AN EXPLORATION OF DIFFERENT OUTLOOKS ON SCIENCE: TOWARDS AN UNDERSTANDING OF THE UNDER-REPRESENTATION OF GIRLS, AND OF MAORI AND PACIFIC ISLAND STUDENTS, IN SCIENCE.

A thesis

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of the requirements for the Degree

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by

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VOLUME 2

APPENDIX 1.1

Science enrolment figures

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Mean percentages of girls and boys in the 5, 6 and 7 forms who took science options for the five years 1976-1980 inclusively.

	Fifth Form		Sixth Form		Seventh Form	
	Girls	Boys	Girls	Boys	Girls	Boys
Science	50.9	68.7	-	-	-	-
Biology	29.2	11.7	74.2	52.8	67.1	49.2
Chemistry	0.9	3.8	22.8	37.4	35.8	52.8
Physics	0.7	5.9	14.6	48.5	22.8	56.4

Source: Annual Education Statistics of New Zealand, Dep. of Ed.

Mean percentage of students classified as Maori and Non-Maori at the 5, 6 and 7 form levels who took science options for the five years 1976-1980 inclusively.

	Fifth Form		Sixth Form		Seventh Form	
	Non-Maori	Maori	Non-Maori	Maori	Non-Maori	Maori
Science	61.8	47.2	-	-	-	-
Biology	20.2	22.8	64.2	57.1	57.0	53.5
Chemistry	2.6	0.5	31.0	15.3	45.9	31.6
Physics	3.6	1.0	33.3	19.1	42.2	34.0

Source: Annual Education Statistics of New Zealand, Dep. of Ed.

APPENDIX 1.2

The proportion of Maori students in New Zealand state secondary schools at each form level for the five consecutive years 1976-1980 inclusively

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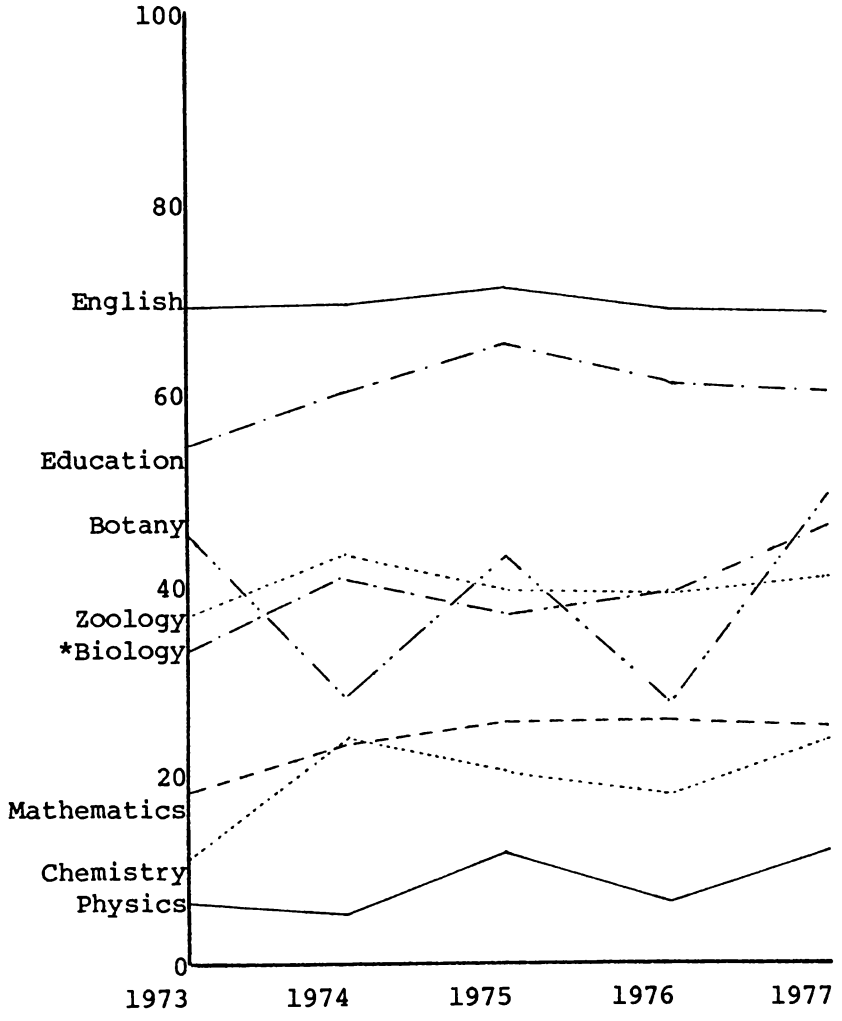
In 1976	Maori students	comprised	14.8%	of the third form
In 1977	Maori students	comprised	13.6%	of the fourth form
In 1978	Maori students	comprised	12.6%	of the fifth form
In 1979	Maori students	comprised	7.0%	of the sixth form
In 1980	Maori students	comprised	3.7%	of the seventh form

(Source: Annual Education Statistics, Dept. of Ed., Govt. Printer, 1976-1980)

APPENDIX 2.1

The proportions of first degrees gained by women in specific subjects in New Zealand universities

The proportions of first degrees gained by women in specific subjects in New Zealand universities



*Biology = Biochemistry + Microbiology + Cell Biology

APPENDIX 3.1

Illustrations of aspects of Personal Construct Psychology

Illustrations of aspects of Personal Construct Psychology

Personal Construct Psychology (PCP) (Kelly, 1955) contributed much to the theoretical and epistemological stance adopted within this thesis. This appendix provides illustrations of how some aspects of the theory may be interpreted with some of the data collected in this study. Only the central components of PCP are considered. These are the Fundamental Postulate; the corollaries, and a few of those terms Kelly explicitly defined which refer to specific 'emotions' (such as 'threat', 'fear' and 'anxiety') and have direct application within the context of this study.

The Fundamental Postulate: A person's processes are psychologically channelised by the ways in which he anticipates events.

Within the context of this study this postulate may be rephrased as, 'a student's thinking about science, and his/her outlooks on science, are determined by the way he/she has come to expect how they will respond to future contact with experiences of a scientific kind.' That is, a person always 'anticipates'. A particular kind of outcome may be anticipated when in contact with scientific events, but this anticipation is essentially a hypothesis in that it may be supported or refuted when the event actually occurs. However, whatever the outcome, the person will continue to anticipate even though the next 'hypothesis' so erected may not be the same as the previous one. It is in this manner that Kelly establishes the notion that a person is essentially a

form of motion and thereby does away with concepts of 'drive', 'needs' and 'stimulus-response' relationships.

> "Like the prototype of the scientist that he is, man seeks prediction. His structured network of pathways leads towards the future so that he may anticipate it. This is the function it serves. Anticipation is both the push and pull of the psychology of personal constructs."
>
> (Kelly, 1955:49)

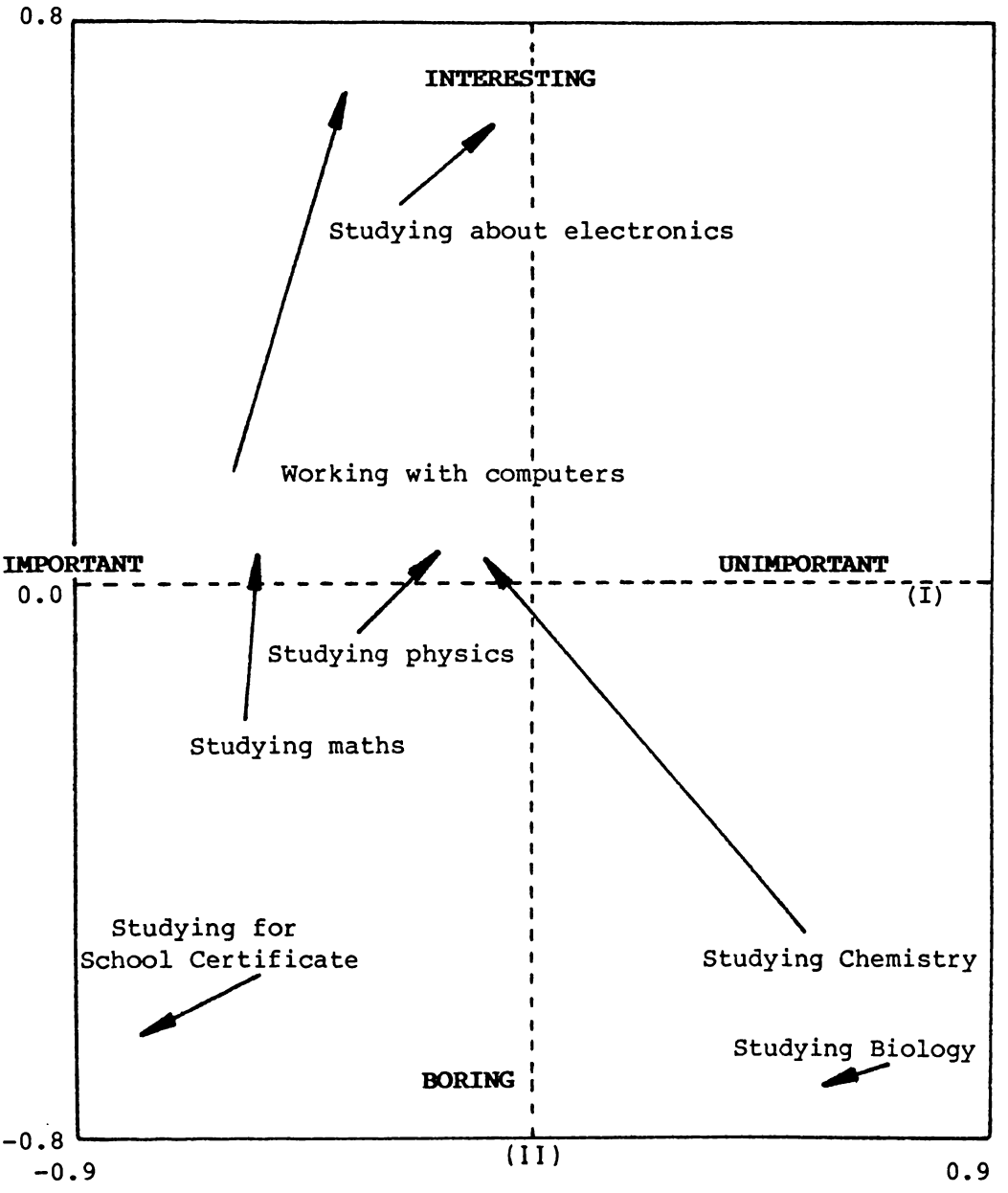
Thus, the student who says, "I don't like science because I can't do it and I find it boring" is not only describing past personal experiences with science but, more significantly, is hypothesising (that is, is 'anticipating') that future experiences with science more likely than not will be unpleasant, difficult and dull. The use of the terms 'don't like', 'can't do' and 'boring' identify the nature of the 'structured network of pathways' (referred to by Kelly in the quotation above); that is, the nature of the student's personal construct system. Should a subsequent science experience be enjoyable and easy, the student's modification to his/her response to science would represent a revised anticipation (hypothesis) with regard to yet further science experiences.

The repertory grid analyses described in this study may be viewed as static representations of individual students' 'structured networks' at the point in time when the raw grid data were collected. The repositioning of particular elements and constructs in subsequent grids reveal the revision of those anticipations which had occurred in the interval between consecutive grid formations.

As an illustrative example, Andrew (one of the sample students) stated in an early interview, "I'm not really interested in Chemistry and Biology" - the implications being from a PCP perspective that he anticipated chemistry and biology would not interest him. However, some ten weeks later, he felt, "Now we're into chemistry, I'm beginning to like it more." That is, in revising his earlier anticipations in the light of subsequent experience Andrew had replaced his previous hypothesis concerning chemistry with an alternative one of possible greater predictive utility. This revision is shown in Figure A3.1 which depicts a simplified analysed repertory grid representation of Andrew's personal construct system on these two occasions and shows considerable repositioning of the chemistry element but very little for the biology element. The full repertory grid representations are given in Appendix 5.1.

It should be noted the Fundamental Postulate is itself a hypothesis in that it is proposed in order to be tested and, if found wanting in the light of experience, to be revised. The same may be said of the entire Personal Construct Theory - it is a reflexive theory and is open for successive revision. Therefore, this current discussion may be viewed as one attempt to test the theory's explanative and predictive utility and to suggest modifications or alternatives where appropriate.

Figure A3.1: A simplified graphical representation showing the extent of Andrew's repositioning of specific elements over a ten week time interval.



(a) The Construction Corollary: A person anticipates events by construing their replications.

This proposition does not imply that events actually repeat themselves but rather that individuals detect recurring

themes in their experiences and use these themes to predict future events. The 'construing' process occurs as individuals detect similarities and contrasts in their experiences - similarity and contrast are inherent in the same construct.

> "A construct which implied similarity without contrast would represent just as much of a chaotic undifferentiated homogeneity as a construct which implied contrast without similarity would represent a chaotic particularised heterogeneity. The former would leave the person engulfed in a sea with no landmarks to relieve the monotony; the latter would confront him with an indeterminable series of kaleidoscopic changes in which nothing would ever appear familiar."
>
> (Kelly, 1955:51)

The positioning of elements with respect to constructs and the articulation of the constructs, as shown in the graphical representations of students' construct systems in this study, reflects something of the nature of the constructions the students used in interpreting their experiences. The manner in which these constructions allow for the anticipation of events is not apparent from the representations themselves. For this, conversations with the students were necessary to allow them to offer possible interpretations.

For example, Sean used a gender-related construct in responding to the study of physics - physics was "mainly for boys ... because I've never seen a woman mechanic before." His construction of the relationship between physics and people likely to do physics was such that, on the basis of previous experience, he anticipated people involved with physics more

likely to be men than women. Note: The possibility arises that the Fundamental Postulate is inherently tautologous - do the anticipations follow the constructions, as implied here, or are the constructions determined by the anticipations, as implied in the way the Fundamental Postulate is worded? This writer suggest the former to be more consistent with common experience.

(b) The Individuality Corollary: Persons differ from each other in their construction of events.

