9, 6 and 4 choices per respondent. These were used to predict the hit rate of the hold out choices

Even with as few as four choice tasks per respondent, the hit rate is much higher than the 20% expected by chance

| No of tasks | Hit Rate |
|--------------------|-----------------|
| | |
| 18 | 0.660 |
| 9 | 0.602 |
| 6 | 0.556 |
| 4 | 0.518 |

Could be a means to do view and taste trials

Conjoint Future

- More incomplete designs
 - These will be suitable for taste factors where few tests per respondent are possible
- More choice based models
 - A recent review noted this to be the fastest growing method
- More internet testing on concepts
 - Costs savings and extra information about respondents will overcome reservations

Combined Approaches

Total Food Quality Model

The importance of cues in decision making and the distinction between intrinsic and extrinsic cues made by Steenkamp, Van Trijp and colleagues are emphasised in this model

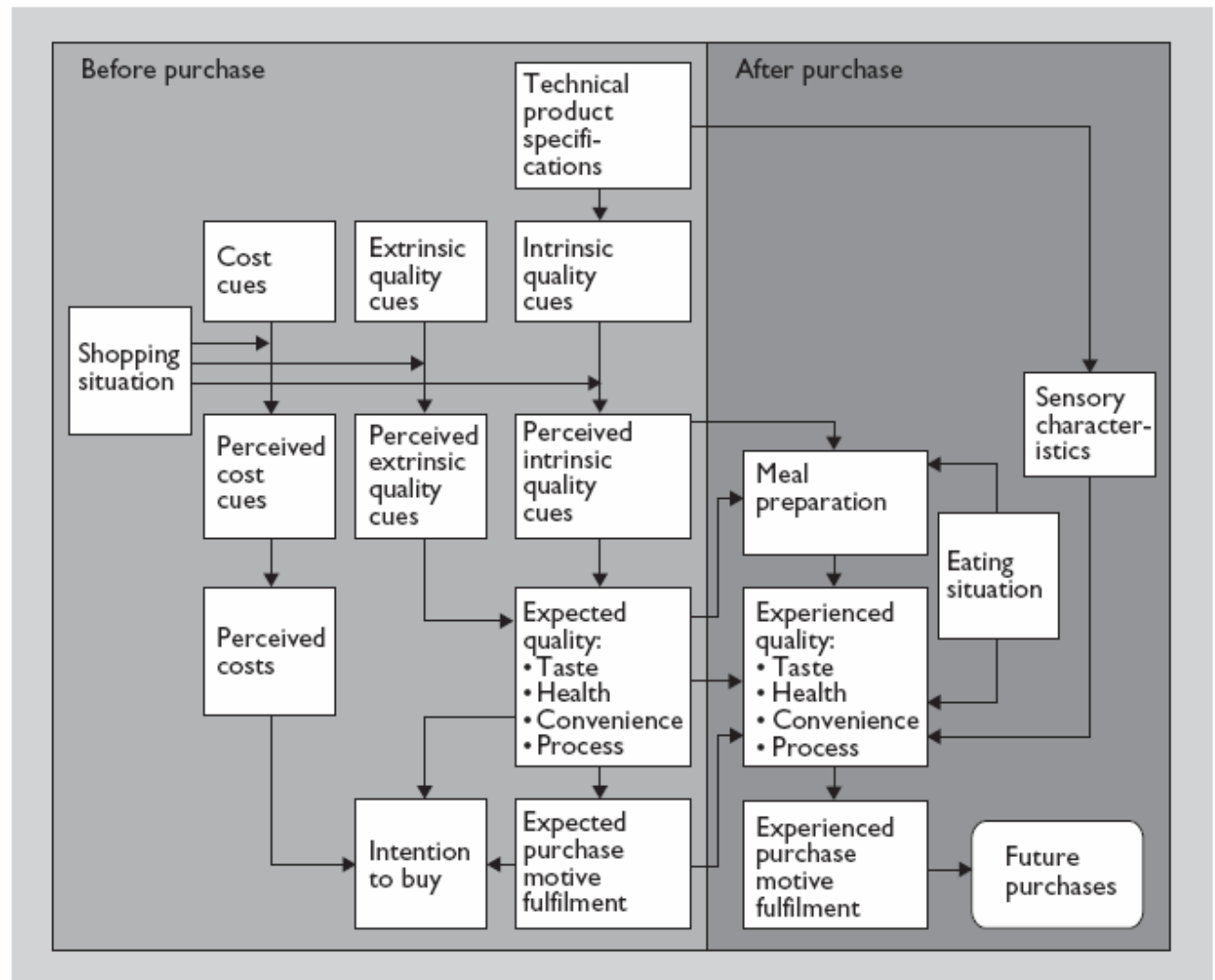


Figure 3.1. The Total Food Quality Model.

What happens when cue expectations are inaccurate

Type 3 meat has a high visible fat level but the sensory properties after cooking are liked.

