EUROFOODS-ENFANT

FLAIR EUROFOODS-ENFANT PROJECT

LANGUAL CODING EXPERIMENT

April 1993

REPORT

LANGUAL CODING EXPERIMENT

By: J. Deary
Ministry of Agriculture, Food and Fisheries
London, United Kingdom

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"Improvement of the Quality and Compatibility of Food Consumption and Food Composition Data in Europe"

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CONTENTS

Section

1. INTRODUCTION

1.1 One of the primary aims of the EUROFOODS-ENFANT Project (a FLAIR Concerted Action Programme of the EC concerned with improvement of the quality and compatibility of food consumption and food composition data in Europe) is to seek ways to facilitate the *exchange* of information on food composition and food consumption in Europe.

1.2 In January 1992 a Working Party on "Food Coding Systems and Food Consumption Data" met to clarify the issues involved in evaluating a common food coding system which is a fundamental requirement for exchanging accurate, unambiguous data on food. The Working Party was looking to a future where, for example,:

- nutrient values for a food could be transferred from one nutrient database to another;

- the degree of similarity of a food in one database could be compared with that in another;

- groups of related foods could be retrieved through commonly-used terminology.

1.3 The ordinary-language description of a food is un-informative about the composition of the food and foods with the same name can be different compositionally in significant respects. The Working Party noted that the requirement was for a food coding <u>and</u> a food description model. Moreover, since LANGUAL was the most developed and widely used model for describing foods, it was decided that resources should be concentrated on evaluating the utility and suitability of LANGUAL as the *de jure* food indexing model in Europe.

1.4 LANGUAL (<u>Langu</u>a <u>Al</u>imentaria) is a faceted, hierarchical food vocabulary developed about 20 years ago by the U.S. Food and Drug Administration in co-operation with the U.S. National Cancer Institute. It is a flexible, open ended food description language in which foods are assigned numerical codes within facets, identified by letter, that describe attributes of the food (e.g. Product Type, Food Source) important for food safety and nutritional quality. *Prima facie* LANGUAL has a number of beneficial features:

(i) it has benefited from considerable investment in the U.S.A.;

(ii) it is a highly developed prescriptive model which is easy to use and well supported with documentation;

(iii) various databases (approximately 20) within the U.S. have been coded using LANGUAL. Within Europe, administrations in Denmark, France, Belgium and Hungary have used LANGUAL to code either food composition or food consumption databases.

1.5 However, members of the Working Party agreed that LANGUAL should be evaluated thoroughly before considering recommending its widespread adoption in Europe. In particular, the evaluation procedure should aim to comment on the following criteria:

(i) **Reproducibility**
The extent to which different people code identical foods the same;

(ii) **Correctness**
The extent to which different people code foods correctly (two people can code the same foods identically but both may be wrong);

(iii) **Completeness**
The extent to which LANGUAL provides descriptors for all the characteristics of interest to a food scientist or nutritionist;

(iv) **Training**
The extent to which LANGUAL training is essential;

(v) **Retrieval**
The extent to which the expected foods are selected when retrieving from a database coded in LANGUAL.

1.6 The Working Party accepted that the retrieval aspect of the evaluation criteria could be problematical (a database of foods coded in LANGUAL with appropriate retrieval software would have to be available) and in any case there would be little point in conducting a retrieval experiment if LANGUAL failed to satisfy the other criteria (especially consistency of coding between different coders). It was decided by the Working Party to concentrate on designing an experiment to evaluate criteria (i) - (iv) and to address the retrieval aspect later and only if LANGUAL could be used successfully as a model for coding foods and the characteristics of foods of interest to a food scientist and/or nutritionist.

2. EXPERIMENTAL OBSERVATIONS AND DETAILS

2.1 In order to test the reproducibility, correctness and completeness of LANGUAL and the importance of training, the Working Party decided that a two stage experiment should be conceived. Candidates would be asked to code a list of foods using the LANGUAL manuals and thesauri before receiving formal training in LANGUAL. The same candidates should then be invited to a LANGUAL training workshop following which they would be asked to code a second list of foods. The Working Party compiled a list of some 50 foods on which to select foods for coding. The select list of foods was designed to be representative of foods eaten across Europe including simple foods, widely available commercial foods and recipe foods.

2.2 In the event 20 candidates from 15 different countries in Europe (including non-EC countries) were invited to participate in the coding experiment. each of the candidates selected had expertise as either a nutritionist, food technologist or food scientist but none had any detailed working knowledge of LANGUAL. A list of the candidates names, organisation and addresses is attached at Appendix 1.

2.3 From the selected list of 50 foods, three members of the Working Party produced two separate lists of foods: one list (the "round 1" list) of 20 foods to be coded before attending the training workshop and the other list, also of 20 foods (the "round 2" list) to be coded after attending the training workshop. Both lists of foods were subdivided into simple foods (for example leek, raw), complex commercial foods (for example puffed rice breakfast cereal) and recipe foods (for example omelette cooked in butter). Recipes were chosen from McCance and Widdowson's "The Composition of Foods" except for two of the recipe foods in "round 2" for which candidates were asked to supply and code their own chosen recipes. the structure of the selected lists of foods was as follows:

STRUCTURE OF SELECTED LISTS OF FOODS

	"ROUND 1" LIST	"ROUND 2" LIST
SIMPLE	10	10
COMPLEX	5	4
RECIPE	5	6

Some of the foods in "round 1" were repeated in "round 2" as follows:

- Simple foods 5
- Complex foods 2
- Recipe foods 2

2.4 It was an important feature of the experiment that all candidates were coding the same identical foods (except for the two national recipe foods in "round 2"). To this end, each candidate was provided with a list of foods and a complete description of each food to be coded.

2.5 In addition to the descriptive lists of foods, candidates were provided with a complete set of LANGUAL documentation and a standard form was prepared to use to code each food. The form is shown in Figure 1 opposite. The lists of foods for both rounds is attached at Appendix 2.

2.6 The form shown at Figure 1 requires some comment. Obviously it had to be prepared in advance and some assumptions had to be made as to how candidates would code foods. As can be seen by inspection of the form, candidates were required to code 13 LANGUAL facets for each food. The facets are identified by letter and the facet description is noted in the second column. It was assumed that candidates would give only one "factor term" for facets A through F, J and K, but, perhaps, more than one factor term would be needed for facets G, H, M, N, P and Z. Based on the description of the food, candidates were required to search the LANGUAL thesaurus for a factor term (or terms) which described as fully as possible the characteristics of the food for each facet.

2.7 Once the "round 1" list of foods was coded, candidates were required to return their coding forms to **Jim Deary** (Ministry of Agriculture, Fisheries and Food, London) who was responsible for evaluating the results. Candidates were then invited to a training workshop in Paris on 7, 8 and 9 May 1992 which was organised by **Jayne Ireland-Ripert** (Centre Informatique sur la Qualité des Aliments, Paris). At the workshop, candidates were trained by **Elizabeth Smith** (Centre for Food Safety and Applied Nutrition, Food and Drug Administration, U.S.A.) assisted by **Jayne Ireland-Ripert.** In addition to training in LANGUAL, candidates also provided information on the problems of using LANGUAL (addressing our "completeness" criteria).

2.8 In order to evaluate the results of each candidate's coding it as decided that an experienced, expert LANGUAL coder should be asked to code all of the foods for both rounds and in this way each candidate's results could be compared with the "ideal" answers. **Jayne Ireland Ripert** together with **Elizabeth Smith**, both experienced LANGUAL coders, provided the "ideal" LANGUAL codes for each food. In addition to providing the "ideal" answers for each food, these experts also provided up to two acceptable alternative answers for each facet wherever appropriate or possible. Typically, the alternatives to the "ideal" codes are "broader" terms which carry less specific information. For example, for "puffed rice breakfast cereal" the ideal code includes two factor terms under facet H for vitamin added (H0215, vitamin C added and H0216, vitamin B added). However, the experts were prepared to accept as a first alternative H0163 (vitamin added) - clearly less specific - or H014 (nutrient or dietary substance added) as a less preferable second alternative. The experts' LANGUAL coding and the alternatives permitted are shown in Figure 2 opposite for the food "puffed rice breakfast cereal".