This proposition reaffirms the uniqueness of individuals. PCP is concerned with individuals (hence the term Personal Construct Psychology) and this corollary makes explicit the emphasis that even when two individuals anticipate the same event (such as two students facing the decision whether to continue with a study of science or not) they do so using their own 'network of pathways'.

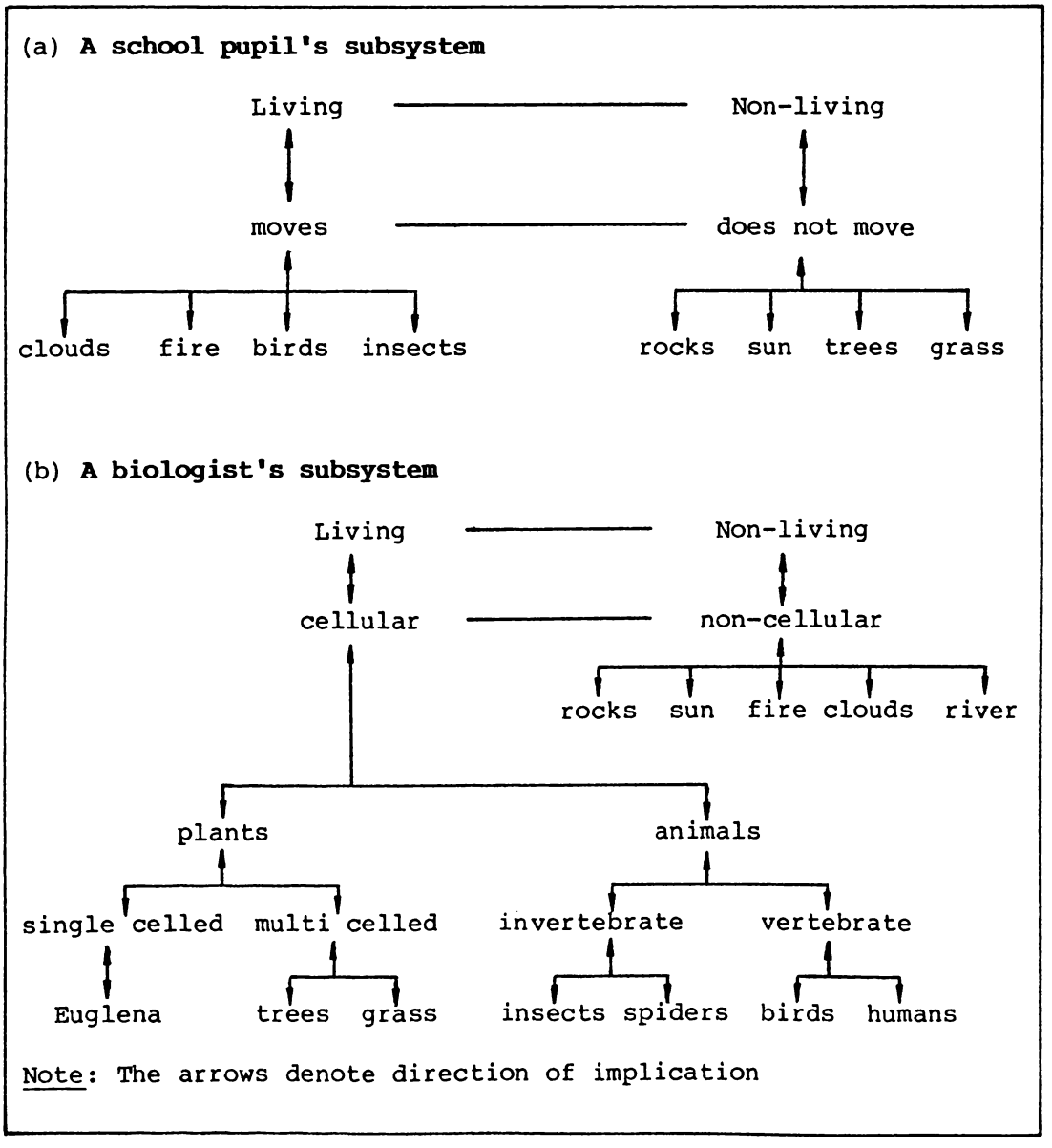
The qualitative research reported in this thesis has accepted this perspective as valid and has sought to identify and to describe several students' 'constructions of events' (in particular, their outlooks on science) even though many of them possibly have shared very similar science experiences.

(c) The Organisation Corollary: Each person characteristically evolves for his convenience in anticipating events a construction system embracing ordinal relationships between constructs.

This proposition suggests that in order to anticipate events using some of the multitude of constructs an individual has in his/her repertoire a personal hierarchical system is developed in which some constructs are more important than others. Thus,

within a personal construct system, each construct, by virtue of its relationship with other constructs, will imply a set of predictions about each event to which it is applied, and different individuals will not only differ in their construction of events but they will also differ in the ways they organise their construction of events. Refer to Figure A3.2.

Figure A3.2: Hypothetical representations of two different construct subsystems subsumed by the super-ordinate construct 'Living-Nonliving'.



Note: The arrows denote direction of implication

In Figure A3.2 (a) the construct 'living-nonliving', as used by a school pupil, implies the construct 'move-does not move'. That is, if something is capable of independent movement it is living (Bell, 1981). Consequently, so too are clouds, rivers, fire, as well as humans, horses, insects, animals and birds, living. Things such as rocks, the sun, and trees and grass, would be categorised as being 'non-moving' and thereby, 'non-living'.

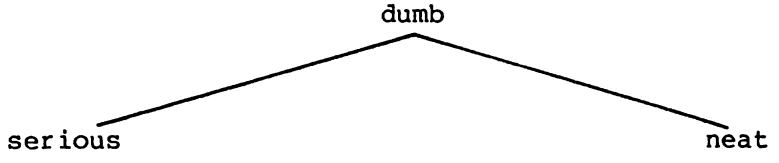
In Figure A3.2 (b) the construct 'living-nonliving', as used by a biologist, implies inter alia, the construct 'cellular-noncellular'. Under the 'cellular' pole of this construct, the subordinate construct 'plants-animals' appears. Each pole of this subordinate construct has further subordinate constructs. For example, under the 'plants' pole, the subordinate construct 'single celled-multicelled' could appear, whilst, under the 'animals' pole, the subordinate construct 'vertebrate-invertebrate' would be possible.

(d) The Dichotomy Corollary: A person's construction system is composed of a finite number of dichotomous constructs. The repertory grid technique is based upon this proposition and the ease with which the students in this study were able to use dichotomous (or 'dichotomised'?) constructs provides some evidence of its 'construct' validity and utility. The answer to the question of whether individuals prefer to use, or do use, only dichotomous constructs, is uncertain.

In discussing this corollary, Kelly (1955) argues that at least three elements are required for a construct to be formed,

two give rise to the similarity pole and the other provides the basis for the contrast pole. Although an individual's construct cannot be fully understood without encompassing both its poles, since the contrast is just as necessary as the similarity in defining its meaning, one pole may be implicit when a specific verbal label does not exist for it.

Several students had difficulty in providing verbal labels for such implicit poles. For example, Sharon was able to say, "I think science is dumb" and thus provided an explicit verbal label for one pole of a construct 'dumb-not dumb'. Ensuing conversations with Sharon revealed the implicit pole to have one of two possible verbal labels; either 'serious' or 'neat' (meaning 'enjoyable'). This establishment of at least two implicit poles initially suggested the possibility of a 'bent' construct which appeared to be incompatible with this corollary. Such a construct could be represented thus:



However, it soon became apparent that Sharon was responding to either one or the other of two distinct constructs and the choice of either was context dependent. That is, she responded to either the construct 'serious-dumb'; or the construct 'neat-dumb'. Thus, science was seen as being 'not serious' as she did not perceive science as having the same status as English and Mathematics. However, science was also perceived as being 'neat', particularly when practical work was

involved.

The point being made in this example is that although the notion of individuals thinking with only dichotomous constructs appears counter-intuitive, operationally the notion can be supported.

(e) The Choice Corollary: A person chooses for himself that alternative in a dichotomized construct through which he anticipates the greater possibility for the elaboration of his system.

In this propostion Kelly is stating that in 'experimenting' with their own behaviour (by erecting 'hypotheses' and by testing them against experience) individuals will choose the alternative which will appear to enhance their capacity to anticipate events. The term 'elaboration of his system' can mean 'to extend his system', as when an individual chooses to explore new areas of possible experience, or it can mean to 'consolidate and minimise inconsistencies within his system'.

An example of the difference between these two forms of elaboration is that choice faced by students whether to take a 'popular' subject for an examination because their peers are taking it and thereby further define themselves as being part of a 'normal' group of students, or to take an atypical subject, and thereby extend their experiences into new areas, but risk having to redefine themselves as a consequence of a possible loss of some degree of internal consistency within their personal construct system.

This may be illustrated with reference to Aroha. Aroha had decided she would continue with a study of the sciences beyond F5

in order to become an architect and so was prepared to weather the social pressures to conform to the 'usual' girls' subjects. "I've had to try and face the fact that I might be the only lady architect for a little while ... so it doesn't really worry me that I'll probably be the only girl in the class". Aroha's choice enabled her to further extend her sphere of experience and thereby to anticipate new events and, at the same time, it enabled her to further redefine herself as a person able to make independent decisions and see them through. Thus, the two aspects of elaboration are seen here to be operating simultaneously.

(f) The Range Corollary: A construct is convenient for the anticipation of a finite range of events only.

A construct has its 'focus of convenience' and its 'range of convenience'. The former refers to the set of events in a particular context to which a construct is usually applied; the latter refers to a broader set of events to which a construct can be applied but with less efficiency. Those events which are not able to be subsumed by a construct are said to fall outside the range of convenience of the construct.

For example, if teacher asks a question of a student and receives a "I don't how" response, it could be because none of the student's constructs had a sufficient range of convenience to encompass the elements comprising the teacher's question. Similarly, an apparent 'incomprehensible' response by the student could indicate that the elements used by the student in the response lay outside the range of convenience of the teacher's constructs.

In the quantitative phase of the study, the use of 'standard' questions provided many situations where students were unable to give a meaningful response because they lacked appropriate constructs. For example, one item on the Science Questionnaire required students to indicate the degree to which they 'liked watching science programmes on TV'. Several students claimed they could not respond to this item because they did not have a TV set at home.

It may be noted that constructs may subsume elements which 'should' lie outside the range of convenience of particular constructs. For example, a student, in using the construct 'many legs-no legs', may 'incorrectly' categorise a centipede as not being an animal because it has too many legs (Bell, 1981). However, within the personal construct system of that student, the categorisation is valid in that the student is able to offer the prediction 'centipedes are not animals'. The prediction would be refuted by a biologist offering an alternative categorical system of greater scientific utility, but this does not effect the range (or focus) of convenience of the student's construct - what may be questioned is the choice of that particular construct in the given context (presumeably, that of a scientific nature).

(g) The Experience Corollary: A person's construction system varies as he successively construes the replication of events.

In essence, this corollary encompasses Kelly's notion of 'learning' although he does not differentiate the process of

learning from any other psychological process.

> "The constructions one places on events are working hypotheses which are about to be put to the test of experience. As one's anticipations or hypotheses are successively revised in the light of the unfolding sequence of events a construction system undergoes a progressive evolution."
>
> (Kelly, 1955)

Thus, an individual is constantly assessing the utility of his/her anticipations post hoc. When his/her hypotheses are supported, his/her constructions can be said to be 'validated'; when his/her hypotheses are refuted, his/her constructions can be said to be 'invalidated'. That is, Kelly is suggesting that an individual is continually evaluating his/her constructions on the basis of their predictive efficiency.

An illustration of a student 'varying' her construction system is suggested in her explanation of her concept of 'gravity':

> "When you swing a bucket over your head, you've got the gravity which holds it in, at least that's what I've been told. And I don't know why. I think it's 'cos it really hasn't got a chance to come out. That's what I think anyway, 'cos you're swirling it that fast and it really can't come out. It's supposed to be something to do with gravity, but I can't see how it can be."
>
> (Stead and Osborne, 1981)

In her account, the student is trying to link someone else's concept of gravity (a teacher's?) to an experience for which she already has a useful explanation. She is thus 'varying' her construction system, but it would appear she is not convinced she needs to.

(h) The Modulation Corollary: The variation in a person's construction system is limited by the permeability of the constructs within whose range of convenience the variants lie.

This proposition is a statement of the recognition that an individual's construct system (or subsystem) imposes limitations to the amount of change it, itself, can undergo. A permeable construct is one which is able to be applied to new events, whilst an impermeable construct cannot be applied to new events - these new events would lie beyond the range of convenience of the construct in question. That is, by permeability, Kelly is referring to a construct's capacity to be used as a reference axis for new events, rather than implying instability. He illustrates this corollary with reference to two types of scientific formulations:

> "The kind of construct which is permeable has more of the qualities of a theoretical formulation, as contrasted with a hypothetical formulation... A hypothesis is deliberately constructed so as to be relatively impermeable and brittle, so that there can be no question about what it embraces and no doubt about its being wholly shattered or left intact at the end of an experiment. A theory is not so inflexibly constructed. It is stated in relatively permeable terms so that it may, in the future, embrace many things which we have not yet thought of. It is stated in an open-ended form. A theory then, both provokes and accepts a wide variety of experimental ventures, some of which may even be antithetical to each other."
>
> (Kelly, 1963)

Thus, an individual's construct system is able to vary, and thereby take account of new events (such as those provided by a teacher in a teaching episode) only if existing constructs are sufficiently permeable to allow for the reconstruction of new 'variants' which have a range of convenience sufficient to

accommodate the elements of the new event.

The following quotation illustrates the case of an individual who probably was trying to apply constructs which were initially too impermeable to accommodate certain events ('concepts'). Later, variants, able to accommodate the concepts were developed which allowed comprehension to occur:

> "Many times my physicist friends have attempted to explain a concept to me and, in their exasperation, have tried one explanation after another, each one of which sound (to me) abstract, difficult to grasp, and generally abstruse. When I could comprehend, at last, what they were trying to communicate inevitably I was surprised to discover that the idea was actually quite simple."
> (Zukav, 1979:24)

(i) The Fragmentation Corollary: A person may successively employ a variety of construction subsystems which are inferentially incompatible with each other.