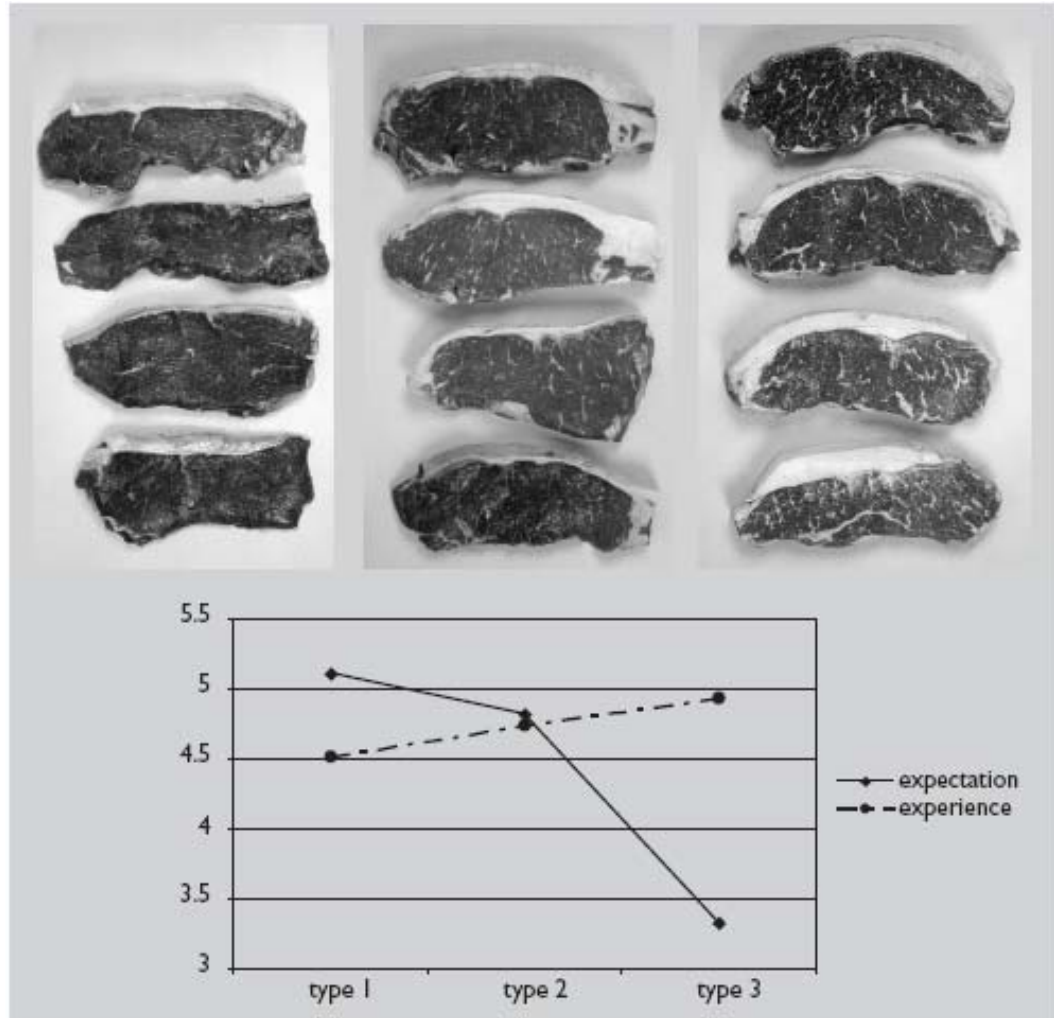


Figure 3.8. Quality expectations and experience for 3 meat types.

A case study in relating sensory descriptive data to product concept fit and consumer vocabulary

Carr, B.T. / Craig-Petsinger, D. / Hadlich, S., Food Quality and Preference, Jul 2001

A nice example of a combined sensory testing and consumer testing with a message for us all

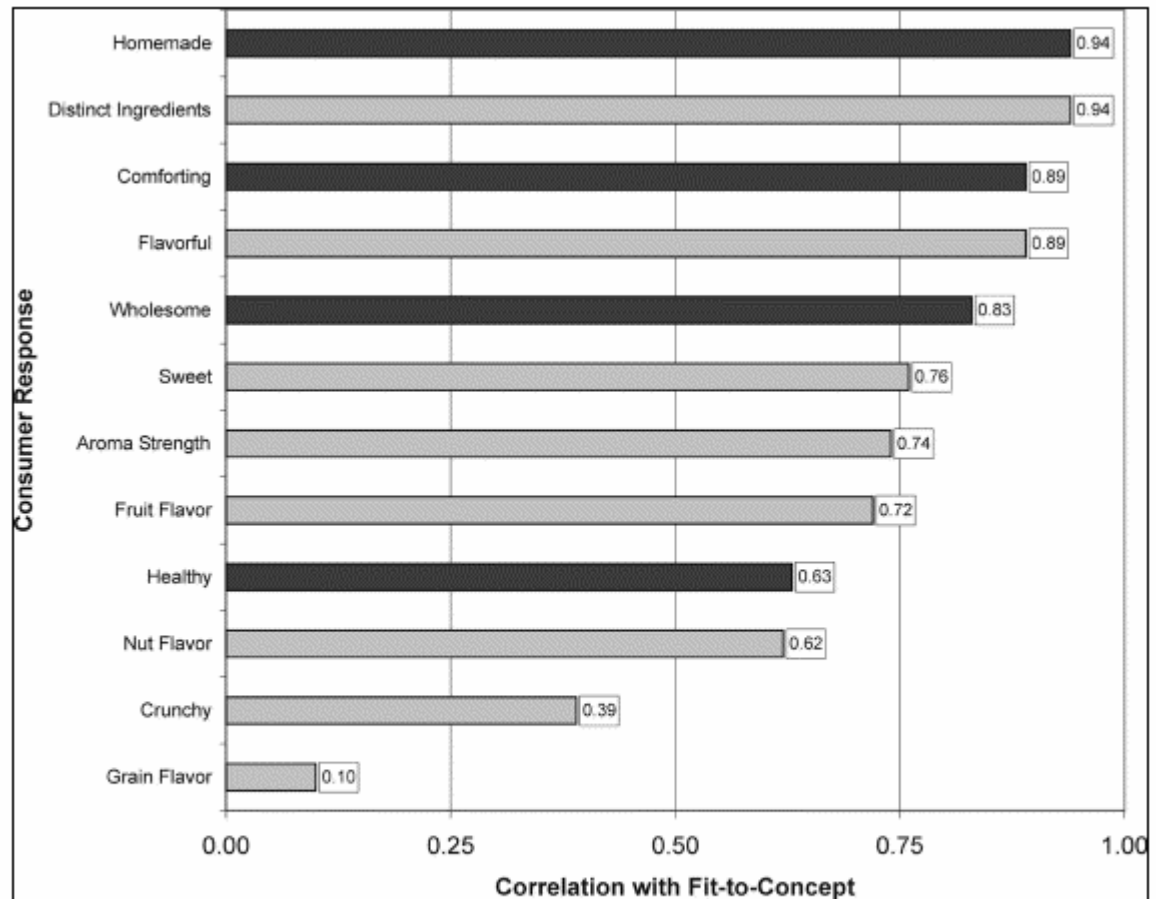
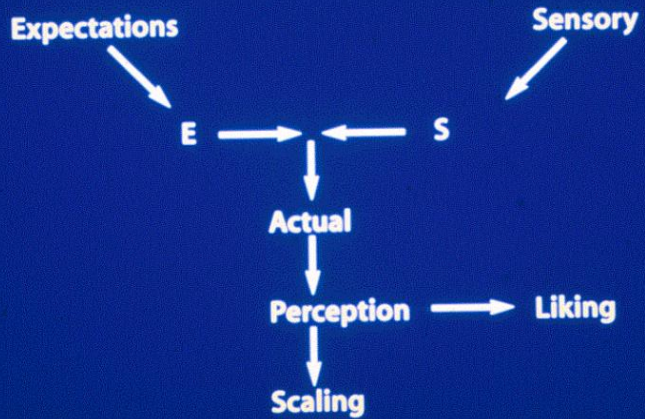