EUROFOODS-ENFANT LANGUAL FOOD CODING EXPERIMENT

Name of Coder

Country:

Date of Entry: ....

BeforeTraining (Tick appropriate box) ☐

After Training ☐

Food Name:

Food Description: .Refer to attached sheet

	FACET	FACTOR DESCRIPTION	FACTOR CODE
A	PRODUCT TYPE		
B	FOOD SOURCE		
C	PART OF PLANT or ANIMAL		
E	PHYSICAL STATE OR SHAPE		
F	EXTENT OF HEAT TREATMENT		
G	COOKING METHOD		
H	TREATMENT APPLIED		
J	PRESERVATION		
K	PACKING MEDIUM		
M	CONTAINER OR WRAPPING		
N	FOOD CONTACT SURFACE		
P	CONSUMER/DIETARY GROUP		
Z	ADJUNCT CHARACTERISTICS		

Comments:

If necessary, please continue overleaf

Figure 1

Puffed Rice Breakfast Cereal (eg Rice Krispies), Cardboard Box With Liner [List of Ingredients]

PREFERRED		1ST ALTERNATIVE		2ND ALTERNATIVE	
Term	Description	Term	Description	Term	Description
A0258	Breakfast Cereal			A0106	Prepared Grain or Starch Product
B1322	Rice				
C0132	Seed or Kernel, Skin Removed, Germ Present	C0134	Seed or Kernel, Skin Removed	C0208	Seed or Kernel, Skin Removed, Germ Removed
E0153	Whole, Shape Achieved by Forming, Thickness <0.3cm	E0147	Whole, Shape Achieved by Forming	E0140	Whole, Shape Achieved by Forming, Thickness 0.3-1.5cm
				E0131	Whole
F0014	Fully Heat Treated				
G0003	Cooking Method Not Applicable				
H0158	Sucrose Added	H0136	Sugar or Sugar Syrup Added		
H0268	Puffed				
H0136	Water Removed				
H0100	Flavouring or Spice Extract or Concentrate Added				
H0181	Iron Added	H0159	Mineral Added	H0194	Nutrient or Dietary Substance Added
H0215	Vitamin C Added	H0163	Vitamin Added	H0194	Nutrient or Dietary Substance Added
H0216	Vitamin B Added	H0163	Vitamin Added	H0194	Nutrient or Dietary Substance Added
(H0311)	(Niacin Added)***				
(H0310)	(Riboflavin Added)***				
(H0309)	(Thiamin Added)***				
J0116	Dehydrated or Dried	J0144	Artificially Heat Dried		
K0003	No Packing Medium Used				
M0155	Paperboard Container with Liner				
N0001	Food Contact Surface Not Known	N0039 N0036	Paper or Paperboard Plastic		
P0024	Human Food, No Age Specification				
(Z0112)	(Food Industry Prepared)***				

Figure 2

2.9 We can use the illustrative example at Figure 2 to make some further important observations. Based on the "ideal" answers for each food, the number of factor terms in a facet determines the **cardinality** of the facet for that food. For example, in the case of "puffed rice breakfast cereal" the cardinality of facet H is 7 because the "ideal" answer had 7 factor terms for this facet. The experts also showed "minor" terms which, although not false, are not required. These terms were ignored in the evaluation of the results.

2.10 In order to introduce a measure into the experiment, necessary for a statistical analyses of the results, it was decided from the outset to score each candidates results compared with how well they matched the "ideal" codes. The scoring algorithm ideally should give higher scores for those candidates who coded closer to the "ideal" codes compared with other candidates. Two scoring algorithms were designed, the first of which was as follows:

(i) Optional terms and minor terms (marked *** in Figure 2) were ignored in the evaluation;

(ii) Where the cardinality of a facet is 1, candidates scored:

- 3 points if they matched the ideal code
- 2 points if they matched the first alternative (where there is one)
- 1 point if they matched the second alternative
- 0 points if they failed to match

(in the scoring algorithm cultural terms or preferable terms were scored if either were used)

(iii) Where the cardinality of a facet is greater than 1, (say 'N') candidates scored:

- 3 points for 'N' matches in the ideal code
- 2 points for 'N' matches if 'N' matches in the ideal and the first alternative
- 1 point for 'N' matches if 'N' matches in the ideal or the first and second alternative codes
- 0 points otherwise

2.11 The weakness in the above scoring algorithm is that for facets where the cardinality is greater than 1, candidates who get some of the factors correct but not all may end up with zero points. For example, for "puffed rice breakfast cereal", the cardinality of facet H is 7. If a candidate got 4 of the "ideal" factor terms then that candidate would score zero for that facet as indeed would a candidate who matched 3 or 2 of the "ideal" factor terms. To correct this "bias" the above scoring algorithm was modified by allowing each candidate to achieve a proportion of the ideal score according to the number of matches with the "ideal" code. A candidate who matched 4 codes out of 7 in the ideal would then obtain a score of 4/7 of 3 points.

2.12 The experts' and candidates' codes were entered into a purpose designed computer system. The computer system was developed by **Jim Deary's** computing staff in London and runs on a PRIME minicomputer. The software used to develop the system is a PRIME proprietary relational database product known as PRIME INFORMATION. The data were double keyed to the computer to avoid keying errors. Each candidate and each food was allocated a unique code in the computer system.

3. OBSERVATIONS ON EXPERIMENTAL DESIGN

3.1 The experiment, although it went well, did not go quite to plan and in this Chapter we highlight the differences between what actually happened compared with the experimental plan.

3.2 Although 20 candidates were invited to code the two lists of foods not all candidates returned results and some candidates did not code all the foods.

3.3 Also, for the evaluation exercise, candidates were required to return to **Jayne Ireland-Ripert** a detailed description of the two chosen national recipes (to be coded in "round 2") so that "ideal" codes for these foods could be generated. We have been unable to include these foods in our evaluation of the results because of a lack of resources and time constraints in finalising this report. But not much has been sacrificed as a result of this negligence.

3.4 Of the 20 candidates invited to code the two lists of foods:

(i) 18 candidates returned results for "round 1";

(ii) Of these only 16 candidates coded all the foods in "round 1";

(iii) Only 15 candidates returned results for "round 2" and all 15 candidates coded all the 18 foods (the two national recipes were ignored for evaluation purposes).

3.5 In scoring a candidate's results, scores were calculated only on what was coded. Typically, we present results as a per cent and these were calculated relative to the ideal total score only for the set of foods coded. In fact this affected only two candidates' results.

3.6 We have calculated candidates' scores based on both scoring algorithms described in the previous Chapter. It does not alter the main conclusions which scoring algorithm is used although it can improve some candidates scores but then only marginally. The graphical presentations in this report are based on the simpler scoring algorithm while our statistical analysis uses scores calculated using the more complex scoring algorithm.

3.7 It is important to note that candidates were required to code the same identical foods, and for this to be successful candidates had to be provided with a detailed description of each food. Had this not been the case, it would not have been possible to decide if differences between candidates results was due to error in coding or genuine differences in the foods. Comparisons between coders and with the ideal code would have been more complex and less informative. On the other hand, giving candidates a prescriptive ingredient list does tend to make the exercise of coding in LANGUAL easier. But the same would be true for any other coding system.

3.8 Strictly speaking, the experiment, as designed, does not permit us to test for a "training effect". We can not distinguish between candidates who improved simply through repetition from those who improved through training. In other words these two effects are confounded.

4. ANALYSIS OF RESULTS

4.1 Our first pass through the data was designed to guage the extent of agreement among coders and to expose the problem areas in using LANGUAL. To do this we compared each candidate's results with the ideal for both rounds for each LANGUAL facet. Candidates scored a "hit" if they *matched the ideal code precisely (ignoring the alternative codes)* for each facet and each food.