This proposition acknowledges that individuals may hold, within their construct system, incompatible subsystems. Thus, although an individual's total system is basically hierarchical, later developed constructs are not necessarily logical derivatives of earlier constructs. This notion describes the phenomenon observed by Osborne et al (1980) when, in interviewing students about their understanding of certain scientific concepts, found that

> "... they acquire and retain in their knowledge store quite contradictory views."
> (Osborne et al, 1980:6)

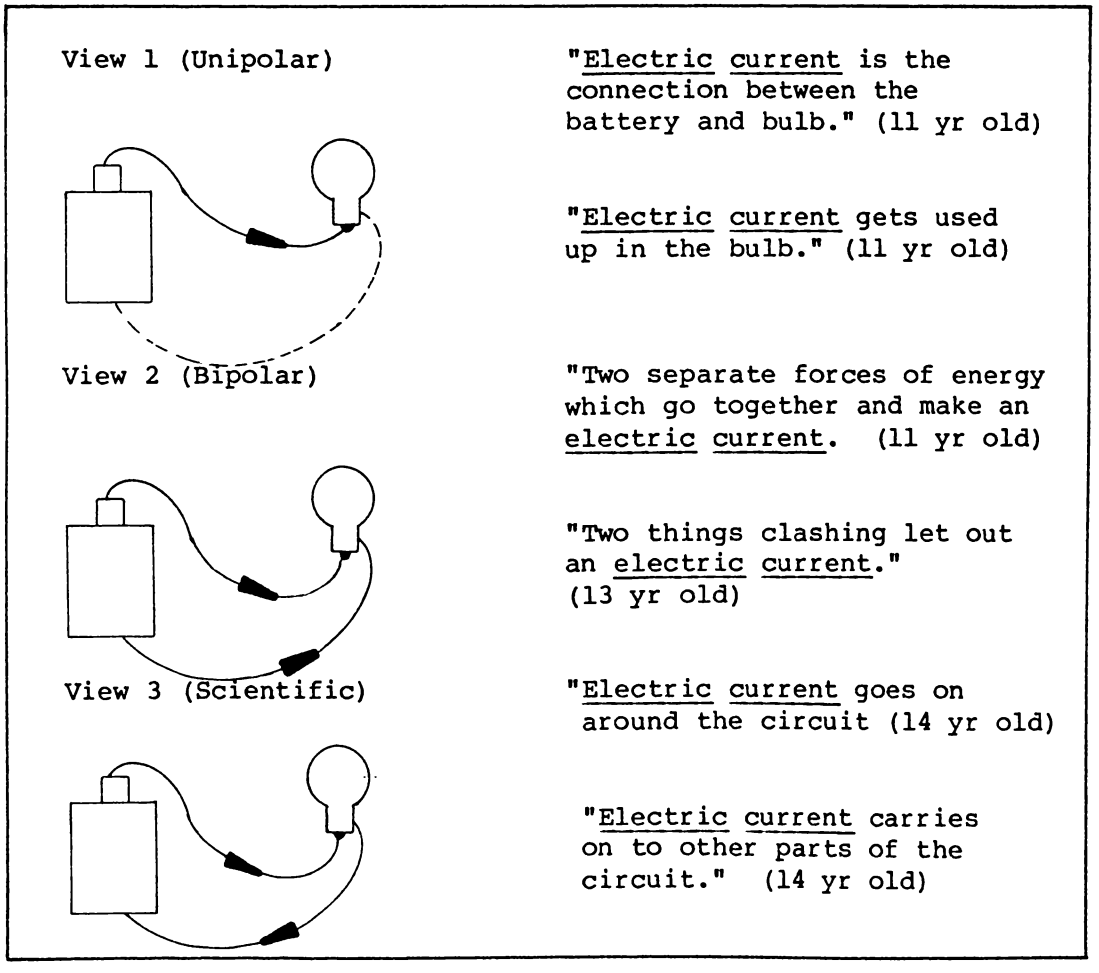
It may be suggested that incompatible subsystems, each able to function without direct reference to each other by permitting parallel processing of information input in addition

to sequential processing, allow for greater efficiency by reducing the cognitive demands on the total system.

(j) The Commonality Corollary: To the extent that one person employs a construction of experience which is similar to that employed by another, his processes are psychologically similar to those of the other person.

This implies that, although two people may witness the same event, it is only if they should construe it in similar ways, that their psychological processes can be said to be similar.

Figure A3.3: Some students' views of electric current in a simple electric circuit (after Osborne, 1981).



For example, Osborne (1981), in investigating children's views of electric current, found three distinct 'models' (see Figure A3.3) to be held by them. Thus, this corollary would suggest, within the sample of students interviewed by Osborne, there were three discernable forms of 'psychological processing' present. The suggestion for teachers would be that any classroom grouping of pupils to facilitate teaching should be based on similar construct subsystems, rather than on the basis of similar experiences (or any other variables such as sex, IQ or age).

(k) The Sociality Corollary: To the extent that one person construes the construction processes of another, he may play a role in a social process involving the other person.

Thus, interpersonal communication and understanding is not simply just a matter of determining the behaviour of others in terms of one's own construct system, but it also involves making inferences about their construct systems. The teacher who is exhorted to 'start where the learner is' is being directed to construct a system like that of the learner's in order to predict the possible directions of movement the learner may make and be able to attempt to modify the learner's construct system as required. Consequently, the learner and the teacher enter into a 'conversation' (Thomas & Harri-Augstein, 1977) whereby the teacher endeavours to construct as accurate a replication of the learner's construct system as possible with the learner's assistance.

Kelly saw the teacher's role explicity as helping

> "... as best she can, to design and implement each child's own undertakings, as well as to assist in interpreting the outcomes and in devising more cogent behavioural inquiries. But usually has to begin, as any apprentice begins, by implementing what others have designed; in this case, what her children have initiated. To be a fully accredited participant in the experimental enterprise she must gain some measure of what is being seen through the child's eyes."
>
> (Kelly, 1970;262)

The rationale for the qualitative phases of research reported in this thesis is based on this view.

(1) Other aspects of PCP.

As a clinician, Kelly was interested in those aspects of an individual's construction processes which related to change, particularly those processes which other psychological theories link with concepts of 'emotion' (such as 'drives', 'motivation', 'affect', 'valence', etc). Educators, similarly, are attempting to bring about a change in the construct systems of their pupils when they teach, and, although not necessarily explicitly concerned with 'emotions' per-se (as a clinician may well be), their existence in the teaching-learning context is often apparent. Three dimensions of change which may be linked with 'emotions' and are observable within the classroom are briefly presented here; these are 'threat', 'fear' and 'anxiety'.

Just as an individual has a set of constructs about his/her personal world, he/she has a set which is concerned with the social world (refer to the TRA's 'social beliefs'), and another set which subsumes aspects of the physical world at large (refer to the TRA's 'objective beliefs'). Many constructs within these

sets will be common with each other and others will probably be related (see the 'Organisation Corollary'). However, when these constructs become invalidated and the individual's world becomes no longer predictable as it appears about to become chaotic, the individual faces the need for a comprehensive change in his/her construct system. It is this 'awareness' which Kelly defines as a 'threat'. That is, 'threat' is the awareness of an imminent comprehensive change in one's core structures (core structures are essentially constructs about the self).

This notion is introduced here to provide a link with Kelly's descriptions of 'anxiety' and 'fear'. Anxiety is described as the awareness that events with which one is confronted lie mostly outside the range of convenience of one's construction system.

Students in the classroom situation occasionally express anxiety when they realise they are unable to completely grasp the event (such as a particular scientific concept) but have sufficient structure to realise the event does exist. If the event lay completely outside the range of convenience of their construct systems, the students would not have perceived it at all and no anxiety would have occurred.

Many students, certainly many girls, profess not only to anxiety, but also to fear in the sciences. Fear is 'the awareness of imminent incidental change in one's core structures' (Kelly, 1955). Stead (1980b) gives an example of a first year teachers' college student who, in describing her feelings within a

chemistry class during the previous year, used constructs indicative of such possible 'incidental change' in her core structures:

> "There were only three girls in our chemistry class last year, the rest were boys. The boys seemed to be a lot more relaxed ... they weren't scared to use their imaginations and the girls sort of were more cautious. They wouldn't answer questions so much until they were sure they were right - this is me included. Whereas the boys didn't mind making a sort of fool of themselves by saying something and actually getting it wrong. They were more at ease on the technical part of it - setting things up and if they broke things they didn't seem to worry about it."
>
> (Stead, 1980b)

The student's reference to "... only three girls in the chemistry class" suggests to this commentator that, within the context of this class at least, the construct 'male-female' (a likely 'core construct') appeared to be salient. Therefore, it may be further suggested that the awareness of the re-positioning of this construct in different contexts (such as might occur when moving from a 'non-science' context to a 'science' context) would be expressed as fear.

Within this interpretation of fear, feelings of fear may be reduced by avoiding situations which occasion 'incidental change' within one's core constructs. F3 and F4 girls, in physically maturing earlier than boys, may possibly already be 'fearful' as they seek to redefine themselves, no longer as children but as young women, and thus be more likely than boys to avoid situations which may tend to increase the extent of personal reconstruction beyond some optimal level. The perceived non-relevancy of science for many girls may well

be an outcome of such an avoidance response.

Kelly's notion of the effect on an individual of a comprehensive change per se within his/her construct system is an important one. Science educators have been concerned primarily with 'cognitive' constructs (and 'objective beliefs') and this notion draws their attention to the need to provide a context in which the student is not only encouraged to reconstruct his/her personal construct system, but also one in which the 'emotions' and actions accompanying any such reconstruction are anticipated, accepted and allowed expression. In such a context the 'popular' view of science and of scientists is being 'cold' and 'impersonal' would be difficult to maintain and would go a long way towards nourishing more positive outlooks on science in all students.

APPENDIX 3.2

A discussion on the reliability and validity of repertory grids, and some practical problems

Difficulties in using the Repertory Grid approach

(a) Practical problems in grid formation.

Fransella and Bannister (1977) identified a number of difficulties in the development and use of the repertory grid technique; such as the tendency for the developing grid technology to become divorced from PCP; the question of bi-polarity in those forms of the grid where only the emergent pole of the constructs is used and unwarranted inferences about the implicit contrast pole are possible; and the danger of researchers imposing their own constructs over those of their subjects.

A number of practical problems commonly experienced in rating grids have been identified by Yorke (1978) and, for convenience, are enumerated here:-

> "(i) Variable perception of elements of low personal relevence
>
> (ii) Varying the context in which the elements are perceived during the administration of the grid
>
> (iii) Halo effect intruding into the ratings where the subject sees the grid matrix building up
>
> (iv) Accidental reversal of rating scale (mentally switching from 5 = high to 1 = high, perhaps because 'five points' and 'first' are both ways of describing high quality). This can happen both within and between constructs, as I have found out from reliability checks which I have carried out, and is particularly likely where a negative, or implicitly negative, property is ascribed to the pair during triadic elicitation.
>
> (v) Failure to follow rules of the rating procedure. For example, where the pair has had to be rated at the high end of a five-point scale, I have come across triads in a single grid rated a 5,4,4; 1,1,2; 1,2,4 which must call into question the constructs and their relationship with the elements."
>
> (Yorke, 1978: 69. Emphasis in original)

(b) Interpretation of output.

Kelly (1969) and Fransella and Bannister (1977) have discussed the problem of the researcher attempting to interpret the numerical data of a grid analysis. To overcome the problem of misinterpretation several commentators (Kelly, 1969; Yorke, 1978; Pope & Keen, 1981;) have suggested the respondent should be actively involved in the interpretation. Ravenette (1977) successfully explained his analyses, presented in the form of a simplified correlation matrix between constructs, to young teenagers. No research has been reported which has discussed the output from a principal component analysis with school age subjects but the use of the 3-dimensional kitset model in this investigation may be seen as being similar to Slater's (1976) spherical geometric representation and this investigator considered it to be successful.

(c) Reliability and validity

(i) Reliability. The concept of reliability in mental measurements generally refers to that characteristic of an instrument which expresses the test's tendency to reveal the same results for the same individual at different times. That is, it is a measure of the inherent 'stability' of the instrument, and is appropriate when that which is being measured is relatively static (such as the height of an adult person) but it is not appropriate for that which is, itself, in motion. Kelly has defined 'reliability' as 'that characteristic of a test which makes it insensitive to change' (Kelly, 1955).

Within PCP "Man is a form of motion" (Kelly, 1955) and, as such, two temporally distinct tests may be viewed as two single 'frames' taken from a cinematic film. If little movement had been captured on the film, these frames may be similar (i.e. 'high reliability' would be demonstrated) but, if rapid action had been recorded by the camera these frames would be quite dissimilar (and 'low reliability' demonstrated).

The raw grid itself contains a considerable amount of complex data from which a wide variety of 'reliability' measures may be obtained. The particular measures obtained would reflect the grid user's focus of interest. To illustrate, the following are some of the possible measures as identified by Fransella and Bannister (1977).

- Stability of elicited constructs. The dichotomy corollary, which states that "a person's construction system is composed of a finite number of dichotomous constructs" is essentially under examination when the stability of the nature and range of elicited constructs is investigated. That is, does an individual select constructs from an almost infinite fund, or does he/she draw from only a finite and relatively stable collection of constructs? Bannister and Mair (1968) suggested the latter and cited research (by Fjeld & Landfield, 1961) which found that subjects, given the same elements (people) after a two week interval, produced very similar constructs (Pearson r=0.79), and even with new elements, subjects still produced their earlier constructs (Pearson r=0.80).

- Pattern of construct relationships. The raw grid provides a pattern of relationships between the constructs which can be used to derive a test-retest reliability measure. When based on a matching ranking of the two matrices, this measure is essentially a Spearman rho which represents an estimate of the stability of the inter-construct pattern of relationships over time. Fransella and Bannister (1977) cite studies with such coefficients of reliability which range between 0.60 and 0.80.