Fig. 1. Correlations of consumer fit-to-concept ratings with consumer image and product description attributes show that fit-to-concept relates more to image attributes than to product description attributes.

Expectations and Sensation - Decision Making

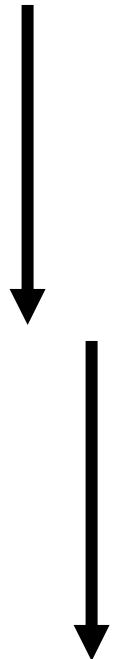


CLT

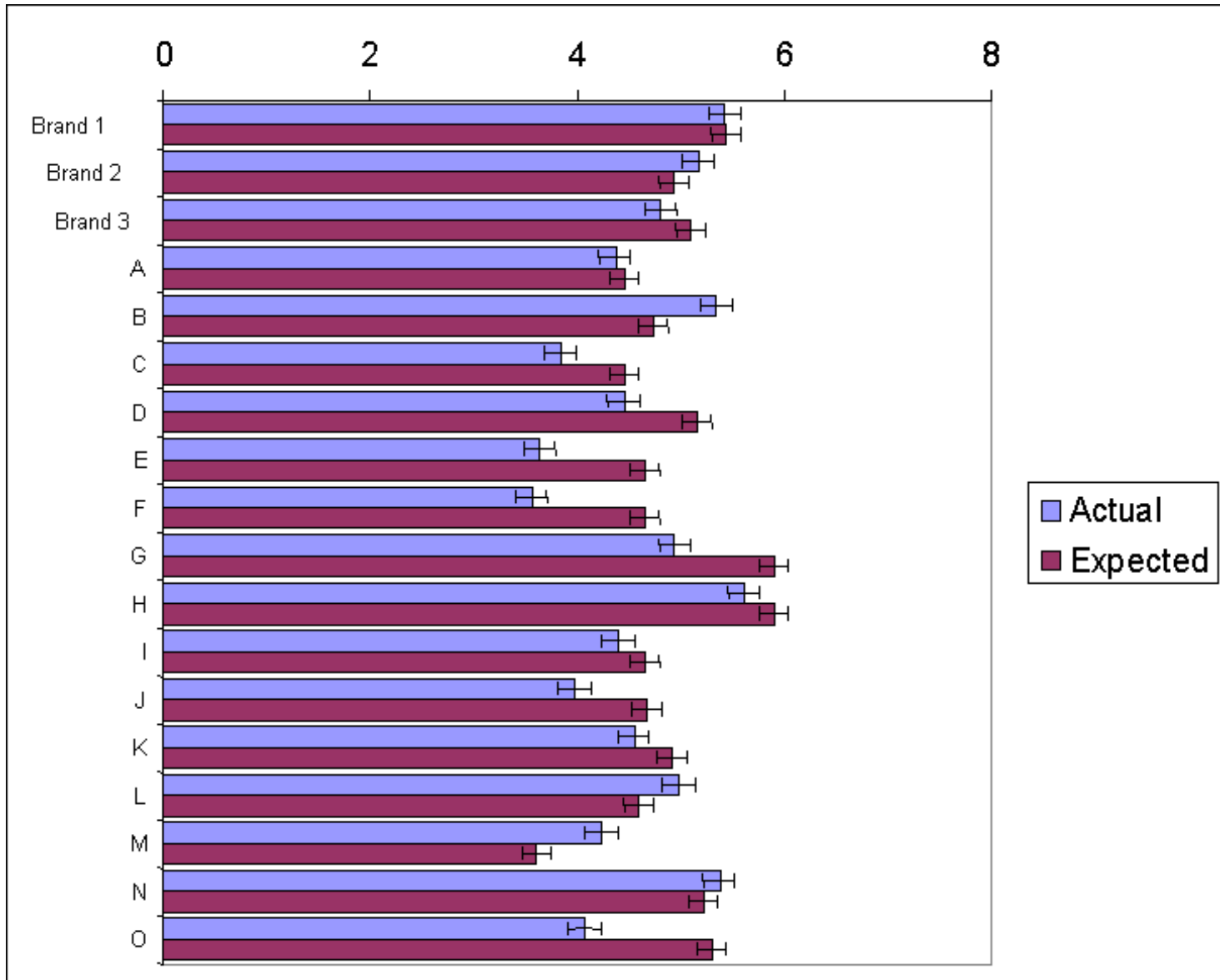
Blind testing