4.2 Figure 3 presents a summary of the hit rate for all candidates separately for all foods in "round 1" and all foods in "round 2". There are three observations worth noting:-

(i) candidates coded better in "round 2" compared with "round 1" for all LANGUAL facets;

(ii) candidates had particular difficulty with (in order of difficulty) LANGUAL facets H (Treatment applied), E (Physical state or shape), J (Preservation method) and C (Part of plant or animal);

(iii) it is worth noting that the cardinality of facets C, E and J is one while H has a cardinality greater than one for most foods.

4.3 It is impossible to tell from this presentation whether the difficulties were confined to particular coders or particular foods or both. In Figure 4, we present the same analysis but separately for simple, complex and recipe foods. In this case we can see:

(i) Candidates coded simple foods consistently better than for other classes.

(ii) Interestingly, candidates appeared to code recipe foods better than complex foods;

(iii) For each of these classes of foods, LANGUAL facets H and E were the most problematical. For simple foods J and C were next most problematical facets. For complex foods J, F and C and to a lesser extent G and N were also problematic. For recipe foods, facet A appeared to cause considerable difficulty.

4.4 The conclusion from these observations is that the type of food appears to affect a candidates ability to code correctly. Moreover although facet H proved the most difficult facet to code correctly, facets C, E, J and facet A, for recipe foods, caused candidates difficulties and these are, of course, mostly fundamental facets which might be considered important to get right.

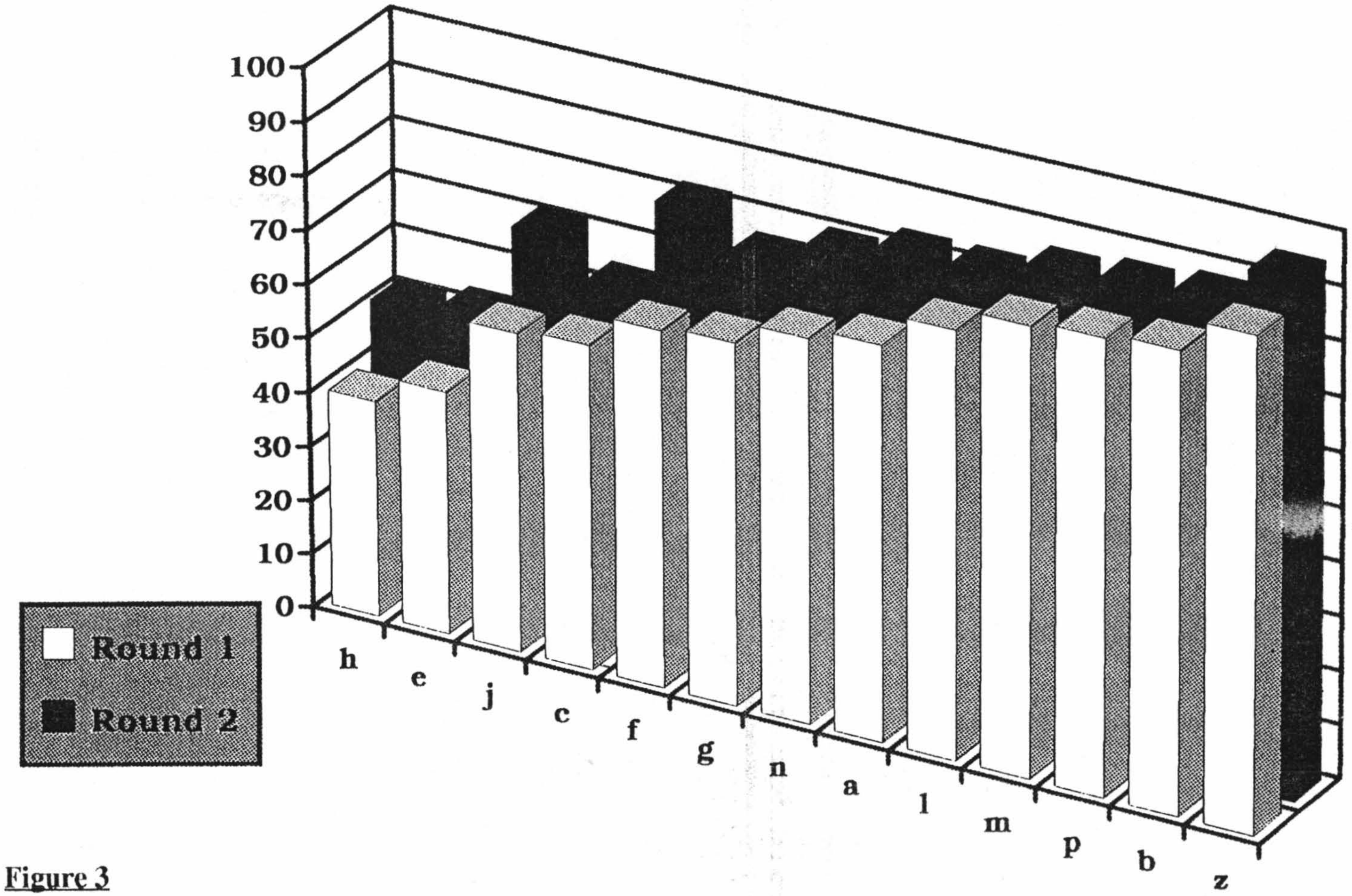
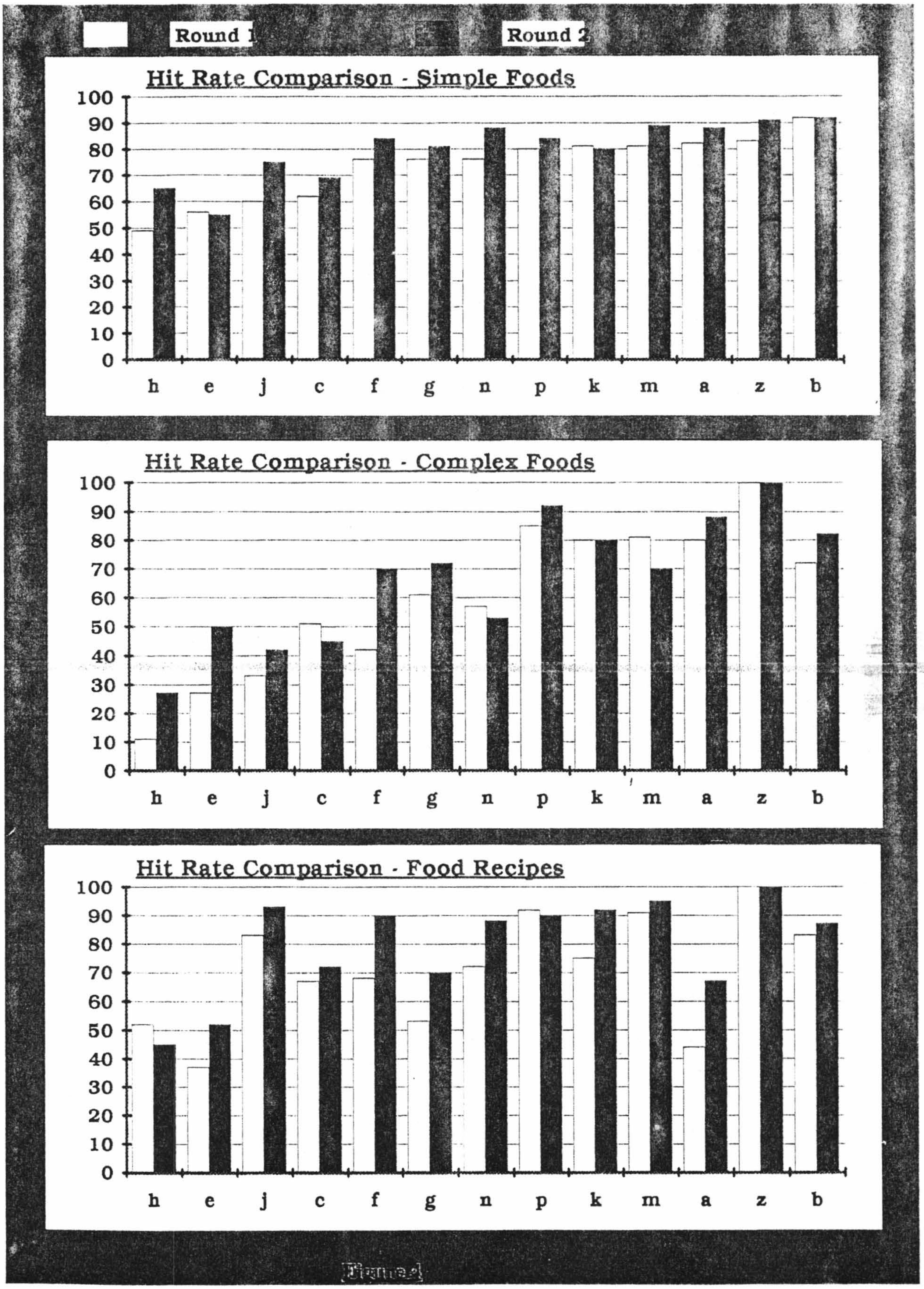