- Intensity. This is a global measure of the amount of correlation or relationship between constructs in a single grid. However, this measure tends to have low reliability (around 0.35) from test to retest, yet the intensity scores themselves may be predicted to increase, which suggests some sort of process is inherent in grid completion. Fransella and Bannister (1977) suggest, as this measure varies under specifiable conditions (e.g. with subjects identified in terms of their psychopathology), it may reflect an aspect of an individual's construction performance and thus its 'sensitivity' may have significant (but unspecified) theoretical implications.

- Mal-distribution. This refers to the degree of lopsidedness of element distribution across the constructs. This is a test-retest measure. The relative numbers of elements allotted towards each pole of the constructs may vary. Bannister (1966a) found a reliability coefficient of 0.76 for the mal-distribution score.

Therefore, it is not possible to refer to the 'reliability' of the grid as if it was a consistent and a unitary measure. As these examples above have shown, and just as there is no such thing as the grid itself, the use of the term 'reliability coefficient' must be treated cautiously.

From the theoretical perspective, as an individual experiences events (even such as completing a repertory grid) his/her "construction system varies as he/she successively construes the replication of events" (The Experience Corollary - Kelly, 1955). Should the construction be validated, by his/her prediction that a particular outcome will occur in a given situation being successful, little alteration to his/her construct system may occur. However, if the construction is invalidated, by his/her prediction being unsuccessful, alteration on his/her construct system will occur. In Kelly's terms:

> "The constructions one places upon events are working hypotheses which are about to be put to the test of experience. As one's anticipations or hypotheses are successively revised in the light of the unfolding sequence of events, a construction system undergoes a progressive evolution."
> (Kelly, 1955: 72)

This 'progressive evolution' will be reflected in those particular reliability coefficients which respond to the relevant aspects of the construct system.

Consequently, while conventional psychometic interpretation of reliability coefficients is inappropriate with repertory grids, an interpretation based on the psychological significance of the degree of inherent construct system change may be very

appropriate.

(ii) Validity. Kelly has defined validity as 'the capacity of a test to tell us what we already know' (Kelly, 1955). By this 'definition' Kelly has drawn attention to the conventional psychometric interpretation of face (or content) validity which requires an independent measure of a variable under investigation, against which a subsequent measure can be compared. The repertory grid does not necessarily provide a specific measure which can be 'correlated' with that of another and, as noted above, there is no such entity as the repertory grid as it takes a variety of forms and is more a method rather than a static 'test'.

Grids provide a way of exploring relationships between constructs (and thereby, between elements) and, as such, the meaningfulness of the grid format for doing so may be questioned - it is this sense that the 'validity' of the grid technique should be explored.

The meaningfulness of the grid format may be derived from PCP itself in that the grid provides a technique for operationally exploring hypotheses arising from the theory's formulations. For example, the Organisation Corollary ("Each person characteristically evolves for his convenience in anticipating events, a construction system embracing ordinal relationships between constructs") would suggest that a person whose construct system does not show 'ordinal relationships between constructs', that is, whose construct system reflects the absence of 'organisation', would not only

be atypical but might perhaps be identifiable in some independent manner. Much work with people diagnosed as thought-disordered schizophrenics confirm this (Bannister, 1965; Bannister & Fransella, 1966). These people, 'whose talk is clinically described as marked by irrelevance, vagueness, clang associations, word salads and neologisms' (Bannister & Mair, 1968) stand in distinct contrast to those people, classifiable as 'typical', whose construct systems do show relationships between constructs.

For other studies which link grids with theory see Bannister and Mair (1968) and Fransella and Bannister (1977). In passing, it is appropriate to note validity may be interpreted in terms of 'usefulness' (Fransella & Bannister, 1977). The ever increasing literature of research using the repertory grid techniques would attest to the supposition that many researchers do find the technique 'valid'.

APPENDIX 3.3

An example of a repertory grid
(Aroha's)

WAIKATO UNIVERSITY

Repertory Grid Response Sheet

Name AROHA ..... Date 12/6/81 .....

School ..... Class Form Five .....

Computer use only	1-4	5	6	7	8	9	10

Topic School subjects, and interests .....

Elements

Constructs	1 Physics A	2 Chemistry B	3 Biology C	4 Architect D	5 Engineering E	6 Woodwork F	7 Technical Drawing G	8 School System H	9 English I	10 Mathematics J	11 Teacher K	12 Maori L	13 Art M	14 Sport N	15 Craftwork O	16 Religion P	17 Q	18 R	19 S	20 T	Constructs
1 clear - understandable	5	4	1	1	2	3	2	1	1	2	2	1	4	4	1	2					Obscure - difficul 1
2 need to know	1	1	3	1	4	2	1	3	2	1	3	2	3	4	4	1					don't need to kno 2
3 boring	4	4	5	5	4	4	5	3	4	4	3	5	5	4	5	5					interesting 3
4 will help	1	2	1	2	4	4	2	3	1	1	3	1	2	2	2	1					will not help 4
5 do not challenge	5	4	4	5	5	5	5	5	3	4	5	3	5	5	4	5					do challenge 5
6 encouraged by parents	1	1	3	1	5	5	1	2	1	1	2	1	4	2	3	1					not encouraged by parents 6
7 does not contribute to environment	5	4	4	5	5	3	4	5	5	5	3	5	3	4	3	5					contributes to en 7
8 I am good at	3	2	2	2	5	5	2	2	1	2	3	1	3	4	2	1					I'm not good at 8
9 Does not contr to Maori culture	4	1	5	3	3	5	4	4	3	4	5	5	5	4	5	5					Contribute to Maori culture 9
10 Not Important	5	4	3	6	3	4	5	3	5	5	3	5	4	3	2	5					Are important 10
11 Most people masculine	3	3	3	1	1	1	1	3	3	3	3	3	3	3	3	3					Most people feminine 11
12 Not important religious view	4	4	4	5	4	4	4	3	4	4	5	1	4	4	4	5					Important from religious viewp 12
13 I consider to be masculine	2	2	3	4	1	1	3	3	2	3	3	3	3	2	3	3					I consider to be feminine 13
14 help when relating to others	3	3	1	3	4	4	3	2	3	3	3	3	3	2	4	1					do not help when relating to oth 14
15																					15

Comments:

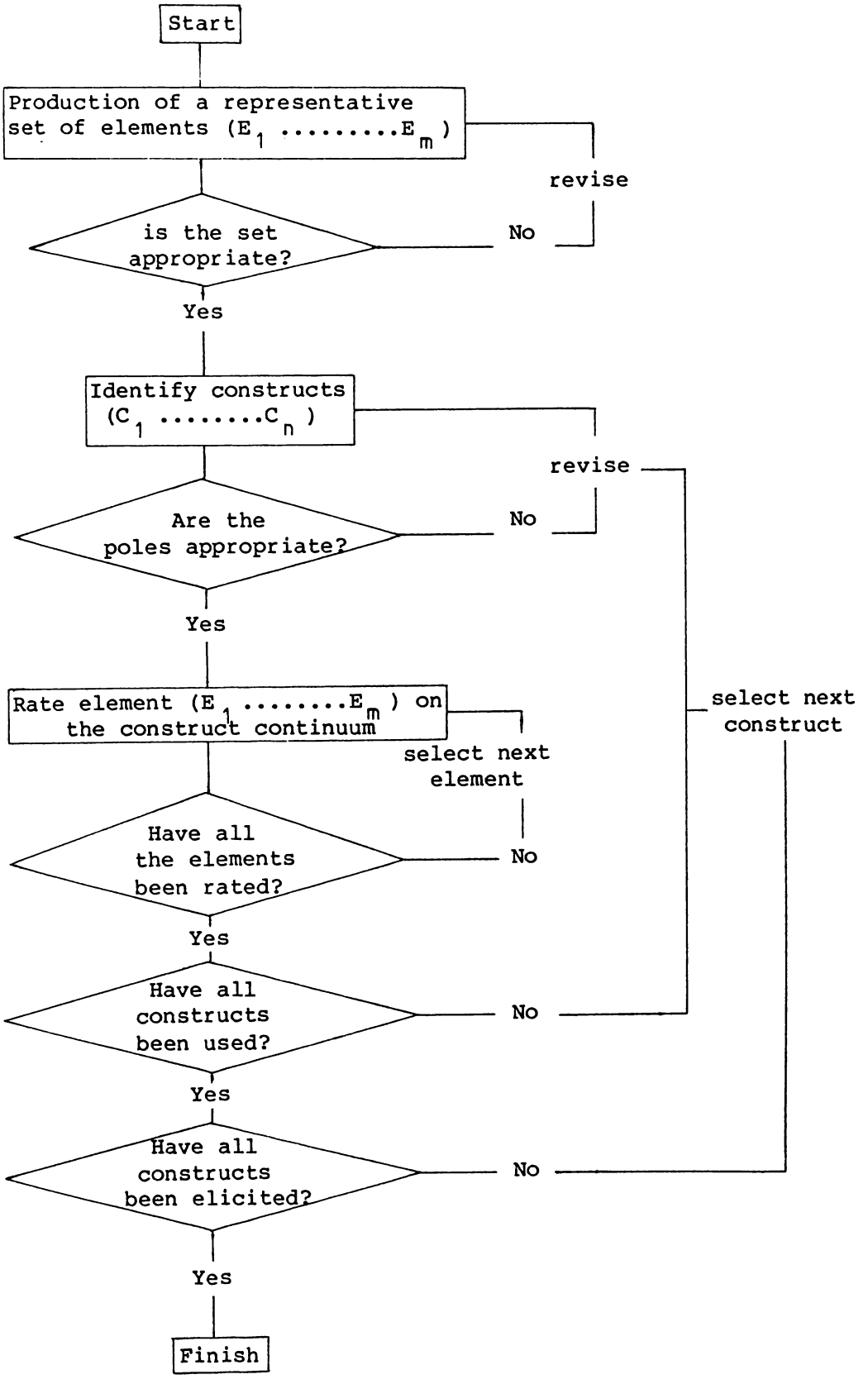
Aroha's elements and constructs

Elements	Constructs (right-hand poles only)
A. Studying Physics	1. Obscure - difficult to understand
B. Studying Chemistry	2. Things I feel I do not need to know much about
C. Studying Biology	3. Things I find interesting
D. Working as an architect	4. Things that do not (or will not) help me in my life
E. Studying Engineering	5. Things that challenge me
F. Studying Woodwork	6. Things that are not encouraged by my parents
G. Studying Technical Drawing	7. Do contribute to an understanding of my own environment
H. The School System	8. What I am not (or will not be) good at
I. Studying English	9. Contributes to our Maori culture
J. Studying Mathematics	10. Things that are important
K. Working as a teacher	11. Things that most people think are feminine
L. Studying Maori	12. Important from a religious viewpoint
M. Studying Art	13. Things that I consider are feminine
N. Playing sport	14. Things that do not help when relating to others
O. Doing craftwork	
P. Religion	

APPENDIX 3.4

Flow diagram for grid formation using the rating method

Flow diagram for grid formation using the rating method



APPENDIX 3.5

Summary of the characteristics of the eight schools used in the investigation (as at 1st July 1981)

Summary of the characteristics of the eight schools used in in the investigation (as at 1st July 1981)

School	Type	Rural/Urban	Roll	% of total school roll classified as Maori or Pacific Island students	Analysis of staff by sex and specialty
1	co-ed	large town	936	35.9	7 male; 1 female (Biologist)
2	Interm.	large town	643	29.4	1 male responsible for Fl science
3	co-ed	city	1206	13.0	6 male; 4 female (1 Chemist, 3 Biologists)
4	Interm.	city	659	20.8	1 male (science specialist)
5	single-sex girls	city	689	15.5	2 male (physics and science); 5 female

Table A3.5 (Continued)

6	single-sex	city	864	12.2	9 male; 1 female (junior science)
7	co-ed	rural town	549	37.9	5 male; 1 female (Biologist)
8	full primary	rural town	176	88.1	No science specialist (all class teachers responsible for science in own classes)

Notes: 1. See appendix 1.1 for an analysis of the sex and ethnic composition of each science option at the 5, 6 & 7th form levels.

2. In some schools only 'Maori' and 'non-Maori' figures were available. Thus, some Pacific Island students could thereby be classified as 'non-Maori'. Consequently, these proportions should be viewed as being conservative.

3. Other than one Chinese male science teacher in one school, and an Indian male science teacher in another, all science teachers were of European descent.