Package
Concept testing

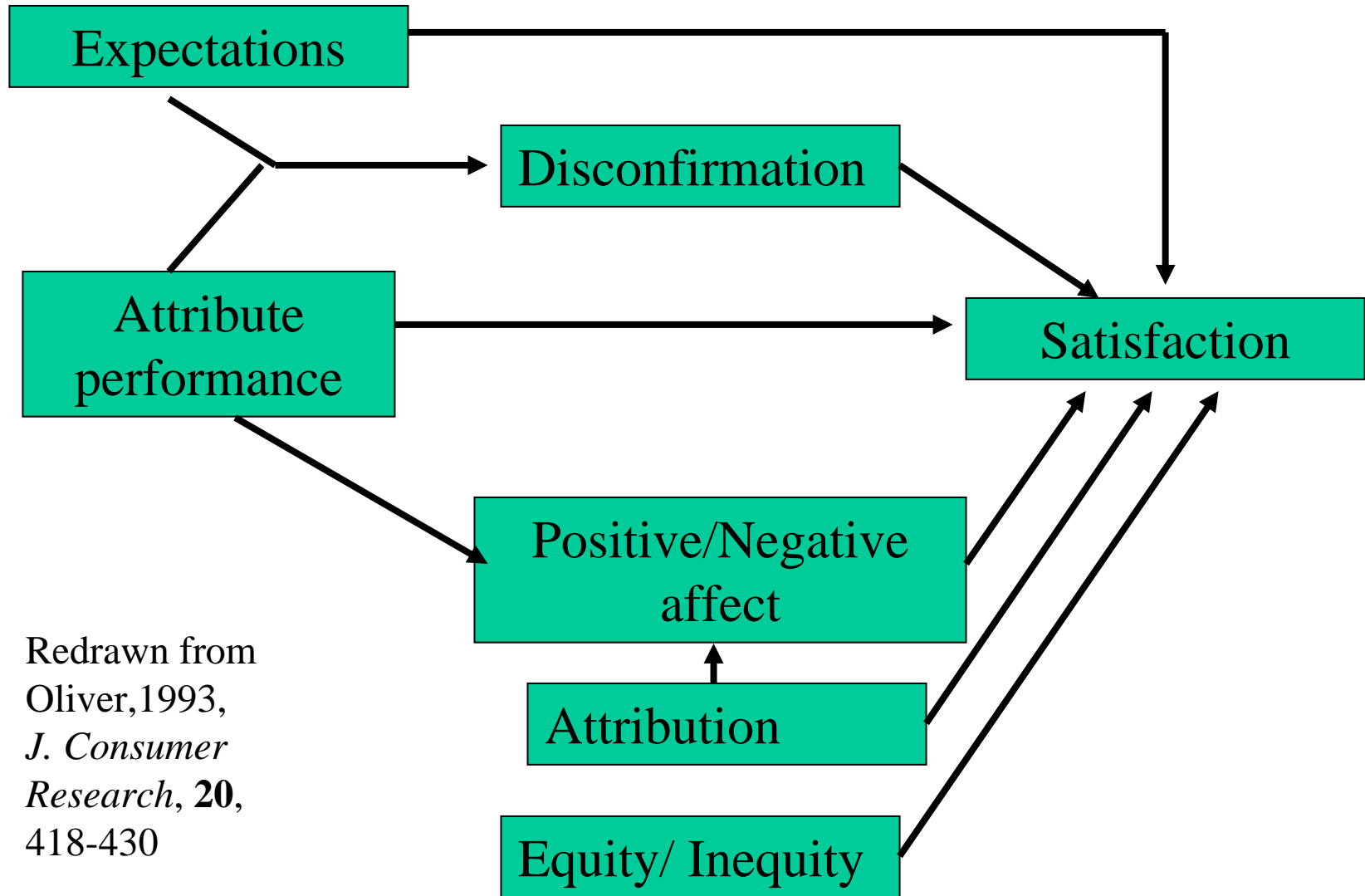
Combined
package/taste



Sensory expectation : eg Creaminess



A model of expectations and performance to satisfaction



Redrawn from
Oliver, 1993,
*J. Consumer
Research*, **20**,
418-430

Food Choice

- Cognitive frameworks
 - Means End chain
 - Fishbein Ajzen

Means End Chain Models