Figure 3

HIT RATE (%) - ALL FOODS - ALL CANDIDATES


Round 1
Round 2
Hit Rate Comparison - Simple Foods
100
90
80
70
60
50
40
30
20
10
0
h e j c f g n p k m a z b
Hit Rate Comparison - Complex Foods
100
90
80
70
60
50
40
30
20
10
0
h e j c f g n p k m a z b
Hit Rate Comparison - Food Recipes
100
90
80
70
60
50
40
30
20
10
0
h e j c f g n p k m a z b

Proportion of Incorrect Matches with Ideal Code

Food	Round	A	B	C	E	F	G	H	J	K	M	N	P	Z
Leek, raw	B													
Potato, steamed, with skin	1													
Pineapple, canned in light syrup	B				73					91	76	79		
Apricot, dried,raw	1													
Coffee, decafeinated, instant powder	B							91	88				81	
Camembert Cheese,45% fat, wrapp	1	94			94	63		100	88		56	81		56
Chicken leg, roasted, meat only	1							59						82
Mutton chop, untrimmed, grilled	B													
Trout, steamed, flesh only	B													
Buckwheat flour in paper bag	1							88	81					
Puffed rice breakfast cereal, cardbo	B				90			93	67			83		
Yoghurt, whole milk, with strawber	1				100			94	100					
Milk chocolate with hazelnuts, alum	1	56	56	63	69	75		100	94					
Vegetable mix, canned, metal can	B			78	69		56					100		
Orange soda, rigid plastic bottle wit	1					100		100						
Omelette cooked in butter	B				70		70							
Beef Stew	1	67			73			93		100				
White sauce	1				73		73							
Croissant made with butter	1	87												
Cookie	B													
Beetroot boiled	2						87							
Mixture of Sweetened, Dried Tropic	2													
Goat's milk fresh cheese	2	60			60			73	80					
Turkey breast, meat only, sauteed in	2													
Wholemeal bread, no wrapping	2													
Margarine, table, spreadable, semir	2					87		93	100					
Peach Jam, glass jar with metal lid	2			100				100						
Tomato sauce	2				100			80						
Mayonnaise	2							100						

Figure 5 [Note: values less than 50% have been suppressed]

Analysis Of Facet Scores - All Foods - All Candidates

Round 1					Round 2			
Max	**Min**	**StdDev**	**Avg**	**Coder**	**Max**	**Min**	**StdDev**	**Avg**
80%	0%	30%	35%	[*] 13	100%	48%	15%	78%
90%	23%	23%	60%	4	100%	61%	14%	85%
95%	15%	24%	66%	17	100%	63%	11%	84%
95%	28%	21%	66%	23	98%	33%	18%	76%
95%	25%	21%	68%	8	94%	39%	17%	75%
95%	0%	27%	68%	14	89%	0%	25%	68%
100%	27%	23%	71%	20	96%	46%	18%	77%
95%	45%	16%	72%	16	94%	52%	14%	78%
95%	45%	14%	78%	11	94%	54%	13%	79%
100%	33%	21%	78%	3	100%	48%	18%	79%
95%	35%	17%	79%	9	100%	67%	10%	85%
98%	45%	17%	79%	7	98%	54%	13%	80%
95%	45%	13%	79%	15	94%	44%	14%	82%
100%	67%	12%	83%	12	100%	65%	12%	89%
100%	50%	15%	85%	[*] 21	94%	59%	12%	80%
95%	22%	29%	64%	6				
100%	0%	27%	63%	10				
95%	60%	14%	81%	19				

Figure 6

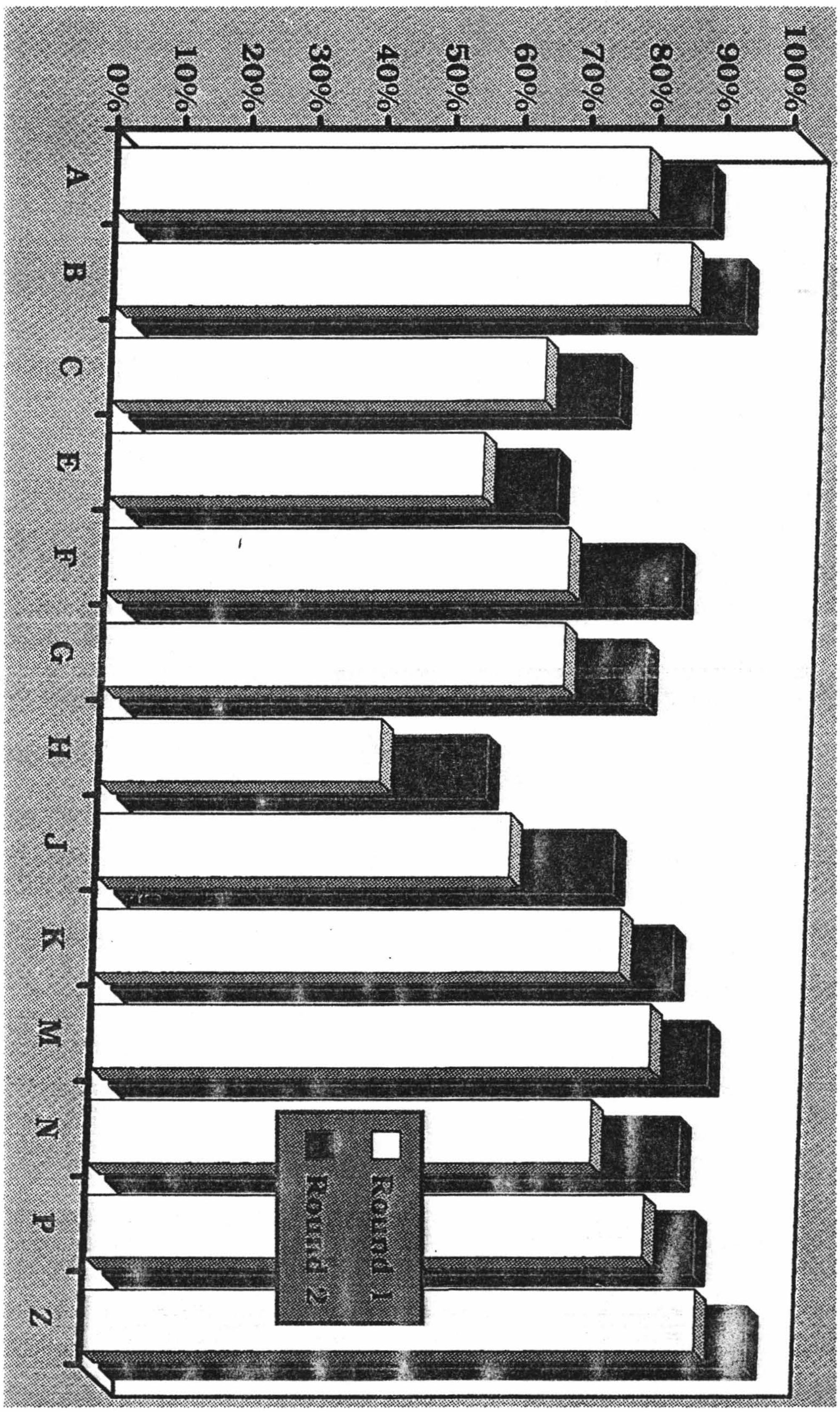


Figure 7 Scores By Facet - All Foods - All Candidates

4.5 Figure 5 gives a clearer picture of where candidates had difficulty in coding correctly. In this table we have shown, for each food and each LANGUAL facet, the proportion (expressed as a percentage) of incorrect matches with the ideal code. To make the table easier to read we have suppressed the percentages if they are less than 50%. In other words, the table highlights those facets and foods where the **majority** of candidates coded incorrectly. Facets E, H and J stand out clearly as problematical for many foods. But this table disguises the difficulty with facet C for most foods because we have suppressed figures less than 50%.