APPENDIX 3.6

Descriptive characteristics of the 20 classes
used to provide the student sample

Descriptive characteristics of the 20 classes used to provide the student sample

Class	Form	No. of Students		Ethnic composition				Sex of Teacher	Approx hours science/ week
		Male	Female	Eur	Maori	PI	Other		
1	3	12	16	14	9	3	2	Male	4
2	3	12	13	15	4	6	0	Male	4
3	4	16	15	15	8	8	0	Female	4
4	1	15	18	16	13	1	2	Male	2
5	2	16	20	21	10	5	0	Male	0.5
6	2	15	17	13	14	3	2	Female	0
7	3	22	13	27	7	1	0	Female	3
8	4	16	13	24	4	1	0	Male	3
9	4	13	19	20	11	0	1	Female	3
10	1	11	21	23	7	0	2	Male	1
11	1	15	18	27	6	0	0	Female	1
12	2	13	18	21	8	1	2	Female	1
13	3	0	33	32	0	1	0	Male	4
14	4	0	31	31	0	0	0	Female	4
15	3	34	0	31	2	0	1	Male	4
16	4	33	0	29	2	1	1	Male	4
17	3	14	12	12	11	3	0	Male	3
18	4	13	10	7	15	0	1	Male	3
19	1	12	16	3	24	0	1	Male	0.5
20	2	10	16	7	19	0	0	Male	0.5

APPENDIX 3.7

Summary of the characteristics of the 26 sample students

Summary of the characteristics of the 26 students used in the investigation

No.	Student	Sex	Age	Ethnic Group	Form[1]	School Type	TOSCA Raw Score	TOSCA Percentile	Hidden[3] Figures	Dominant[4] Cognitive Style	IAR[5] +I	IAR[5] -I	IAR[5] I tot.	Science[6] Questionnaire
1	Lei	M	15/8	PI	4	s/s city	49	87	11	C	13	11	24	+12
2	Louana	F	13/2	M	2	int. city	30	43	11	C	12	8	20	+8
3	Linda	F	14/6	E	4	s/s city	31	47	7	C	8	13	21	+2
4	Amanda	F	13/7	E	3	s/s city	37	72	12	D	8	7	15	-12
5	Robert	M	14/2	E	3	s/s city	37	66	6	C	15	9	24	+12
6	Peter	M	12/1	E	2	int. city	32	53	7	C/D	12	13	25	+2
7	Jackie	F	15/5	M	4	coed city	34	50	3	C	14	9	23	-4
8	Sean	M	11/11	E	1	int. city	37	78	10	D	12	13	25	+18
9	Wayne	M	12/2	M	1	int. city	33	58	6	D	10	12	22	-20
10	Murphy	M	13/10	PI	3	coed city	23	33	11	D	11	10	21	-6
11	Amanda	F	12/7	E	2	int. city	32	51	5	D	15	12	27	-6
12	Jackie	F	14/1	E	3	coed city	33	63	8	D	13	15	28	-2
13	Russell	M	13/9	PI	2	int. city	39	58	1	C	10	12	22	+14
14	Jocelyn	F	14/11	E	4	coed city	42	72	12	C	15	14	29	+40
15	Aroha	F	14/6	M	4	coed rural	35	54	13	C	11	11	22	+26
16	Susan	F	11/3	M	1	prim. rural	28	60	4	C	14	12	26	-26
17	Mihi	F	12/9	M	2	prim. rural	32	50	7	C	9	11	20	-6
18	Andrew	M	14/6	E	4	coed rural	41	71	7	R	14	11	25	+10
19	Maurice	M	14/7	M	3	coed rural	44	85	9	C	16	14	30	+10
20	Sharon	F	12/6	E	2	int. rural	32	55	4	R	12	13	25	-16
21	Sandra	F	13/2	M	2	int. rural	30	43	-	D	14	16	30	-28
22	Angela	F	14/2	M	3	coed rual	22	22	9	D	13	13	26	-20
23	John	M	13/10	M	3	coed rural	29	45	5	C	14	11	25	-2
24	Leanne	F	12/5	E	1	int. rural	36	69	3	D	12	14	26	-12
25	Ruth	F	13/6	PI	3	coed rural	32	56	9	C	17	12	29	+6
26	Janis	F	14/6	PI	4	coed rural	41	71	9	R	15	16	31	+8

Notes:

1. As at the commencement of the study
2. Test of Scholastic Ability See Reid et al (1980)
3. Used here as a measure of 'Field Independence' See Ekstrom et al (1976)
4. R = relational style
   C = categorical style
   D = descriptive style
   See Kagan et al (1963)
5. These give the subscores and total score for the 'Intellectual Academic Responsibility' questionnaire See Crandall, Katkovsky, & Crandall (1965)
6. Possible range = $\pm$ 60; Mean = 1.63; s.d. = 15

APPENDIX 3.8

The Science Questionnaire

Science Questionnaire

Objectives:-

1. To provide a standard method of evaluating the views of students on several specific science topics.

2. To provide a coarse device to enable an independent (of the school/teacher) appraisal of particular student's appropriateness for inclusion in the indepth case-study investigation of student attitudes to science.

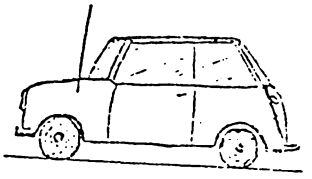
Notes:- 1. A secondary analysis of the responses from the total sample to reveal particular 'profiles', rather than just the total scores, would be possible.

2. Most of the Science Questionnaire (SQ) items were drawn from the 'Interview-about-instances' cards (Osborne & Gilbert, 1980) or survey instruments used in the Learning in Science Project. The exceptions were items 4 (Nussbaum, 1979), 12 (Erickson, 1977), and 13 (Novick & Nussbaum, 1978).
All items were chosen because of their proven value in generating qualitative insights into the ways children perceive their world. Thus, it was anticipated that the quantitative data generated by the SQ could be set against the considerable body of qualitative material already familiar to this researcher.

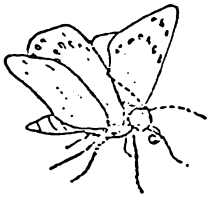
1 Which of the following are living?

A cat watching a bird

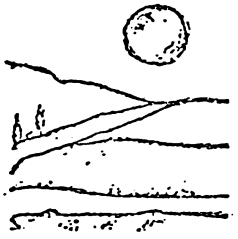
A flickering fire



A car going along the road

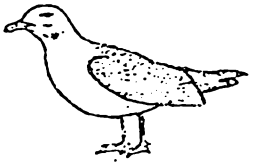


A butterfly sitting on a leaf



The sun in the sky

Grass in a field

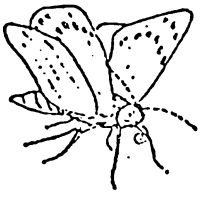


A bird standing on the sea-shore

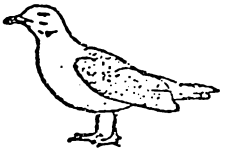
A cloud in the sky

2 Which of the following are animals?

Dog

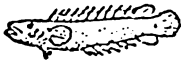


Butterfly



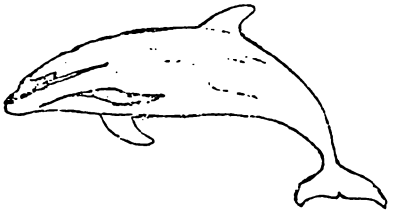
Bird

Snail

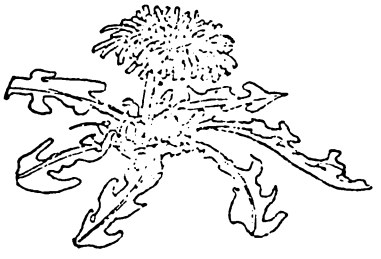


Fish

Boy



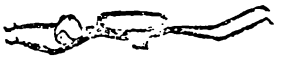
Dolphin



Dandelion

3 In which of the following would there be gravity?

A person standing on Earth

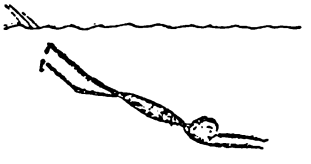


A sky-diver falling from a plane

A person standing on the Moon

A space-man near a satellite

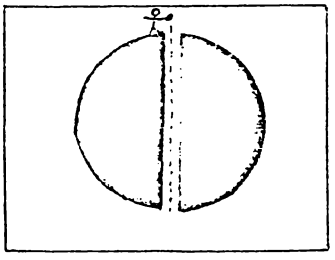
A person swimming in the sea

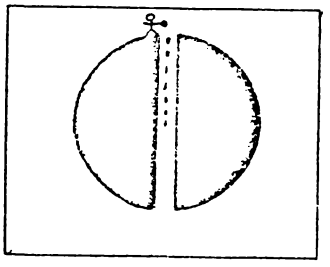


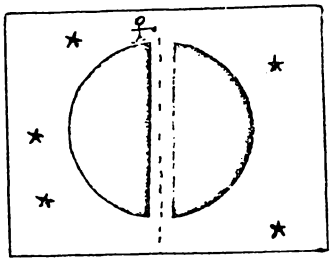
A person swimming under-water

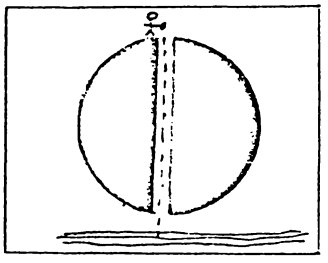
4 Suppose that someone had dug a hole all the way through the earth and dropped a rock into it.

Which picture below shows where the rock would eventually stop?

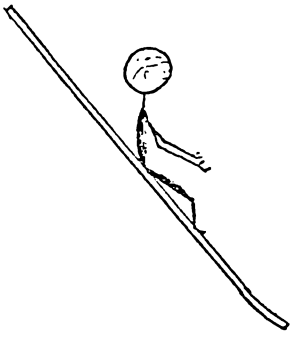




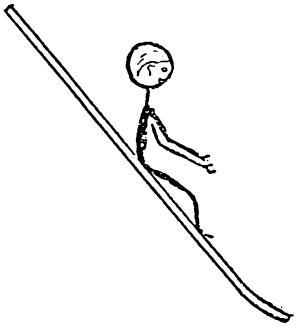




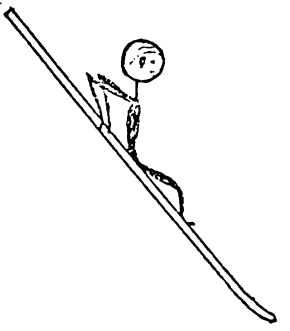
5 In which pictures would there be friction?



coming down a slide fast and getting faster

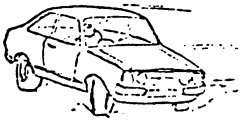


coming down a slide slowly and steadily.

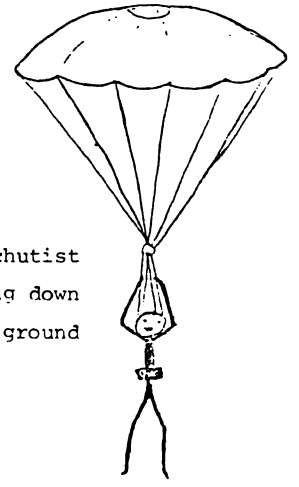


not moving on the slide

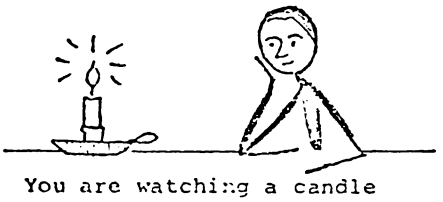
A person swimming in the sea



A car sliding sideways on ice



A parachutist floating down to the ground



6 You are watching a candle burning during the day.

The light from the candle:

A: stays on the candle.

B: comes out about halfway towards you.

C: comes out as far as you but no further.

D: comes out until it hits something.

7 There is a power cut during the night. You are using a candle.

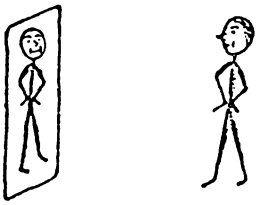
The light from the candle:

A: stays on the candle.

B: comes out about halfway towards you.

C: comes out as far as you but no further.

D: comes out until it hits something.



8 You are looking at yourself in the mirror.

The light from the mirror:

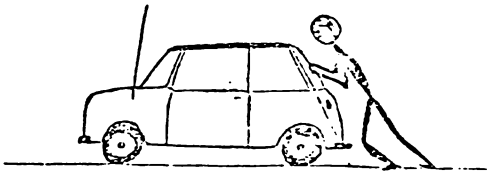
A: stays on the mirror.

B: comes out about halfway towards you.

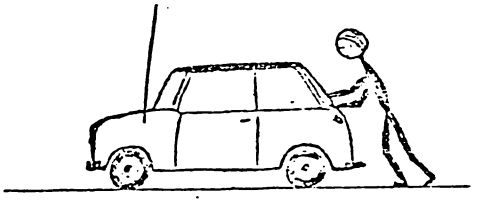
C: comes out as far as you but no further.

D: comes out until it hits something.

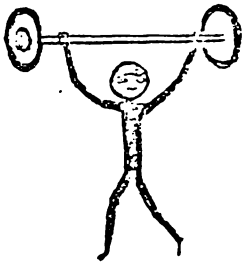
9 The man is trying to move the car but the car is not moving.



10 The man is trying to move the car and the car is now moving.



11 The weight-lifter is holding the bar steady.



If there is a force involved in each drawing which way does it go?
(Note: there could be more than one force involved)

A There is no force

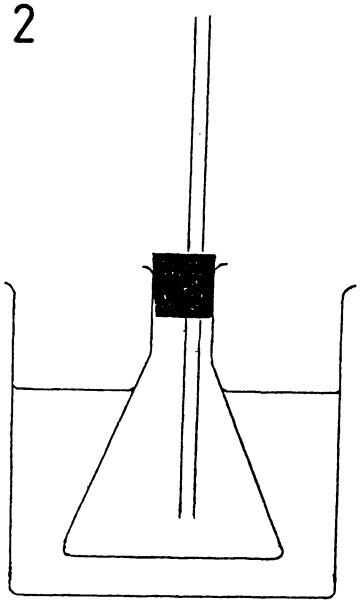
B There is a force upwards

C There is a force downwards

D There is a force to the left

E There is a force to the right.

12



The red water goes up the tube because:-

A. The red water molecules get bigger

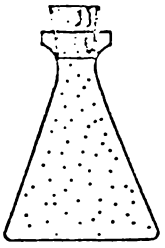
B. Heat pushes red water up the tube

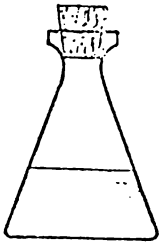
C. Molecules of water move around more and take up more space

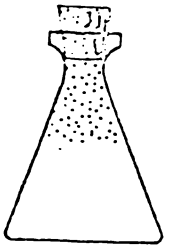
D. The red water takes up more space when it gets hotter and it goes up

E. Steam or gas gets in from outside and pushes water up the tube.

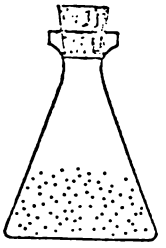
13



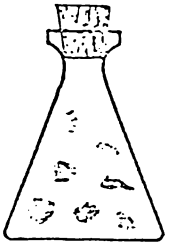


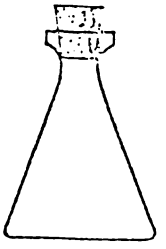


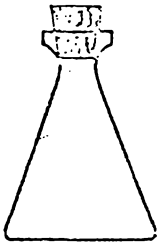
Here are some drawings showing the flask <u>after</u> the vacuum pump has been used.