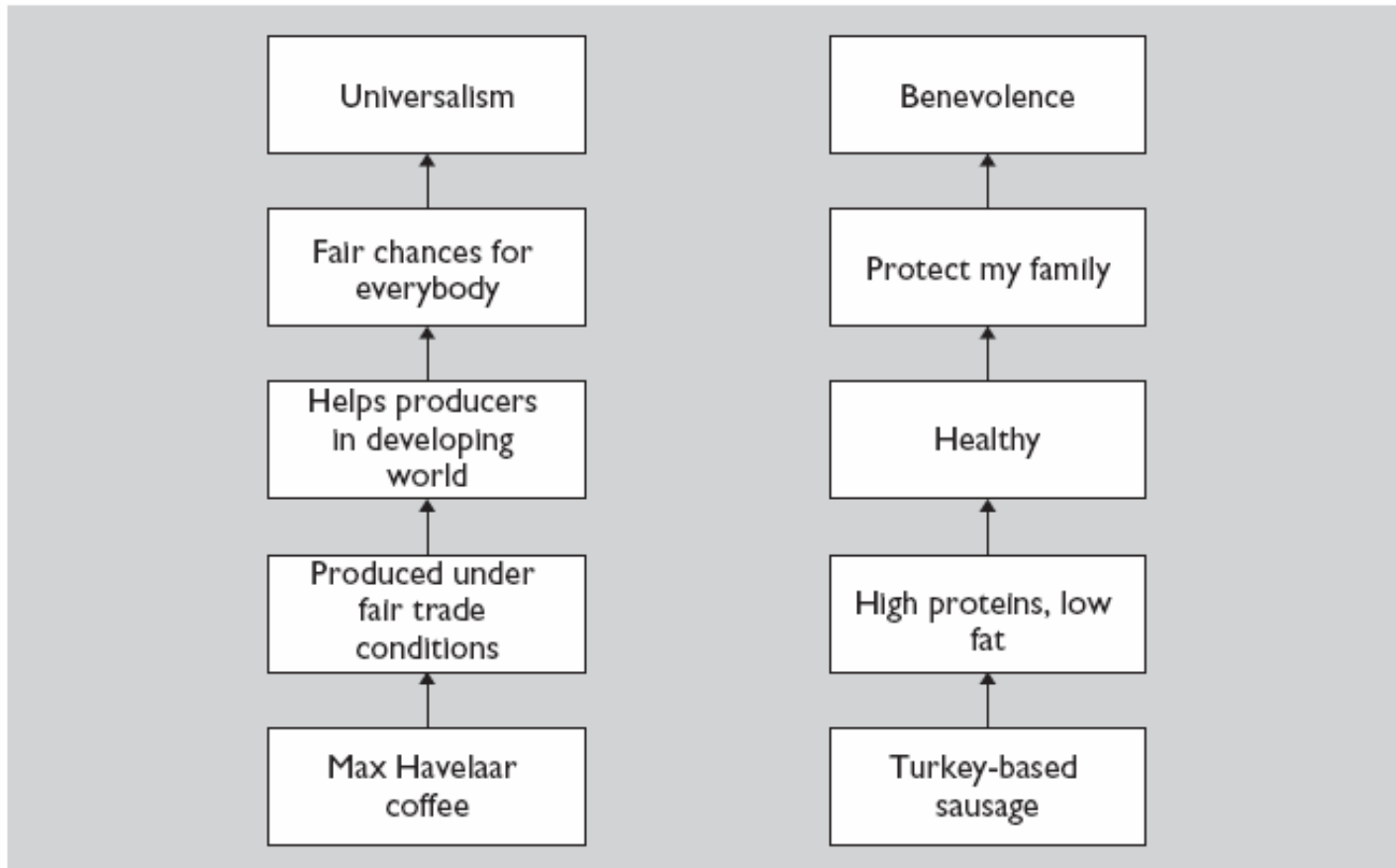


Figure 3.2. Relationship between product characteristics and personal goals at different levels of abstractness.

Hierarchical Value Maps

Consumer behaviour with regard to food innovations: Quality perception and decision-making

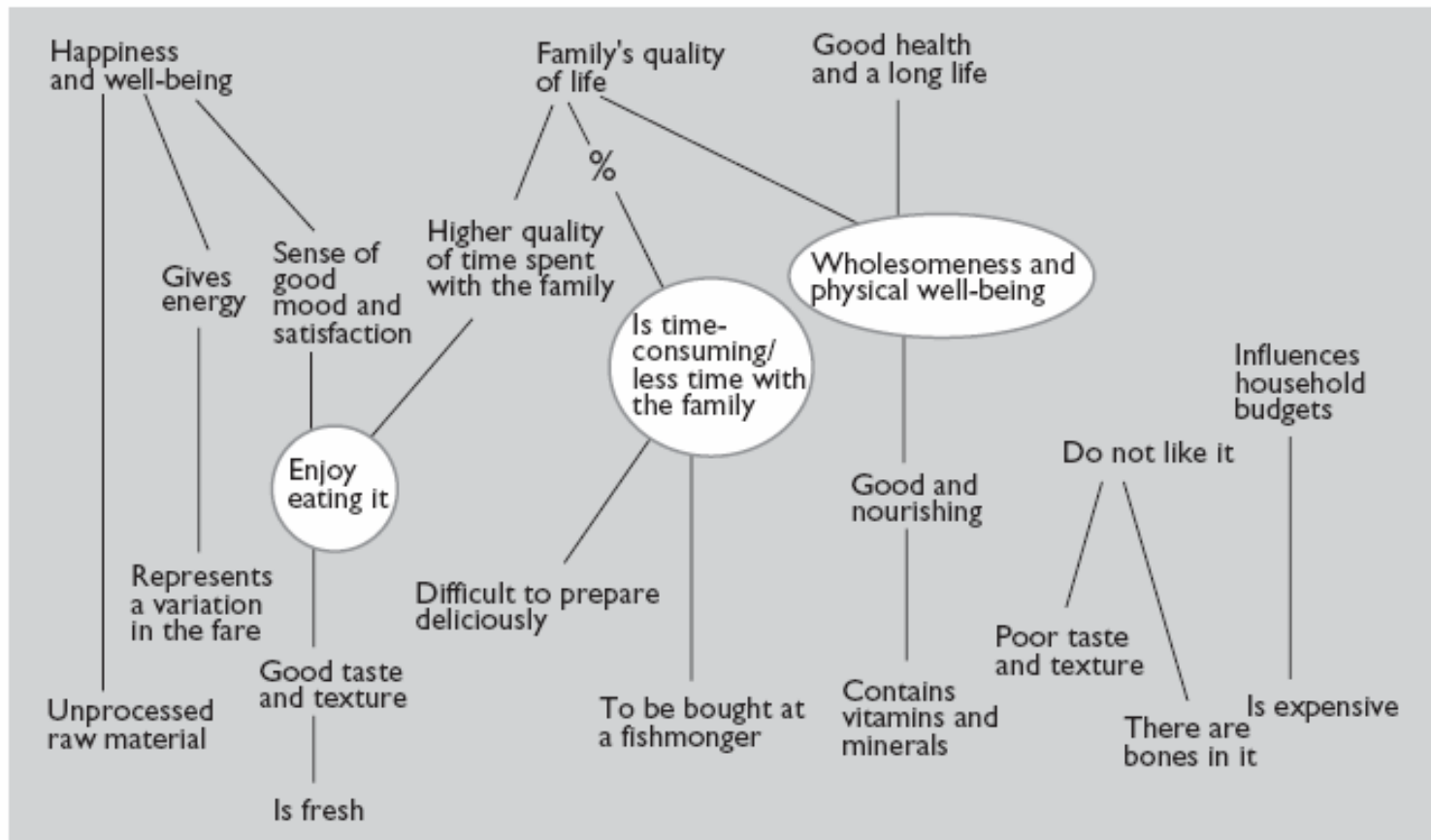


Figure 3.3. Hierarchical value map for fresh fish.