4.6 Figure 5 illustrates vividly those particular foods which candidates found difficult to code. Camembert cheese and milk chocolate with hazelnuts (both "round 1" foods), in particular, were coded quite poorly by the majority of candidates. It is interesting also to note, but not unexpected, that all candidates failed to match the ideal code for facet H for both of these foods. The other striking observation is that the majority of candidates had difficulty with at least one LANGUAL facet for most of the foods. It would be important to establish which, if any, of the LANGUAL facets are regarded as essential descriptors, in the sense that it is considered essential to code these facets correctly, before assessing how serious the candidates errors are. For example candidates had difficulty with LANGUAL facet E (Physical state or shape) but this may be considered a relatively unimportant facet from a nutrition science view?

4.7 A word of caution in interpreting these findings. The analysis of "hit rates" is quite exact and would be expected to show candidates in the worst possible light. The analysis takes no account of the alternative acceptable answers and, for facets where the cardinality is greater than 1, candidates would have to match exactly with the ideal code for a match to occur. Neither, incidentally, does the analysis take account of the possible situation where candidates coded the food "correctly" when the "ideal code" itself was wrong. At the workshop, the experts were prepared to accept that they may not have got the code correct in all its particulars for some foods.

4.8 The foregoing analysis has been helpful in pointing to how well candidates coded and indicating the problem foods and problem LANGUAL facets. However, it does not point up differences between candidates. To get some idea of differences between candidates we scored each candidate's results using the two scoring algorithms set out in Chapter 2.

4.9 The table in Figure 6 is a detailed summary of the scores candidates achieved (for both rounds) using the simpler of the two scoring algorithms. In the table, candidates are identified individually by their unique "coder number", and the table shows the average, maximum and minimum score for each candidate. Candidates who did not code all the foods in "round 1" are shown with an asterisk whilst candidates who completed "round 1" but not "round 2" are clearly visible. It is a very useful summary of the outcome of the experiment. For example we can observe:

(i) Candidates scores were, generally, better in round 2 compared to round 1 (confirming our earlier observation based on "hit rates");

(ii) There is considerable variation, for all candidates, between their minimum and maximum scores. All candidates had difficulty coding at least one LANGUAL facet for some food (we know what these foods probably are from the analysis above);

(iii) There is considerable variation between candidates scores suggesting that different candidates cannot be relied upon to code the same identical food identically;

4.10 Figure 7 displays these same scores by LANGUAL facet.

4.11 In order to be more precise about the above analysis, we have analysed scores using standard statistical methods. In this analysis, we have used the more complex of the two scoring algorithms. Using Analysis Of Variance techniques we have confirmed that there is a significant difference between candidates scores, that results for "round 2" are significantly higher than "round 1" (by 10% on average) and that there is a food effect (the ability to code depends on the food being coded). Details of these analyses are set out clearly in Appendix 3.

4.12 Our experimental objectives required us to consider the "completeness" of LANGUAL as a model to use to code all the characteristics of interest. We asked all the candidates to give us details of where they thought LANGUAL was deficient in providing adequate coverage for characteristics of foods of interest to a food scientist. We then asked the experts to review the candidates observations and to confirm that LANGUAL was indeed deficient or problematical in that respect.

4.13 The main common observations by candidates were as follows:

(i) Clarification of the use of facets F (Extent of Heat Treatment), J (preservation method) and Z (Adjunct Characteristics) will be necessary;

(ii) The choice of principal ingredient (whether by % weight, % energy, by safety or nutritional density) must be clarified;

(iii) There is insufficient provision for quantitative information (e.g. fat content, sucrose added);

(iv) A new facet (or factor) should be considered to better describe ingredient added (e.g. fibre, salt added);

(v) There should be a factor term for 'raw';

(vi) It can be difficult sometimes to decide how 'solid' foods are;

(vii) Some facets require an extensive knowledge of food science to code correctly (particularly heat treatment where it can be difficult to decide which method was used). Some coders felt that the existing LANGUAL methods of handling and processing are insufficient;

(vii) Facet E requires clarification (e.g. it is not clear whether this facet is related to the food or its main ingredient);

(ix) LANGUAL facets are not always independent of each other which can cause ambiguity and confusion when coding.

5. DISCUSSION AND RECOMMENDATIONS

5.1 Can different LANGUAL coders be expected to index the same identical food identically? And if so, can they be expected to code it correctly? Is experience in using LANGUAL important and is LANGUAL a complete model for describing foods? These are the fundamental questions we set out to investigate.

5.2 Based on the experimental results evaluated, the answer to the first two questions is strictly "no" and, not surprisingly, experience with LANGUAL improves a coders ability to code correctly. However, it is evident that most candidates, especially in "round 2", did achieve a high degree of conformance with the "experts" views for most of the foods. We cannot, therefore, dismiss LANGUAL, out if hand, as an unsuitable model for describing foods. On the contrary, despite the negative statistical results, the degree of conformance with the set of "ideal" codes is quite impressive. It is important, therefore, to understand the reasons why candidates differed and to assess whether the reasons are a cause for concern and whether they could be expected to be corrected with appropriate advice and guidance.

5.3 LANGUAL Facets E (physical state or shape), H (Heat Treatment) and J (preservation method) caused the most difficulties. Facet H caused problems because for most foods candidates were required to give more than one factor - sometimes as many as 7 - and most candidates gave only what they considered to be the main relevant factors. Although facet E was coded incorrectly for many of the complex and recipe foods, it hardly seems to be a particularly relevant facet from the point of view of exchanging information on food composition and food consumption. Facet J is important and candidates failure to code this correctly is a matter of concern. Many candidates indicated that they did not have the relevant knowledge to be able to comment on the technical preservation methods used. Failure here, to code correctly, was due more to ignorance rather than inherent difficulties in LANGUAL. It is worth stating the obvious point that coders must be aware of all the characteristics of foods (not just nutritional composition) before using LANGUAL. If LANGUAL is used to describe foods then *it should be a co-operative effort by a group of knowledgeable individuals, with a comprehensive understanding of food science,* rather than left to one individual alone.

5.4 All of the candidates in the experiment found LANGUAL and the documentation easy to use and were quick to navigate around the LANGUAL thesauri - the "learning curve" is not steep. But our evaluation has concluded that experience with LANGUAL is important and *coders must be aware of, and make use of, the few LANGUAL rules that exist*. For example, in coding facet B (Food Source) for 'milk chocolate' most candidates selected 'cocoa' as the food source. In the experts' view the correct answer is sugar because, following the LANGUAL rules, this is the main ingredient by weight.

5.5 Whilst candidates made a number of suggestions about improving the completeness of LANGUAL (with regard to improving the ability to further describe, or discriminate between food characteristics of interest), the clear impression of most candidates was that LANGUAL, as it exists, is sufficiently comprehensive to be used as a common food description model. The model will need to evolve and this should be through a centrally organised (European) committee charged with managing the evolution of the model in Europe and liaising with the appropriate authority in the U.S.A. Moreover, such a committee is seen as essential if different administrations in different countries are to be persuaded to adopt LANGUAL. Candidates also felt that coding foods using paper-based procedures is unacceptable and that computer aided tools need to be developed to support LANGUAL coders.