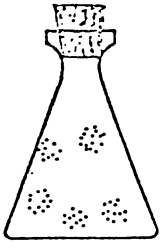


<u>Which one(s) do you think BEST show what happens?</u>

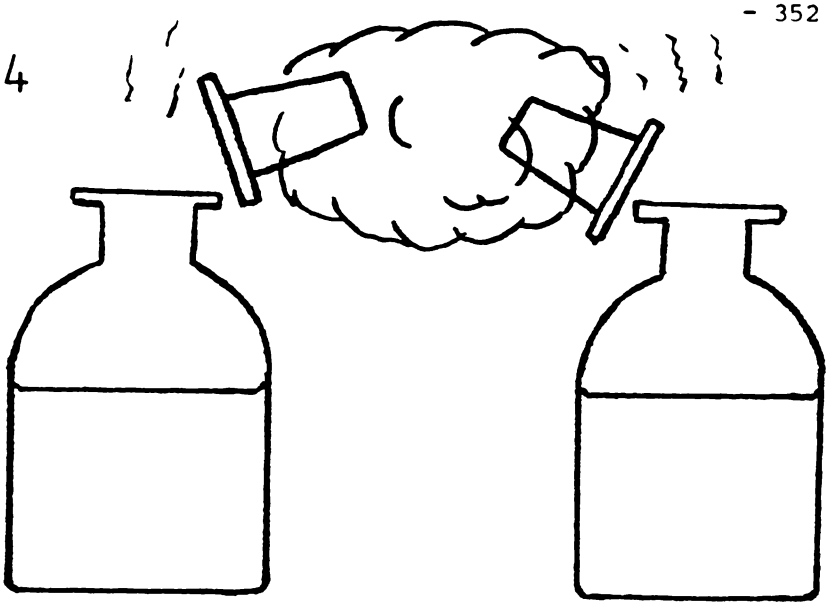








14



The white floating stuff formed is:-

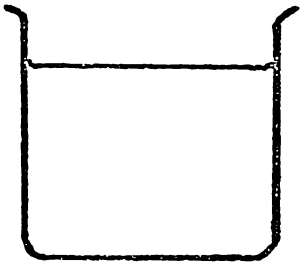
A. Smoke

B. Water vapour

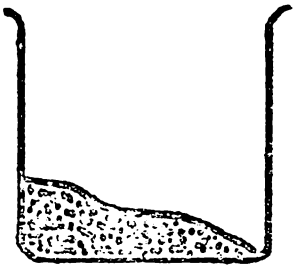
C. A mixture of chemicals

D. A concentration of dust

E. A visible gas

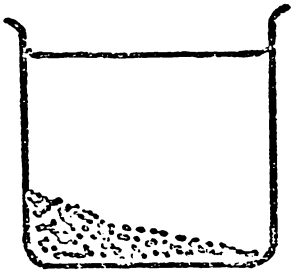


600 gm of water



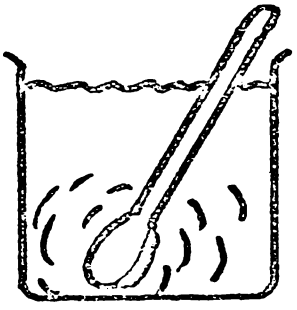
100 gm of sugar

15



What will the contents of the beaker weigh now?

16



After dissolving all the sugar by stirring, what will the contents of the beaker weigh now?

A. Less than 600 gm

B. 600 gm

C. between 600 and 700 gm

D. 700 gm

E. more than 700 gm

-2-

Section Three

How much do you agree or disagree with each of these statements?
Tick your choice.

	Strongly agree	Agree	Undecided	Disagree	Strongly disagree
1. I find science interesting.					
2. I enjoy doing science experiments					
3. My parents encourage me to take an interest in science.					
4. I would like to get a job which deals with science.					
5. I find science pretty easy.					
6. I read a lot about science.					
7. I like watching science programmes on T.V.					
8. I know someone who is a scientist					
9. I will never need to know much about science.					
10. I think girls find science harder than boys do.					

The Science Questionnaire

Administration Procedure: The prepared 'Science Questionnaire Response Sheet' (see yellow sheet) was handed out, one to each student and the identification details filled in. The procedure to be adopted was explained (with an emphasis on the measure being a 'learning' device rather than as a 'test').

OHP transparencies were prepared for all the sheets in the measure (including the response sheet - both sides - for explaining the instructions and the measure itself).

Section 1: Each OHP transparency was displayed and the question, together with any accompanying text, read out. Students were informed more than one alternative was possible for questions 1, 2, 3, 5, 9, 10 + 11. Only the 'best' alternative was to be selected in questions 4, 6, 7 + 8.

Section 2: Question 12. 'Flask'. A 250 ml conical flask, entirely filled with red coloured water, was shown to the class and a rubber bung with a single straight glass delivery tube was inserted into its neck, such that fluid was seen displaced some distance up the tube. The flask was placed into a 1 litre beaker containing a quantity of hot water (poured from a vacuum flask) and the students' attention was drawn to the movement of the fluid in the delivery tube. The accompanying OHP transparency was shown and the 'explanations' read out by the investigator. Only the one alternative response was permitted.

Question 13. 'Vacuum'. A side-armed conical flask attached to a vacuum pump was displayed to the class and the students

told they were to imagine they were to put on a pair of 'magic' spectacles which would enable them to see the air inside the flask. The vacuum pump was used to partially evacuate the air from the flask and the accompanying OHP transparency displayed with the text material and the question read out by the investigator. Only the one alternative response was permitted.

Question 14. 'Stuff'. Two reagent bottles, one containing concentrated hydrochloric acid and the other containing '880' ammonia solution, were shown to the class and then shaken so as to moisten the glass stopper in each reagent bottles' neck. The stoppers were drawn from the bottles and held near each other to produce visible ammonium chloride fumes. The accompanying OHP transparency was then displayed and read out. Only the one alternative response was permitted.

Questions 15 & 16. 'Sugar'. Two empty 750 ml glass beakers were shown to the class before 600 gm of water was added to one, and 100 gm of sugar was added to the other (these quantities were 'ostensibly' 'weighed' in front of the class by using a spring balance - in reality only very approximate masses were used). Then the water for the first beaker was carefully poured into the second beaker so as not to disturb the sugar. The 'composite' OHP was shown with the two masks in position - these prevented the centre of the OHP from being revealed - such that only the visual 'equation' at its top and the five alternative 'answers' at its bottom were displayed.

(a) The upper OHP mask was removed and the question "What

will the contents of the beaker weigh now?" read out. Only one response alternative was permitted. After the class had responded to this, the beaker containing the sugar (still visible) and the water was held up and then vigorously stirred with a plastic spoon to dissolve all the sugar.

(b) The upper OHP mask was replaced and the lower one removed to reveal the question "After dissolving all the sugar by stirring, what will the contents of the beaker weigh now?". Once again, only the one alternative response from those displayed at the bottom of the page was permitted.

Section 3: A copy of the students' response form to this section (found on the second side of their prepared form) was shown on the OHP and the students were instructed to respond to each statement as it was read out by the investigator. In being self-explanatory, little comment was provided by the investigator other than to request only one response per statement was permitted.

APPENDIX 3.9

The response sheet for the Science Questionnaire,
with the scoring details

Waikato University

Science Questionnaire Response Sheet

Name: ..... School: .....

Date: ..... Class: .....

Section One

									max pts
1. Living:	A	B	C	D	E	F	G	H	4
2. Animal:	A	B	C	D	E	F	G	H	7
3. Gravity: (a)	A	B	C	D	E	F			5
4. " (b)	A	B	C	D					4
5. Friction:	A	B	C	D	E	F			5
6. Light: (a)	A	B	C	D					3
7. " (b)	A	B	C	D					3
8. " (c)	A	B	C	D					3
9. Force: (a)	A	B	C	D	E				4
10. " (b)	A	B	C	D	E				4
11. " (c)	A	B	C	D	E				2

Section Two

12. Flask:	A	B	C	D	E				4
13. Vacuum:	A	B	C	D	E	F	G	H	4
14 Stuff:	A	B	C	D	E				2
15. Sugar: (a)	A	B	C	D	E				3
16. " (b)	A	B	C	D	E				3

APPENDIX 3.10

The TOSCA Form B (Secondary and Intermediate levels)

N C E R Z TEST OF SCHOLASTIC ABILITIES **B**

NAME: . . . . . CLASS: . . . . . .
(First) (Last)

SCHOOL: . . . . . AGE: . . . .yrs . . . .mths

SEX: BOY/GIRL *(circle one)* ETHNIC ORIGIN: EUROPEAN/MAORI/PACIFIC ISLANDER/OTHER *(circle one)*

FATHER'S OCCUPATION: . . . . . MOTHER'S OCCUPATION: . . . . . .

This is a test of how well you can think. The test is made up of different kinds of word and number problems.

There are two ways of answering the test questions. For some questions four or five answers are given. You are to choose the *one* answer you think is *best*. The sample exercises, S.1. and S.2., show you what to do.

SAMPLE EXERCISES

S.1. Begin means most nearly the *same* as

(A) work (B) ready (C) early (D) start (E) first .....▶ [D]

The *best* answer is 'start', a word which means much the same as 'begin'. The word 'start' has the letter (D) in front of it. Now look at the end of the line of dots. The letter D has been printed in the brackets. This is how you will answer questions of this kind. In the brackets, just print the letter of the answer you think is best. Now try this example:

S.2. Sue has $6. She spends a quarter of it. How much money has she left?

(A) $1.50 (B) $3.00 (C) $4.50 (D) $5.00 .....▶ [ ]

Choose the *best* answer. Then in the brackets at the end of the dotted line print the letter of the answer you have chosen. Do that now.
The *best* answer is (C) $4.50, as a quarter of $6 is $1.50 and $6 - $1.50 is $4.50. If you have printed the letter C in the brackets you are right.

For some other questions you must write out the whole answer in the space inside the brackets. Your answer will sometimes be a word, sometimes a letter or a numeral. The sample exercises, S.3., S.4. and S.5., show you what to do.

SAMPLE EXERCISES

S.3. What is the missing word?

TOP:POT , NIB:_ ? _ .....▶ [BIN]

In the first pair of words, the second word POT is the first word TOP with the letters around the other way. So the missing word in the second pair of words would be the first word NIB with the letters reversed, BIN. You can see that the word 'BIN' has been printed in the space in the brackets. Now try this example:

S.4. Below is a jumbled sentence written in capital letters.

FLOATS OIL WATER ON .....▶ [ ]

Change the words around so as to make a *sensible, true* sentence. Write the *last* word of your new sentence in the brackets at the end of the dotted line. Do that now.

The rearranged sentence should read, OIL FLOATS ON WATER. 'WATER' is the last word of the sentence. The word 'WATER' should be written in the brackets.

Do this example yourself:

S.5. What number is 10 times greater than 0.5? .....▶ [ ]

Write the numeral in the brackets at the end of the dotted line.
Your answer should be 5. The numeral 5 should be written in the brackets.

Answer each question even if you are not sure of the answer. Use the blank space at the foot of each page for working if you need to. Work as quickly as you can. Do not spend too much time on questions you find hard. Try to finish the 70 questions in the test but do not worry if you have to miss some out.

Be sure to read the directions for each question very carefully. Ensure that your answers are written clearly and can be read easily.

You have *30 minutes* to work on the test.

DO NOT START UNTIL YOU ARE TOLD

USE THE FOOT OF THE PAGE FOR WORKING IF NEEDED

1. A message *always* involves

   (A) writing (B) speech (C) communication (D) listening (E) the telephone ....▶ [ ]

2. Rearrange the words in capitals to make a *sensible* sentence. Write the *last* word of that sentence in the brackets.

   WAS BARBECUE BY ENJOYED THOSE WENT WHO ALL THE .....▶ [ ]

3. The line of capital letters can be divided up to make a sensible sentence. Write the *first* letter of the *second* word of that sentence in the brackets.

   HANDLETHEMWITHMUCHCARE .....▶ [ ]

4. Pear is to tree as grape is to

   (A) bush (B) vine (C) juice (D) berry (E) wine .....▶ [ ]

5. Write the numeral that completes this series.

   6, 12, ? , 48, 96 .....▶ [ ]

6. Which word *best* completes this sentence?

   Fertile soil ____?____ the growth of plants.

   (A) promotes (B) rotates (C) exaggerates (D) reduces (E) prohibits .....▶ [ ]

7. Which of the words below *best* fits the description given?

   A METAL WHICH IS VERY LIGHT

   (A) copper (B) zinc (C) bronze (D) aluminium (E) platinum .....▶ [ ]

8. People who work together in combination are

   (A) deliberating (B) fabricating (C) collaborating
   (D) interfering (E) notifying .....▶ [ ]

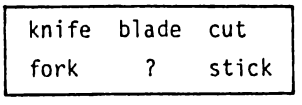
9. A potent drink is one that is

   (A) watery (B) powerful (C) delicious (D) artificial (E) sweet .....▶ [ ]

10. A bus which can carry 60 passengers started its journey with 34 aboard. At the first stop 5 people got off and those getting on filled the bus. How many people boarded the bus at the first stop? .....▶ [ ]

11. If it is true that all mammals are vertebrates and that all whales are mammals, it follows that

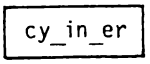
    (A) all vertebrates are whales. (B) some mammals live on land.
    (C) all whales are vertebrates. (D) some mammals are very large.
    (E) all mammals are whales. .....▶ [ ]

12. 

    The words in the box go together in a certain way. Which word belongs in the space?

    (A) hand (B) spoon (C) spines (D) table (E) prongs ▶ [ ]

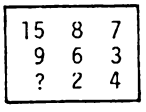
13. Two letters are missing from the word in the box. Decide what the missing letters are, then write the *whole* word in the brackets.

    .....▶ [ ]

14. Kitchen is to hotel as galley is to

    (A) ship (B) prison (C) house (D) motel (E) pantry .....▶ [ ]

15. 