The meaning of Price

Price is used at purchase

But is it an important cue affecting sensory expectations?

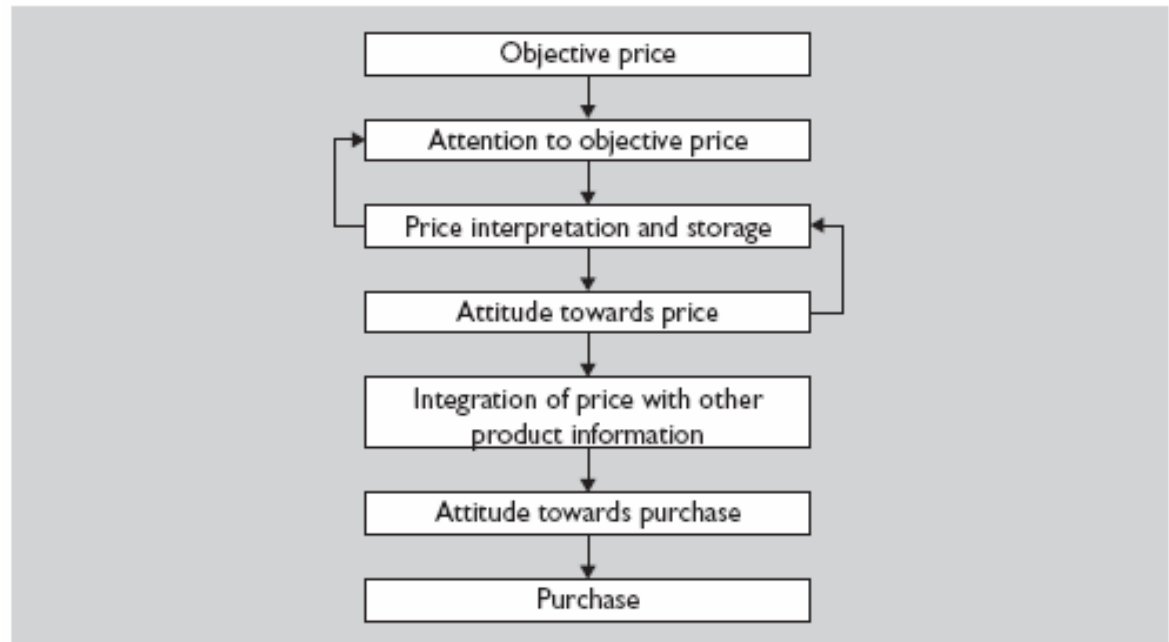


Figure 3.9. Price perception and processing.

Structural Equation Modelling

Widely used in economics, psychology, marketing modelling

It enables complex interrelated hypotheses to be tested

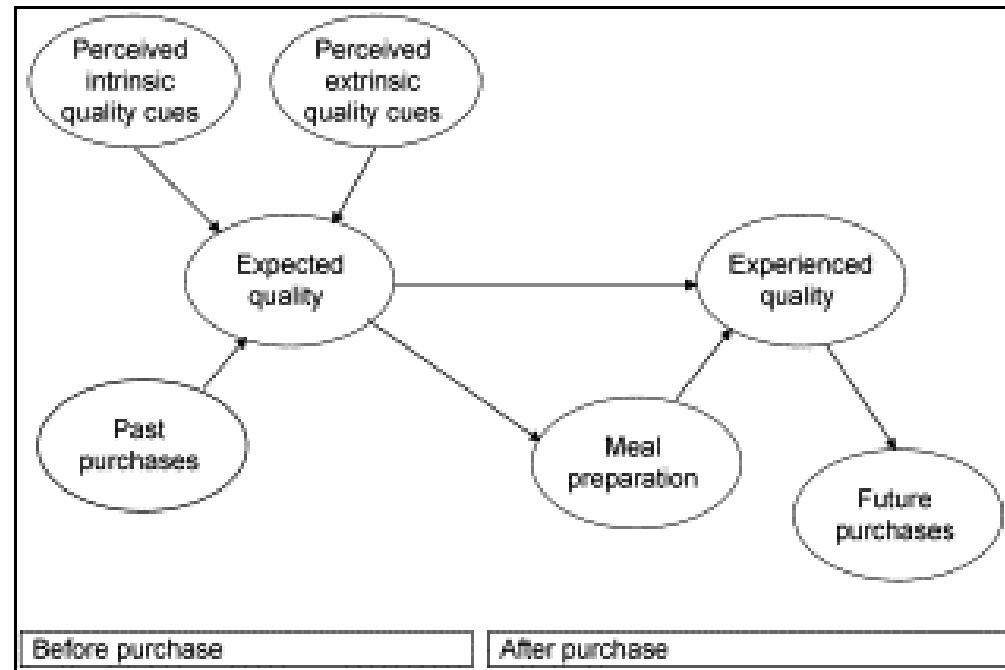
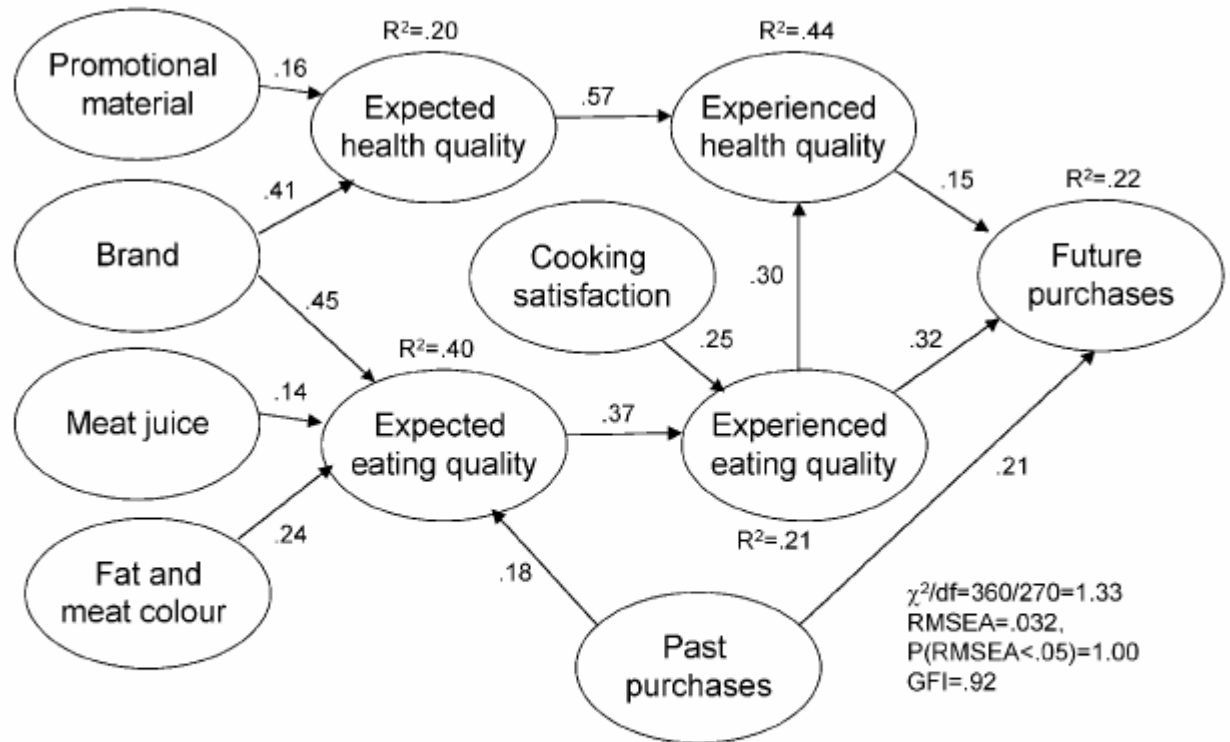