5.6 Candidates did, however, express the view that the *organisation* of the LANGUAL facets and factors could be usefully reviewed although this was not seen as an obstacle to using the vocabulary.

5.7 LANGUAL itself is only a means to an end and requires a significant resource effort to code a wide range of foods. Before different authorities can be persuaded to adopt LANGUAL, it is essential that the model can be demonstrated successfully to *retrieve* specified foods or groups of foods from databases.

6. ACKNOWLEDGEMENTS

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Mr M Day (MAFF - UK) for assistance with the statistical analyses.

Last, but not least, all of the candidates (see Appendix 1) who gave up their time to participate in the experiment by coding up the select lists of foods.

APPENDIX 1. NAMES AND ADDRESSES OF PARTICIPANTS

* indicates observers
# indicates trainers

TITLE	INITS	SURNAME	ADDRESS
Dr	T.	Arnouts *	EuroNIMS, N.V. Logimed Prins Albertlei 7 B-2600 ANTWERPEN, Belgium
Ms	V.	Beaudoin *	Centre de Recherches pour l'Etude et l'Observation des Conditions de vie (CREDOC) 142 Rue du Chevaleret F-75013 PARIS, France
Ms	L.	Bergström	National Food Administration P.O. Box 622 S-75126 UPPSALA, Sweden
Ms	J.	Castenmiller	FLAIR Eurofoods-Enfant Project Wageningen Agricultural University Department of Human Nutrition P.O. Box 8129 6700 EV WAGENINGEN, The Netherlands
Mr	J.	Deary *	Ministry of Agriculture, Fisheries and Food (MAFF) Ergon House, c/o Nobel House 17, Smith Square, Westminster LONDON SW1P 3JR, United Kingdom
Dr	M.	Feinberg *	Centre Informatique sur la Qualité des Aliments (CIQUAL) 16 Rue Claude-Bernard 75231 PARIS Cedex 05, France
Mr	B.	Gion	University of Horticulture and Food Industry Department of Canning Technology Mènesi u. 45 H-1119 BUDAPEST, Hungary
Ms	S.	Hernando Tundidor	Instituto de Información y Documentación en Ciencia y Técnologia Joaquin Costa, 22 28006 MADRID, Spain
Dr	J.	Ireland-Ripert #	Centre Informatique sur la Qualité des Aliments (CIQUAL) 16 Rue Claude-Bernard 75231 PARIS Cedex 05, France

TITLE	INITS	SURNAME	ADDRESS
Dr	A.	Kaic-Rak	Institute of Public Health of SR Croatia Department of Food and Nutrition Rockefellerova 7 41000 ZAGREB, Croatia
Ms	A.	Lagiou	Dept of Nutrition and Biochemistry Athens School of Public Health Leof. Alexandras 196 11521 ATHENS, Greece
Dr	S.	Lahlou *	Centre de Recherches pour l'Etude et l'Observation des Conditions de vie (CREDOC) 142 Rue du Chevaleret F-75013 PARIS, France
Ms	M.	Leperq	Centre Technique Salaison Charcuterie 7 Avenue du Général de Gaulle 94700 MAISONS-ALFORT, France
Dr	I.	Martins	Nutrition Research Centre National Institute of Health Avenida Padre Cruz 1699 LISBON CODEX, Portugal
Dr	P.	Mathias	Department of Biological Sciences Dublin Institute of Technology Kevin Street DUBLIN 8, Ireland
Prof.	O.	Moreiras	Department of Nutrition Faculty of Pharmacy Universidad Complutense Ciudad Universitaria 28040 MADRID, Spain
Ms	M.	Peetz-Schou	National Food Agency Mörkhöj Bygade 19 DK-2860 SÖBORG, Denmark
Ms	M.	Rastas	Rehabilitation Centre of the Social Insurance Institution Peltolantie 3 SF-20720 TURKU, Finland
Ms	A.H.	Rimestad	National Nutrition Council Box 8139 Dep N-0033 OSLO, Norway

TITLE	INITS	SURNAME	ADDRESS
Ms	C.	Seeuws	Ministry of Public Health and Environment vzw NUBEL asbl Quartier Vésale, Locale 407 Pachecolaan 19, Bus 5 B-1010 BRUSSELS, Belgium
Ms	N.	Slimani *	International Agency for Research on Cancer/WHO 150, Cours Albert-Thomas 69372 LYON Cedex 08, France
Ms	E.	Smith #	Food and Drug Administration Center for Food Safety and Applied Nutrition, HFF-037 200 C Street, S.W. WASHINGTON, D.C. 20204, U.S.A.
Ms	J.	Storey	Information Section Food Science Division II Ministry of Agriculture, Fisheries and Food (MAFF) Room 203A, Ergon House c/o Nobel House 17, Smith Square LONDON SW1P 3JR, United Kingdom
Mr	P.	van Stratum	Rondo 94 2925 AG KRIMPEN AAN DE IJSSEL, The Netherlands

APPENDIX 2A. LIST OF FOODS FOR ROUNDS 1 AND 2

Food Num	Food Name	Rnd 1	Rnd 2
1	Leek, raw	Y	Y
2	Potato, steamed with skin	Y	N
3	Pineapple, canned in light syrup	Y	Y
4	Apricot, dried, raw	Y	N
5	Coffee, decaffeinated, instant powder, in glass jar with plastic lid	Y	Y
6	Camembert cheese, 45% fat, wrapped in waxed paper in paperboard box	Y	N
7	Chicken leg, roasted, meat only	Y	N
8	Mutton chop, untrimmed, grilled	Y	Y
9	Trout, steamed, flesh only	Y	Y
10	Buckwheat flour, in paper bag	Y	N
11	Puffed rice breakfast cereal	Y	Y
12	Yoghurt, whole milk, with strawberries, sweetened	Y	N
13	Milk chocolate with hazelnuts	Y	N
14	Vegetable mix, canned	Y	Y
15	Orange soda	Y	N
16	Omelette, cooked in butter	Y	Y
17	Beef stew	Y	N
18	White sauce	Y	N
19	Croissant made with butter	Y	N
20	Cookie	Y	Y
21	Beetroot, boiled	N	Y
22	Mixture of sweetened, dried tropical fruit, in plastic bag	N	Y
23	Goat's milk, fresh cheese	N	Y
24	Turkey breast, meat only, sauteed in sunflowerseed oil	N	Y
25	Wholemeal bread, no wrapping	N	Y
26	Margarine, table, spreadable	N	Y
27	Peach jam	N	Y
28	Tomato sauce	N	Y
29	Mayonnaise	N	Y

APPENDIX 2B. LIST OF FOODS AND DESCRIPTIONS

Round 1

Simple food items (10)

Leek, raw
Potato, steamed with skin
Pineapple, canned in light syrup
Apricot, dried, raw
Coffee, decaffeinated, instant powder, in glass jar with plastic lid
Camembert cheese 45% fat, wrapped in waxed paper in paperboard box
Chicken leg, roasted, meat only
Mutton chop, untrimmed, grilled
Trout, steamed, flesh only
Buckwheat flour, in paper bag

Generic complex foods (5)

Puffed rice breakfast cereal (e.g. Rice Krispies)
- ingredients: rice, sugar, salt, malt, vitamins (C, PP, B5, B6, B2, B1, folate, B12), iron
- container: cardboard box with liner

Yoghurt, whole milk, with strawberries, sweetened
- ingredients: whole milk 69%, sugar 14.2%, fruit 10.5%, lactic ferments, powdered milk, fruit preservative, E202, flavouring
- container: semi-rigid plastic container with aluminium foil top

Milk chocolate hazelnuts
- ingredients: sugar, milk powder, cocoa butter, hazelnuts 16%, cocoa paste, soy lecithin emulsifier, artificial vanilla flavour, cacao 30%
- container: aluminium foil wrapper

Vegetable mix, canned
- ingredients: carrots, turnips, peas, baby lima beans, green beans
- container: metal can