    The numerals in the box form a pattern. What is the missing numeral? .....▶ [ ]

GO ON TO THE NEXT PAGE ——

USE THE FOOT OF THE PAGE FOR WORKING IF NEEDED

16. Which order of events given below provides the *most sensible* sequence?

I Water rushed into the buoyancy tanks.
II The hatches were all secured.
III The submarine slowly sank beneath the surface.
IV The captain left the conning tower.

(A) IV,I,III,II (B) I,III,IV,II (C) IV,II,I,III (D) II,I,IV,III .....▶ [ ]

17. Which word best goes with *both* the words in capitals?

MUSIC FISH

(A) scales (B) catch (C) waves (D) shoal (E) band .....▶ [ ]

18. The *opposite* of tender is

(A) timid (B) coarse (C) vicious (D) mild (E) tough .....▶ [ ]

19. Rearrange the words in capitals to make a *sensible* sentence. Write the *last* word of that sentence in the brackets.

ROAR FALLS AN INCESSANT NIAGARA MAKE THE .....▶ [ ]

20. If $\frac{\blacktriangle}{2} = \frac{2}{\blacktriangle}$, then $\blacktriangle$ is

(A) 0 (B) 1 (C) 2 (D) 3 (E) 4 .....▶ [ ]

21. Which word suggests the *best* reason for what is stated in the sentence?

MOST CHILDREN WILL BE ENJOYING SKYROCKETS AND FIRECRACKERS ON 5 NOVEMBER.

(A) safety (B) tradition (C) convenience (D) consideration (E) economy .....▶ [ ]

22. If a Vip is a Flip, but only some Flips are Vips, then

(A) if it is a Flip it is also a Vip.
(B) some Flips may also correctly be called Vips.
(C) it cannot be both a Vip and a Flip.
(D) only some Vips can correctly be called Flips.
(E) Flip is a name for Vip, and Vip is a name for Flip. .....▶ [ ]

23. Factory worker is to wage as manager is to

(A) profession (B) overtime (C) executive (D) salary (E) money .....▶ [ ]

24. Premature means most nearly the *same* as

(A) unfortunate (B) tardy (C) prejudiced (D) final (E) early .....▶ [ ]

25. After the temperature dropped steadily 2 degrees per hour for $4\frac{1}{2}$ hours the temperature was -7°C. What was the temperature before it began to drop?

(A) -16° (B) -11.5° (C) -2.5° (D) 2° (E) 5° .....▶ [ ]

26. Synthetic material is

(A) easily made (B) cheap (C) imported (D) new (E) artificial .....▶ [ ]

27. Which word best goes with *both* the words in capitals?

HAIR KEY

(A) lock (B) style (C) door (D) ring (E) head .....▶ [ ]

28. A ship *always* has

(A) a funnel (B) passengers (C) engines (D) an anchor (E) a hull .....▶ [ ]

29. Which of the five words given has quite a *different* meaning from the word in capital letters?

BUSY

(A) indolent (B) industrious (C) occupied (D) active (E) engrossed .....▶ [ ]

GO ON TO THE NEXT PAGE

USE THE FOOT OF THE PAGE FOR WORKING IF NEEDED

30. If a boy cycles directly west from his home for nine kilometres and then rides directly east for four kilometres, how many kilometres is he from his home then? .....▶ [km]

31. A palette would be used by a

(A) plumber (B) dancer (C) mechanic (D) painter (E) sailor .....▶ [ ]

32. Beer is to brewery as whisky is to

(A) hostelry (B) hotel (C) factory (D) alcohol (E) distillery .....▶ [ ]

33. Rearrange the letters of the word in capitals so that the sentence makes sense. Write the new word in the brackets.

Gold GRINS are worn as jewellery. .....▶ [ ]

34. In a class of 20 pupils there are 11 boys. Six of the pupils play tennis and seven of the girls do not play tennis. How many boys play tennis? .....▶ [ ]

35. Which one of the five statements below would *not* need be used to solve this problem?

HOW MUCH FURTHER CAN ONE OF THE TWO LANDROVERS GO THAN THE OTHER BEFORE THEY BOTH RUN OUT OF PETROL?

(A) Landrover A has 20 litres of fuel (B) Landrover B has 15 litres of fuel
(C) Landrover A uses 1 litre every 5 kilometres
(D) Landrover B uses 1 litre every 4 kilometres
(E) They start together and drive towards the same point in single file ..▶ [ ]

36. In a foreign language: his car = konerta, car = konu, his chair = banderta
Which word means 'chair'?
(A) band (B) bandu (C) bande (D) derta (E) erta .....▶ [ ]

37. Write a quarter of a million as a numeral. .....▶ [ ]

38.

book	reader	library
picture	viewer	?

The words in the box go together in a certain way. What word belongs in the space?
(A) artist (B) museum (C) painting
(D) gallery (E) collection .....▶ [ ]

39. If some Drips are Flabs and some Yobs are Drips and all Yobs are Pips, then
(A) all Yobs are Flabs. (B) no Drips are Pips.
(C) some Pips are Drips. (D) all Pips are Flabs.
(E) all Drips that are not Flabs are Yobs. .....▶ [ ]

40. Which of the five words given has quite a *different* meaning from the word in capital letters?

NOTORIOUS

(A) disreputable (B) conspicuous (C) unworthy (D) deplorable (E) despicable ▶ [ ]

41. Which word best goes with *both* the words in capitals?

FOOTBALL AMBITION

(A) score (B) goal (C) team (D) aim (E) career .....▶ [ ]

42. Three boys each had 6 model racing cars. Altogether there were 4 silver, 6 red and 8 blue ones. Vic's cars were all the same colour and Craig had only 4 that were blue. How many silver cars did George have?

(A) none (B) 1 (C) 2 (D) 3 (E) 4 .....▶ [ ]

43.
a
b e t
c r i m e
?

Which of the following is *most likely* to be the word which continues this series?

(A) decodes (B) justice (C) drowned (D) reports (E) escaped ▶[ ]

GO ON TO THE NEXT PAGE

USE THE FOOT OF THE PAGE FOR WORKING IF NEEDED

44. In a garden there are five native trees. The kauri tree is taller than the rimu, which is almost as tall as the tawa. The kowhai is not as tall as the kauri, but it is taller than the tawa. When the kauri grows another metre it will be taller than the matai. Which tree has two trees taller and two trees shorter than it?

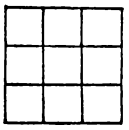
(A) kauri (B) tawa (C) rimu (D) matai (E) kowhai .....▶ [ ]

45. What number is as many more than 24 as 18 is less than 30? .....▶ [ ]

46. Which one does *not* belong with the other four?

(A) clock (B) calendar (C) sundial (D) almanac (E) register .....▶ [ ]

47. Mrs Pese has one more child in her family than Mrs Agnew, and Mrs Robinson has one more child than Mrs Pese. Mrs McKenzie's family of one, is half the size of Mrs Agnew's. How many children do Mrs Pese and Mrs Robinson have between them? .....▶ [ ]

48. 

How many crosses can be drawn in this grid so that only the diagonal boxes are filled?

(A) 1 (B) 3 (C) 4 (D) 5 (E) 6 .....▶ [ ]

49. An explorer leaves his camp by a river which flows due south and follows it down for 5 km. He then turns left, away from the river, and strikes out along a straight jungle trail for 3km, then turns left again and follows a path parallel to the river for another 5km. At this point, in which direction must he tramp to get back to his camp?

(A) north (B) south (C) east (D) west .....▶ [ ]

50. As there are very few human beings who have never made a mistake it can be concluded that

(A) it is impossible to avoid making mistakes.
(B) it is a characteristic of humans that they always make mistakes.
(C) most people have made at least one mistake.
(D) people who make mistakes are often 'accident prone'.
(E) almost all people have been punished at some time or another. .....▶ [ ]

51. Rearrange the letters of the word in capitals so that the statement makes sense. Write the new word in the brackets.

MASTERS flow into rivers .....▶ [ ]

52. Which is another name for quicksilver?

(A) stainless steel (B) mercury (C) platinum (D) aluminium (E) chromium ....▶ [ ]

53. In the sentence written in capitals, a group of consecutive letters spells the name of a type of animal. Write the name of that type of animal in the brackets.

THE LEAF IS HANGING FROM THE TWIG .....▶ [ ]

54. There are seven books on the bookshelf. How many books have two or more books on either side of them?

(A) 2 (B) 3 (C) 4 (D) 5 (E) 6 .....▶ [ ]

55. The relationship between 0.25 and 25 is the *same* as the relationship between

(A) 2.05 and 250 (B) 250 and 2500 (C) 25 and 2500
(D) 2.5 and 205 (E) 25 and 250 .....▶ [ ]

56. Three vowels are missing from the word in the box. Decide what the missing letters are and then write the *whole* word in the brackets.

n_ut_c_l

.....▶ [ ]

GO ON TO THE NEXT PAGE

USE THE FOOT OF THE PAGE FOR WORKING IF NEEDED

57. The charges for sending a telegram are 65 cents for the first ten words and four cents for each additional word. A telegram cost $1.13. How many words did it contain? .....▶ [ ]

58. Which one of the five words given has quite a *different* meaning from the word in capital letters?

OLD

(A) subtle (B) ancient (C) antique (D) obsolete (E) early .....▶ [ ]

59.

2	2	4
4	½	2
8	?	8

The numerals in the box form a pattern.
What is the missing numeral? .....▶ [ ]

60. Which conclusion follows from the statement given?

BEFORE STARTING TO READ THE STORIES IN THE BOOK I LOOKED AT SOME OF THE PICTURES IN IT.

(A) There was more than one story in the book. (B) The book was interesting.
(C) Pictures in story books are usually coloured.
(D) Stories that have pictures in them are the most exciting.
(E) Story books usually have pictures in them. .....▶ [ ]

61. The words in this series follow a rule. Work out the rule, then write the missing word in the brackets.

COSMOS, MOSQUE, QUEENS, ___?___, IGNITE .....▶ [ ]

62. One who is unjustly blamed for the faults or misdeeds of others is a
(A) charlatan (B) agitator (C) radical (D) scapegoat (E) hypocrite ....▶ [ ]

63. ■ - ▲ - ▲ - ▲ = 0

If this number sentence is true, then

(A) ■ ÷ ▲ = 0 (B) ■ ÷ 0 = ▲ (C) ▲ ÷ ■ = 3
(D) ■ ÷ 3 = ▲ (E) ■ ÷ ▲ = -3 .....▶ [ ]

64. Enmity means most nearly the *same* as

(A) warfare (B) tension (C) poverty (D) friendship (E) hostility .....▶ [ ]

65. From 1.30 p.m. to 2.30 p.m. there are history and geography lessons. The geography lesson is 10 minutes longer than the history lesson. How long is the geography lesson? .....▶ [mins]

66. Train is to tunnel as ship is to

(A) wharf (B) canal (C) sea (D) captain (E) funnel .....▶ [ ]

67. Which conclusion follows from the statement given?

BILL LOOKED THROUGH THE GLASS WINDOW AND COULD SEE HIS FRIENDS PLAYING OUTSIDE.

(A) All Bill's friends were playing outside.
(B) Playing is more fun than looking through windows.
(C) Bill was not allowed outside to play.
(D) The window Bill was looking through was transparent.
(E) If the window had not been made of glass Bill could not have seen through it. .....▶ [ ]

68. Erroneous means

(A) strange (B) outrageous (C) mistaken (D) stupid (E) interesting ....▶ [ ]

69. A reaction *always* involves

(A) an action (B) a response (C) a consequence (D) a retaliation
(E) a repercussion .....▶ [ ]

70. Three times a certain number is 36 more than the number. What is the number? .....▶ [ ]

GO BACK AND CHECK YOUR WORK

Intermediate Form B

N C E R Z TEST OF SCHOLASTIC ABILITIES

B

NAME: . . . . . CLASS: . . . . . .
(First) (Last)

SCHOOL: . . . . . AGE: . . . .yrs . . . .mths

SEX: BOY/GIRL *(circle one)* ETHNIC ORIGIN: EUROPEAN/MAORI/PACIFIC ISLANDER/OTHER *(circle one)*

FATHER'S OCCUPATION: . . . . . MOTHER'S OCCUPATION: . . . . . .

This is a test of how well you can think. The test is made up of different kinds of word and number problems.

There are two ways of answering the test questions. For some questions four or five answers are given. You are to choose the *one* answer you think is *best*. The sample exercises, S.1. and S.2., show you what to do.

SAMPLE EXERCISES

S.1. Begin means most nearly the *same* as

(A) work (B) ready (C) early (D) start (E) first .....▶ [D]

The *best* answer is 'start', a word which means much the same as 'begin'. You can see that the word 'start' has the letter (D) in front of it. Now look at the end of the line of dots. You will see that the letter D has been printed in the brackets. This is how you will answer questions of this kind. In the brackets, just print the letter of the answer you think is best. Now try this example:

S.2. Sue has $6. She spends half of it. How much money has she left?

(A) $1 (B) $2 (C) $3 (D) $4 .....▶ [ ]

Choose the *best* answer. Then in the brackets at the end of the dotted line print the letter of the answer you have chosen. Do that now.
The *best* answer is (C) $3, as half of $6 is $3. If you have printed the letter C in the brackets you are right.

For some other questions you must write out the whole answer in the space inside the brackets. Your answer will sometimes be a word, sometimes a letter or a numeral. The sample exercises, S.3., S.4. and S.5., show you what to do.

SAMPLE EXERCISES

S.3. What is the missing word?

TOP:POT , NIB:_ ? _ .....▶ [BIN]

You will see that in the first pair of words, the second word POT is the first word TOP with the letters around the other way. So the missing word in the second pair of words would be the first word NIB with the letters reversed, BIN. Now look at the end of the dotted line. You can see that the word 'BIN' has been printed in the space in the brackets. Now try this example:

S.4. Below is a jumbled sentence written in capital letters.

FLOATS OIL WATER ON .....▶ [ ]

Change the words around so as to make a *sensible, true* sentence. Write the *last* word of your new sentence in the brackets at the end of the dotted line. Do that now.

The new sentence should read, OIL FLOATS ON WATER. 'WATER' is the last word of the new sentence. If you have put the word 'WATER' in the brackets you are right.