Fig. 1. Elements investigated and their hypothesized interrelations.

Structural Equation Modelling

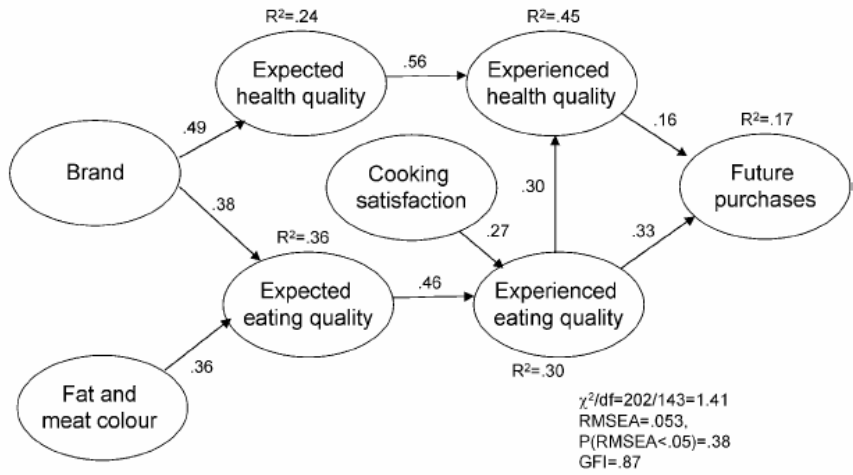
The existence and strength of interrelations are indicated



¹ Only statistically significant relations are shown ($p < .05$).

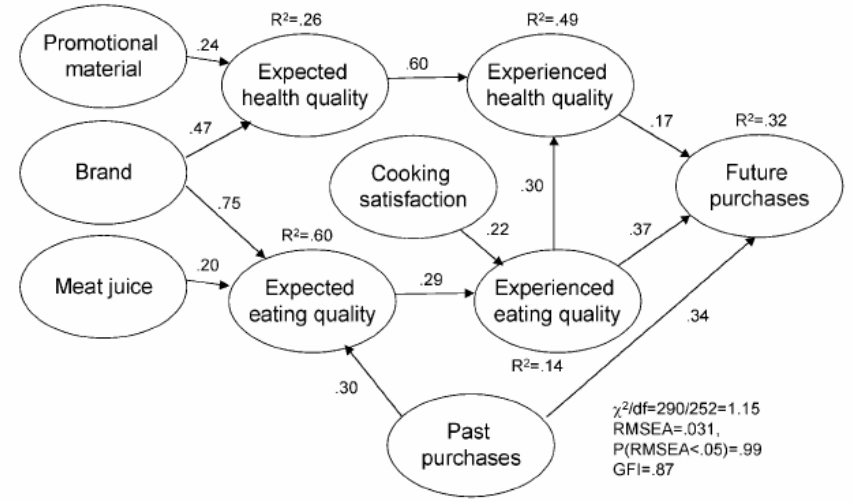
Fig. 2. Structural model—all respondents.

Structural Equation Modelling



¹ Only statistically significant relations are shown (p<.05).

Fig. 3. Structural model—high familiarity respondents.



¹ Only statistically significant relations are shown (p<.05).