Orange soda (e.g. Fanta)
- ingredients: carbonated water, sugars, orange juice (5%), acidifier (citric acid), citrus and plant extracts, preservative (sodium benzoate), antioxidant (ascorbic acid), colorant (beta carotene)
- container: rigid plastic bottle with plastic cup

Recipes (5)

Omelette cooked in butter

2 eggs; 10 ml water; 10 g butter; ½ teaspoon salt; pepper

Beat eggs with salt and water. Heat butter in an omelette pan. Pour in the mixture and stir until it begins to thicken evenly. While still creamy, fold the omelette and serve. Weight loss: 5.7%

Beef stew

250 g raw stewing steak (beef); 75 g onion; 75 g carrots; 15 g dripping (animal fat); 300 ml water; 15 g flour; 1 teaspoon salt; pepper

Melt the dripping in a casserole and brown the pieces of meat. Remove the meat and brown the onion. Add the flour and cook the roux. Gradually blend in the water, add the meat, carrots and seasoning, bring to the boil and finish cooking at 180°C for about 2 hours. Weight loss: 24.5%

White sauce

350 ml milk; 25 g flour; 25 g margarine; ½ teaspoon salt

Melt fat in a pan. Add flour and cook for a few minutes, stirring constantly. Add milk and salt, and cook gently until the mixture thickens. Weight loss: 18.1%

Croissant made with butter

450 g flour; 200 g butter; 28 g dry yeast; 1 egg; 1 teaspoon salt; 240 ml water

Glaze: 30 ml water; 2½ g sugar; 1 egg

Blend yeast and water, sift flour and salt. Mix together until smooth. Roll out, dot with butter and fold into three. Repeat twice, cover and rest for 30 minutes. Repeat process a further 3 times, then place in refrigerator for 1 hour. Roll out, trim, cut and shape into crescents. After 30 minutes brush with glaze and bake for 20 minutes at 220°C/mark 7. Weight loss: 15%

Cookie (biscuit)

200 g flour; 1 egg; 100 g margarine; 100 g sugar

Cream fat and sugar. Mix in egg, then flour, and knead the dough lightly until smooth. Roll out thinly, prick and shape. Bake 10-15 minutes at 180°C/mark 4. Weight loss: 10%

Round 2

Simple food items (10)

Leek, raw
Beetroot, boiled
Pineapple, canned in light syrup
Mixture of sweetened, dried tropical fruit, in plastic bag
Coffee, decaffeinated, instant powder, in glass jar with plastic lid
Goats milk fresh cheese
Turkey breast, meat only, sauteed in sunflowerseed oil
Mutton chop, untrimmed, grilled
Trout, steamed, flesh only
Wholesale bread, no wrapping

Generic complex foods (4)

Vegetable mix, canned
ingredients: carrots, turnips, peas, baby lima beans, green beans
container: metal can

Puffed rice breakfast cereal (e.g. Rice Krispies)
ingredients: rice, sugar, salt, malt, vitamins (C, PP, B5, B6, B2, B1, folate, B12), iron
container: cardboard box with liner

Margarine, table, spreadable
ingredients: vegetable oils, as oil and partially hydrogenated 82% (sunflowerseed 79%, palm 3%), water, milk proteins and fat, salt, emulsifiers, preservative, corrector of acidity, colorant, flavouring
container: semi-rigid plastic container with plastic lid

Peach jam
ingredients: fruit 50%, sugar, glucose syrup, pectin, citric acid
container: glass jar with metal lid

Recipes (4)

Omelette cooked in butter

2 eggs; 10 ml water; 10 g butter; ½ teaspoon salt; pepper

Beat eggs with salt and water. Heat butter in an omelette pan. Pour in the mixture and stir until it begins to thicken evenly. While still creamy, fold the omelette and serve. Weight loss: 5.7%

Cookie (biscuit)

200 g flour; 1 egg; 100 g margarine; 100 g sugar

Cream fat and sugar. Mix in egg, then flour, and knead the dough lightly until smooth. Roll out thinly, prick and shape. Bake 10-15 minutes at 180°C/mark 4. Weight loss: 10%

Tomato sauce

400 g tomatoes; 25 g carrot; 50 g onion; 25 g bacon, streaky; 15 g margarine; 250 ml stock; 25 g flour; ½ teaspoon salt; herbs (bouquet garni)

Fry the chopped vegetables gently with the margarine and bacon. Stir in the flour, blended with some of the stock, then the rest of the stock and the herbs. Simmer for 40 minutes, then sieve. Weight loss: 44.4%

Mayonnaise

1 egg yolk; 125 g oil; ¼ teaspoon salt; ¼ teaspoon; mustard; 20 ml vinegar; pepper

Beat yolk and seasoning in a bowl. Whisk oil in very gradually to form a thick emulsion, adding the vinegar.

APPENDIX 3. STATISTICAL ANALYSIS OF RESULTS

Contents

Introduction

In order to test for the presence and significance of a number of factors, we employed an implementation of the "Generalised Linear Model" (GLM). We used one scoring variable, called SCORE2 as it was based on the second, slightly more sophisticated method of evaluating the participants' answers, it was re-scaled to be between 0 and 1. There were a number of variables which we regarded as capable of explaining the observed scores. These were -

ROUND	values of 1 or 2	representing before (1) and after (2) "training"
GROUP	values 1, 2 or 3	representing simple (1), complex (2) or recipe (3)
FOOD	values 1 to 29	numerical labels for the foods
PERSON	values 1 to 23	1 code for each participant

Additionally, we established selection factors, "ROUND1", "ROUND2" and "FDANDPERSINBOTH" to allow us to restrict the analysis to a subset of observations. The first two evidently determine whether an observation was made before or after training; the third signifies whether or not an observation applies to a participant who submitted answers both before and after the workshop training and also to a food common to both rounds. The acronym stands for FooD-AND-PERSon-IN-BOTH-rounds. The selection is achieved by using these factors as weights.

The analyses that follow are effectively examples of Analysis of Variance (ANOVA) sometimes shown together with tables (effectively Multi-Linear Regression results) that DISPLAY the extra additive effects found for each instance of a factor variable <u>other than</u> the first. For instance, if we are testing for the effect of **GROUP** which has values 1 to 3, the effect for GROUP 1 (simple foods) is subsumed in the effect of **GM**, the "Grand Mean"; the estimated effect shown for GROUP 2 (complex foods) is therefore the difference found between the two groups. Although the factors are generally shown by the ANOVA to have significant effects, not all their separate instances are necessarily significant as may be seen in the DISPLAYed regression analyses.

The tables produced by FIT show the effect of exploiting all the factors listed at the one time. On the other hand TESTHYP tries out each factor in turn. It is a little like forward stepwise regression but where the order of introduction of new factors is predetermined.

We begin with an annotated example to examine the simultaneous effects of GROUP (is food simple, complex or recipe?) and PERSON (which individual's scores?), followed by briefer presentations of the results for other factors singly or in groups.

The factor FOOD does not appear in the following tests. It was found to be significant and to reduce the residual variation, but was not unexpectedly correlated with ROUND or PERSON while not adding any helpful explanatory power to the simpler derived variable, GROUP.

TABLE 1. AN ANNOTATED EXAMPLE. TEST THE JOINT EFFECTS OF GROUP AND PERSON AFTER TRAINING

Y variable	SCORE2	more "sophisticated" method
Linear Predictor	GM+GROUP +PERSON	i.e. explanatory variables GM = "Grand Mean" (Intercept) GROUP Factor level 1, 2 or 3 for simple, complex, recipe PERSON Factor level 1 to 23, one for each person
Prior Weight	ROUND2	effectively confines results to "after training only"
Error Distribution	NORMAL	} i.e. use the standard
Link Function	IDENTITY	} regression assumptions

FIT'GM+GROUP+PERSON' ... fit the linear model

source	ss	df	ms
Due to model	0.9469	16	0.0592
Residual	4.153	253	0.0164
Total Corrected	5.1	269	0.019

N.B. ss = sum of squares
df = degrees of freedom

Percentage Variation Accounted for 18.57 (=94.69/5.1)
F-statistic 3.61 (=592/164)
p-value 0.00 (probability of F-statistic)

N.B. This means that GROUP and PERSON together play a significant role in predicting SCORE2, even though there is considerable residual variance.

TESTHYP'GM+GROUP+PERSON' like forward stepwise regression, try the effect of each new factor

model	residual ss	df	reduction	df	
GM	5.1	269	5.1	269	
GM+GROUP	4.745	267	0.3557	2	add group
GM+GROUP +PERSON	4.153	253	0.5912	14	add person

model	hypothesis model	F-statistics	df1	df2	p-value
GM-GROUP-PERSON	GM-GROUP	2.57	14	253	0.0
GM-GROUP	GM	10.01	2	267	0.0

N.B. This means that Food Group (GROUP) is itself a significant predictor of SCORE2, but that the inter person effect explained by PERSON is also significant even after the group effect is allowed for.

TABLE 2. TEST FOR DIFFERENCES BETWEEN FOOD GROUPS - WITHIN ROUNDS

Table 2A

Prior Weight variable ROUND1 only

FIT'GM+GROUP'

source	ss	df	ms
Due to model	0.8769	2	0.4385
Residual	8.188	323	0.0254
Total Corrected	9.065	325	0.0279

Percentage Variation Accounted for	9.67
F-statistic	17.30
p-value	0.00

DISPLAY'' .... show the results of linear regression

Y variable	SCORE2
Linear Predictor	GM+GROUP
Prior Weight variable	ROUND1 only

Var	Est.	Std Err	t-stat	p-val
GM	0.7147	0.0121	58.87	0
GROUP 2	-0.1173	0.0216	-5.423	0
GROUP 3	-0.0846	0.022	-3.842	0.0001

N.B. t-stat = Student's t-statistic with 323 degrees of freedom
p-val = 2 x tail probability of t_{323}

N.B. Group factor is significant. Before training (only) both food groups 2 and 3 (complex foods and recipes) are found to be significantly "harder" than group 1 (simple foods). This shows that in "round 1" the average score for simple foods (1) is 0.71, for complex foods (2) 0.6 and for recipes (3) 0.63.

Table 2B

Prior Weight Variable ROUND2 only

FIT'GM+GROUP'

source	ss	df	ms
Due to model	0.3557	2	0.1778
Residual	4.745	267	0.0178
Total Corrected	5.1	269	0.019

Percentage Variation Accounted for	6.97
F-statistic	10.01
p-value	0.00

DISPLAY''

Y variable SCORE2
Linear Predictor GM+GROUP
Prior Weight variable ROUND2 only

Var	Est	Std Err	t-stat	p-val
GM	0.7669	0.0109	70.46	0
GROUP 2	-0.0896	0.0204	-4.402	1.554E-5
GROUP 3	-0.0412	0.0204	-2.024	0.0439

N.B. Group factor is significant. After training (only) both food groups 2 and 3 (complex foods and recipes) are still found to be significantly "harder" than group 1 (simple foods).

Table 2C

Now limit analysis to foods and people common to both rounds.

Prior Weight Variable FDANDPERSINBOTH
i.e. both rounds, common foods + persons only

FIT'GM+GROUP'

source	ss	df	ms
Due to model	0.8092	2	0.4046
Residual	5.701	260	0.0219
Total Corrected	6.511	262	0.0248

Percentage Variation Accounted for 12.43
F-statistic 18.45
p-value 0.00

DISPLAY''

Y variable SCORE2
Linear Predictor GM+GROUP
Prior Weight variable FDANDPERSINBOTH
i.e. both rounds, common foods + persons only

Var	Est	Std Err	t-stat	p-val
GM	0.7560	0.0121	65.52	0
GROUP 2	-0.1394	0.0230	-6.052	0
GROUP 3	-0.0266	0.0232	-1.148	0.2522 (NS)

N.B. Group factor is significant. Limiting selection to people and foods present both Before and After training, only food group 2 (complex foods) is still found to be significantly "harder" than group 1 (simple foods). Group 3 (recipes) is not significantly different from group 1 in this analysis.

N.B. We shall examine the <u>joint</u> effect of ROUND, GROUP and PERSON in Table 5 below.

TABLE 3. TEST FOR DIFFERENCES BETWEEN PEOPLE - ROUND 2 ONLY, I.E. AFTER TRAINING

Prior Weight variable ROUND2 only

FIT'GM+PERSON'

source	ss	df	ms
Due to model	0.5912	14	0.0422
Residual	4.509	255	0.0177
Total Corrected	5.1	269	0.019

Percentage Variation Accounted for	11.59
F-statistic	2.39
p-value	0.00

N.B. Evidently different people achieved significantly different scores, even after they had benefited from experience and training.

TABLE 4. TEST FOR EFFECT OF "TRAINING" (ROUND) FOR PEOPLE AND FOODS COMMON TO BOTH ROUNDS

Prior Weight variable FDANDPERSINBOTH
i.e. only foods and people pre-post training

FIT'GM+ROUND'

source	ss	df	ms
Due to model	0.44	1	0.44
Residual	6.071	261	0.0233
Total Corrected	6.511	262	0.0248

Percentage Variation Accounted for	6.76
F-statistic	18.92
p-value	0.00

DISPLAY''

Y variable SCORE2
Prior Weight variable FDANDPERSINBOTH
i.e. only foods and people pre-post training

Var	Est	Std Err	t-stat	p-val
GM	0.6781	0.0135	50.3	0
ROUND 2	0.0818	0.0188	4.349	1.961E-5

N.B. The effect of training (or experience?) is found to be significant. When excluding other factors (GROUP, PERSON) and selecting only observations on people and foods in both rounds, training appears to enhance the score by about 8% (absolute) or a little more than 10% relative to no training. See also Table 5 on the next page where the other factors are allowed to enter the analysis.

TABLE 5. TEST FOR SIMULTANEOUS EFFECT OF ROUND, GROUP AND PERSON FACTORS

Prior Weight variable FDANDPERSINBOTH
i.e. both rounds, common foods + persons only

FIT'GM+ROUND+GROUP+PERSON'

source	ss	df	ms
Due to model	2.264	17	0.1332
Residual	4.246	245	0.0173
Total Corrected	6.511	262	0.0248

Percentage Variation Accounted for	34.78
F-statistic	7.69
p-value	0.00

DISPLAY''

Y variable SCORE2
Line Predictor GM+ROUND+GROUP+PERSON
Prior Weight variable FDANDPERSINBOTH

Var	Est	Std Err	t-stat	p-val
GM	0.6684	0.0328	20.35	0
ROUND 2	0.0872	0.0163	5.347	0
GROUP 2	-0.144	0.0205	-7.012	0
GROUP 3	-0.0344	0.0207	-1.664	0.0973 (NS)
PERSONs 2-23 not shown here!				

N.B. The GM here (0.67) is the estimated average score for person 1 in Round 1 for simple foods (1).

TESTHYP'GM+ROUND+GROUP+PERSON'

model	residual ss	df	reduction	df
GM	6.511	262	6.511	262
GM+ROUND	6.071	261	0.44	1
GM+ROUND+GROUP	5.238	259	0.8323	2
GM+ROUND+GROUP+PERSON	4.246	245	0.9921	14

model	hypothesis model	F-statistics	df1	df2	p-value
GM+ROUND+GROUP +PERSON	GM+ROUND +GROUP	4.09	4	245	0.00
GM+ROUND+GROUP	GM+ROUND	20.58	2	259	0.00
GM+ROUND	GM	18.92	1	261	0.00

N.B. We see here that the different factors (ROUND, GROUP, PERSON) are each still significant when allowed to act simultaneously. The analysis is again restricted to those people and foods present in both rounds. (Similar results are found if this restriction is removed). The regression analysis demonstrates that at least for the restricted set of foods the effect of GROUP 3 (recipes) is not significantly different from GROUP 1 (simple foods).