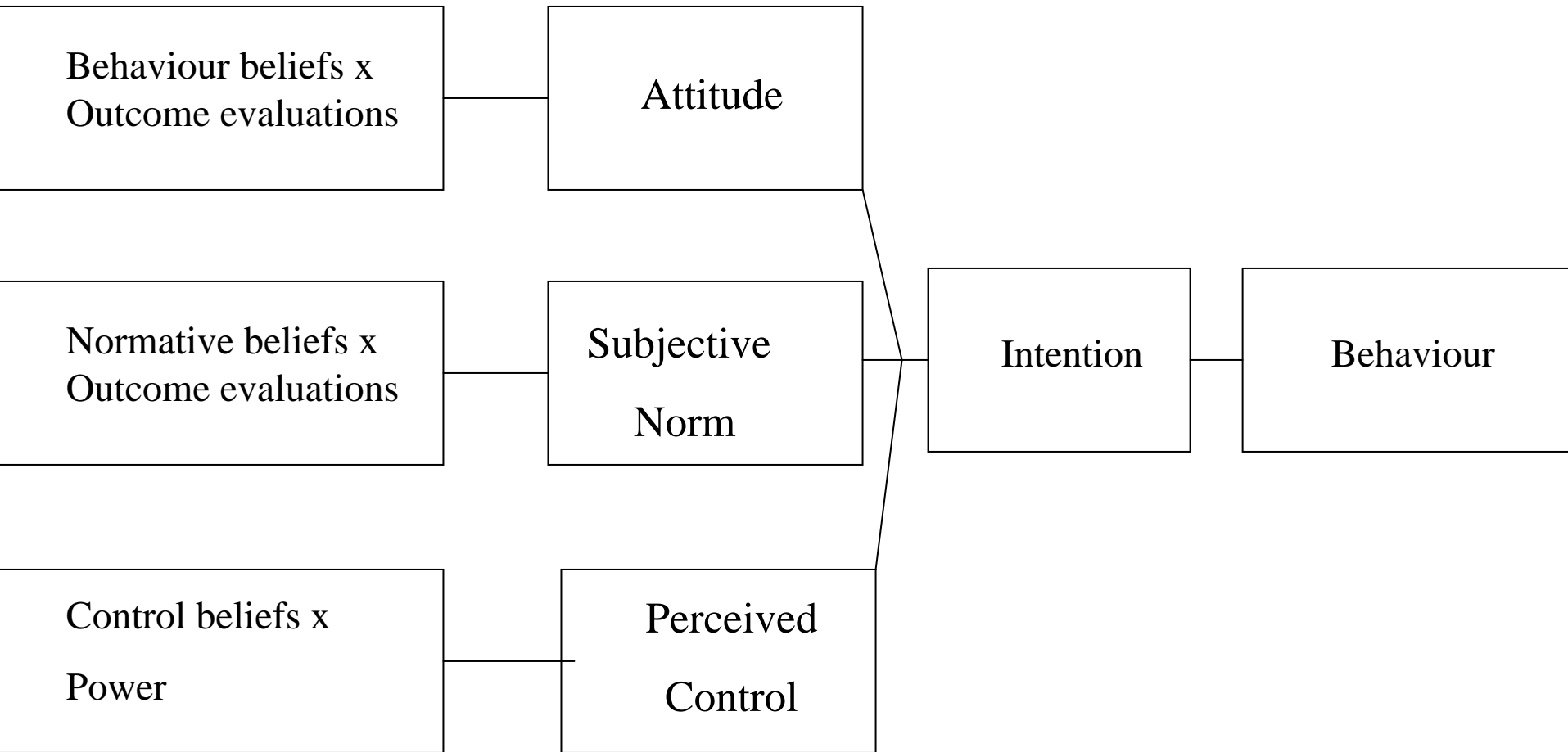
Fig. 4. Structural model—low familiarity respondents.

And compare the relations in different segments.

It is a very powerful technique

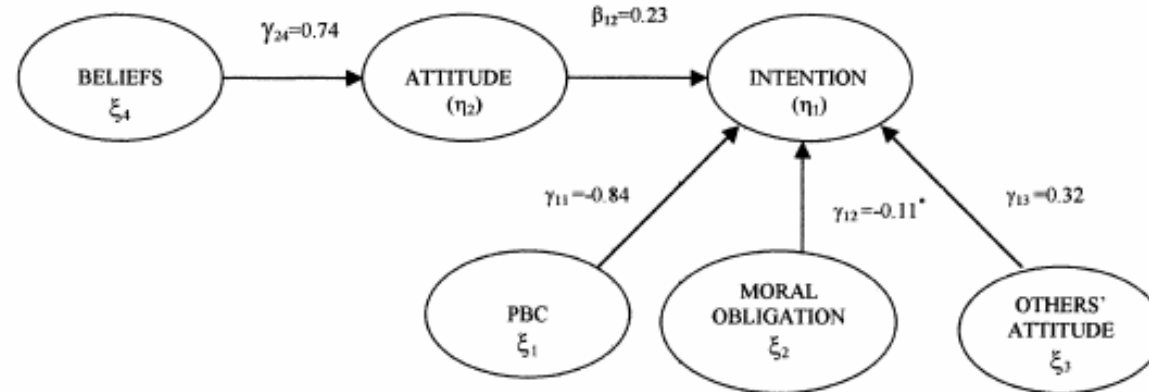
Attitude Change

Schematic Representation of the theory of planned behaviour



Consumer attitudes toward the use of gene technology in tomato production

Anna Saba*, Marco Vassallo



* t-value not-significant at level 0.05

Fig. 3. A representation of the model. The causal standardized path coefficients between the variables beliefs, attitudes, planned behavioural control, moral obligation, intention, are shown. The indexes GFI, AGFI, RMSR, the multiple coefficients of determination for the structural equations of the variables attitude and intention, $R_{\eta_1}^2$ and $R_{\eta_2}^2$, respectively, are reported as well.

Structural Equation modelling is very useful in this application too.

Where are we going?

- Coming out of the kitchen
- Measurement issues must be addressed
- Cognitive sensory interactions will be better understood (Brand/Package/Sensory)
- Structural modelling big potential
- Higher level input into product development cycle