Do this example yourself:

S.5. What number is 10 times greater than 4? .....▶ [ ]

Write your answer in the brackets at the end of the dotted line.
Your answer should be 40. The numeral 40 should be written in the brackets.

Answer each question even if you are not sure of the answer. Use the blank space at the foot of each page for working things out if you need to. Work as quickly as you can. Do not spend too much time on questions you find hard. Try to finish the 70 questions in the test but do not worry if you have to miss some out.

Be sure to read the directions for each question very carefully. Write your answers clearly so that they can be read easily.

You have *30 minutes* to work on the test.

DO NOT START UNTIL YOU ARE TOLD

USE THE FOOT OF THE PAGE FOR WORKING IF NEEDED

1. Which word suggests the *best* reason for what is stated in the sentence?
   YOU SHOULD NOT CROSS THE STREET WHEN THE TRAFFIC LIGHT IS AGAINST YOU.
   (A) tradition (B) welfare (C) faith (D) utility (E) safety .....▶ [ ]

2. A tree *always* has
   (A) roots (B) flowers (C) leaves (D) fruit (E) buds .....▶ [ ]

3. The *opposite* of late is
   (A) hurry (B) early (C) wait (D) stay (E) quick .....▶ [ ]

4. During a health inspection, a school nurse examined 10 pupils in an hour. What was the average time taken to check each child? .....▶ [mins]

5. The question in capitals has been written backwards. Read it, then write the answer in the brackets.
   ?RALLOD A NI STNEC YNAM WOH .....▶ [ ]

6. Wayne is older than Steven, Dianne and Robyn are twins, and David is younger than Steven but older than Robyn. Who is/are the *oldest*?
   (A) Wayne (B) Steven (C) David (D) Dianne and Robyn .....▶ [ ]

7. What is commonly called the black art?
   (A) grave digging (B) coal mining (C) burglary (D) witchcraft (E) astrology .▶ [ ]

8. Absurd means
   (A) exciting (B) upsetting (C) ridiculous (D) absorbing (E) troublesome .....▶ [ ]

9. Which of the words below *best* fits the description given?
   A BIRD THAT CANNOT FLY
   (A) kaka (B) cormorant (C) vulture (D) emu (E) quail .....▶ [ ]

10. Which word *best* completes this sentence?
    ___?___ the northern part of New Zealand was covered with dense native forest, but this has now been cleared to make way for farms.
    (A) Definitely (B) Fortunately (C) Originally (D) Periodically (E) Regrettably ▶[ ]

11. To baffle means most nearly the *same* as to
    (A) frighten (B) puzzle (C) annoy (D) surprise (E) fight .....▶ [ ]

12. If there are more E's in the word MEDITERRANEAN than there are A's, write YES. If not, write the number of E's there are. .....▶ [ ]

13. Which word best goes with *both* the words in capitals?
    LION DIGNITY
    (A) feline (B) hunt (C) family (D) growl (E) pride .....▶ [ ]

14.

Q	A	T
S	I	P
U	N	H

    Which one of the words can be made by joining letters in order with straight lines without going through a letter that is not in the word?
    (A) QUIT (B) SUIT (C) PANT (D) SNAP (E) THIN .....▶ [ ]

15. Write the numeral which completes this series in the brackets.
    3, 4, 6, 9, 13, 18, ___?___ .....▶ [ ]

GO ON TO THE NEXT PAGE ——————

USE THE FOOT OF THE PAGE FOR WORKING IF NEEDED

16. A game which is strenuous is never

(A) won (B) played (C) easy (D) decisive (E) rough .....▶ [ ]

17. Rearrange the words in capitals to make the most *sensible* sentence. Write the *last* word of that sentence in the brackets.

FINDS OWN ALWAYS WATER LEVEL ITS .....▶ [ ]

18. In which order should the events be arranged?

I Evans placed the ball.
II The crowd roared as the penalty was given.
III Evans' kick was straight and true.
IV More points appeared on the score board.

(A) II,I,III,IV (B) II,IV,I,III (C) II,III,I,IV (D) IV,II,III,I .....▶ [ ]

19. When two more zeros are put after the numeral 2000 the new numeral names a number

(A) 10 times greater. (B) 20 times greater. (C) 100 times greater.
(D) 200 times greater. (E) 1000 times greater. .....▶ [ ]

20. Wiki is one year older than Ben. Ben is two years younger than Mary. Ben is 12 years old. Which of these is true?

(A) Mary is 10. (B) Wiki is older than Mary. (C) Mary is 13.
(D) Mary and Wiki are the same age. (E) Wiki is 13. .....▶ [ ]

21. Rearrange the letters of the word in capitals so that the statement makes sense. Write the new word in the brackets.

The FLOW is a wild member of the dog family .....▶ [ ]

22. What is the missing numeral?

3 : 12 as 5 : ?

(A) 15 (B) 20 (C) 25 (D) 30 (E) 75 .....▶ [ ]

23. Which word best goes with *both* the words in capitals?

MUSIC MONEY

(A) sound (B) fortune (C) bank (D) key (E) note .....▶ [ ]

24.
```
   X
  A A
 R V V R
P H Z ? ? ?
```

Which group of letters will *best* fit into this series?

(A) RAX (B) ZHP (C) AVZ (D) PHZ (E) RVA .....▶ [ ]

25. Which one is *least* like the others?

(A) weta (B) mantis (C) cicada (D) snail (E) dragonfly .....▶ [ ]

26. The line of capital letters can be divided up to make a sensible sentence. Write the *first* letter of the *second* word of the sentence in the brackets.

THEIRONLYHOPEWASGONE .....▶ [ ]

27. Dad's tomato plant is now 10cm tall. If it continues to grow an average of 2cm a day, how tall will it be in one week's time? .....▶ [cm]

28. The school bus I was on was late throughout its journey this morning. It can be concluded that

(A) I was 10 minutes late for school.
(B) I got to school later than usual.
(C) the bus was late because of a mechanical breakdown.
(D) school buses usually run late.
(E) the bus was more crowded than usual. .....▶ [ ]

GO ON TO THE NEXT PAGE

USE THE FOOT OF THE PAGE FOR WORKING IF NEEDED

29. A car has number plates because

(A) they identify it. (B) cars have always had to have number plates. (C) they are required by traffic officers. (D) drivers are unable to drive without them. (E) they show the year the car was registered. .....▶ [ ]

30. 25% is to $\frac{1}{4}$ as 0.75 is to

(A) 100% (B) 75 (C) 10 (D) 7½% (E) $\frac{3}{4}$ .....▶ [ ]

31. Which of these is a fungus?

(A) pumpkin (B) mushroom (C) orchid (D) fern (E) seaweed .....▶ [ ]

32. Rome is to Italy as Madrid is to

(A) Mexico (B) Portugal (C) Spain (D) Turkey (E) Albania .....▶ [ ]

33. The words in this series follow a rule. Work out the rule, then write the missing word in the brackets.

ENOUGH:ONE , FLEECE:ELF , TRADE: ? .....▶ [ ]

34.

12	4	3
6	2	?
2	2	1

The numerals in the box form a pattern. What is the missing numeral? .....▶ [ ]

35. Which of the five words given has quite a *different* meaning from the word in capital letters?

CHEAP

(A) inexpensive (B) low-priced (C) reduced (D) distinctive (E) cut-rate ....▶ [ ]

36. Arrange the words in capitals in their proper order. Then write the *middle* word of the series in the brackets.

SENTENCE, BOOK, WORD, CHAPTER, PARAGRAPH .....▶ [ ]

37. A large box has four smaller boxes inside it. In each of the smaller boxes there are three tiny boxes. How many boxes are there altogether?

(A) 7 (B) 8 (C) 15 (D) 17 (E) 19 .....▶ [ ]

38.

fuel	engine	launch
?	sail	yacht

The words in the box go together in a certain way. Which word belongs in the space?

(A) canvas (B) blow (C) wind (D) water (E) sailing▶[ ]

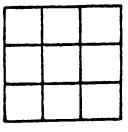
39. Which word *best* completes this sentence?

Lightning may sometimes start a forest fire, but fortunately it is a _____?_____ occurrence.

(A) dangerous (B) regular (C) costly (D) rare (E) spectacular .....▶ [ ]

40. In which of these words can the letters be rearranged to make *another* English word?

(A) stoat (B) inlet (C) black (D) hedge (E) teeth .....▶ [ ]

41. 

What is the largest number of crosses that can be drawn in this grid so that no box with a cross touches another box with a cross?

(A) 1 (B) 2 (C) 4 (D) 8 (E) 9 .....▶ [ ]

42. Summit is to mountain as spire is to

(A) top (B) climb (C) bells (D) church (E) roof .....▶ [ ]

GO ON TO THE NEXT PAGE

USE THE FOOT OF THE PAGE FOR WORKING IF NEEDED

43. Of the four months of the year that end in the letter R, write down the *first* letter of the month which has the *longest* name. .....▶ [ ]

44. A person who uses his power unjustly or in a cruel way is

(A) a tyrant (B) an upstart (C) an emperor (D) an imposter (E) a tycoon ....▶ [ ]

45. In a garden there are five native trees. The kauri tree is taller than the rimu, which is almost as tall as the tawa. The kowhai is not as tall as the kauri, but it is taller than the tawa. When the kauri grows another metre it will be taller than the matai. At present, the matai is *taller* than how many of the other trees in the garden?

(A) none (B) 1 (C) 2 (D) 3 (E) 4 .....▶ [ ]

46. If ■ always stands for the same number, which is greater than zero, then ■ - ■ equals

(A) one (B) a greater number (C) zero (D) a lesser number (E) that same number▶[ ]

47. To menace means to

(A) alter (B) threaten (C) benefit from (D) help (E) be sorry for .....▶ [ ]

48. A freight train travelling at 60 km/h takes 25 minutes on a certain journey. How many minutes would the same train take at 30 km/h to travel twice the distance? .....▶ [mins]

49. If all Zacs are Yobs and all Woks are Zacs, then which of these statements is true?

(A) All Yobs are Zacs (B) All Zacs are Woks
(C) Only a few Zacs are Yobs (D) Only some Woks are Yobs
(E) All Woks are Yobs .....▶ [ ]

50. In a foreign language:

sana mona teka = very cold weather, sana feta = hot weather, mona bene = very humid

Which word means 'cold'?

(A) sana (B) mona (C) teka (D) feta (E) bene .....▶ [ ]

51. Which one of the five words given has quite a *different* meaning from the word in capital letters?

TAKE

(A) discover (B) get (C) receive (D) catch (E) seize .....▶ [ ]

52. Arrange the words in capitals in their proper order. Then write the *middle* word of the series in the brackets.

BLAZE, SMOULDER, SCORCH, FLAME, INFERNO .....▶ [ ]

53. If $\frac{3}{▲} = \frac{▲}{12}$, then ▲ is

(A) 1 (B) 3 (C) 4 (D) 6 (E) 8 .....▶ [ ]

54. In the sentence written in capitals, a group of letters which come one after the other, spells the name of a fish. Write the name of that fish in the brackets.

SHE ELECTED TO ABSTAIN. .....▶ [ ]

55. To writhe means to

(A) jump over (B) twist (C) gnaw (D) drop (E) pull up .....▶ [ ]

56. Three vowels are missing from the word in the box. Work out what the missing letters are, then write the *whole* word in the brackets.

_rch_str_	.....▶ [ ]

GO ON TO THE NEXT PAGE

USE THE FOOT OF THE PAGE FOR WORKING IF NEEDED

57. What two letters in the word HARMFUL have as many letters between them in the word, as between them in the alphabet? ..... ▶ [and]

58. 12 is to 8 as 36 is to

(A) 8 (B) 16 (C) 20 (D) 24 (E) 30 ..... ▶ [ ]

59. A name taken by a person, but which is not his own name is an

(A) alibi (B) alias (C) anonymous (D) alien (E) allergy ..... ▶ [ ]

60. If it is true that only soldiers carry guns and that all soldiers are in the army, it follows that

(A) all soldiers carry guns.
(B) guns are safe in the hands of soldiers.
(C) the army needs soldiers who know how to shoot.
(D) soldiers always fight with guns.
(E) someone carrying a gun must be a soldier. ..... ▶ [ ]

61. Someone who never makes mistakes is

(A) incorrigible (B) immortal (C) invincible (D) impervious (E) infallible . ▶ [ ]

62. If Alison's desk is the sixth from each end of a row, how many desks in Alison's row? ..... ▶ [ ]

63. The words in this series follow a rule. Work out the rule, then write the missing word in the brackets.

DREAM:ARE , DEATH:TEA , MATCH:_?_ ..... ▶ [ ]

64. Michael is standing on the northwest corner of a rugby field. He is facing south. He then walks along three sides of the rugby field. In what direction will he be facing *before* turning to walk along the fourth side?

(A) north (B) south (C) east (D) west (E) northwest ..... ▶ [ ]

65. What number between 20 and 30 can be subtracted from 100, so that the answer is divisible by 9? ..... ▶ [ ]

66. If most of Sam's marbles are blue or red and all his red marbles are large, which of the following is true?

(A) All the marbles that are not red are small.
(B) None of the blue marbles is large.
(C) All Sam's marbles are either blue or red.
(D) Some of the blue marbles may also be large.
(E) Some of the red marbles are small. ..... ▶ [ ]

67. How many *different* groups of two *or* three children can be formed from two boys and a girl?

(A) 2 (B) 3 (C) 4 (D) 5 (E) 6 ..... ▶ [ ]

68. The words in this series follow a rule. Work out the rule, then write the missing word in the brackets.

HERBAL, BALLET, LETHAL, __?__, TERROR ..... ▶ [ ]

69. In the sentence in capitals, a group of consecutive letters spells the name of an animal. Write the name of that animal in the brackets.

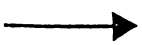
SHE FEARED ELSE ALL WOULD BE LOST. ..... ▶ [ ]

70. Which one of the words given is a *specific* example of the word in capital letters?

ALLOY

(A) steel (B) iron (C) aluminium (D) alkali (E) catalyst ..... ▶ [ ]

GO BACK AND CHECK YOUR WORK



APPENDIX 3.11

The Hidden Figures Test

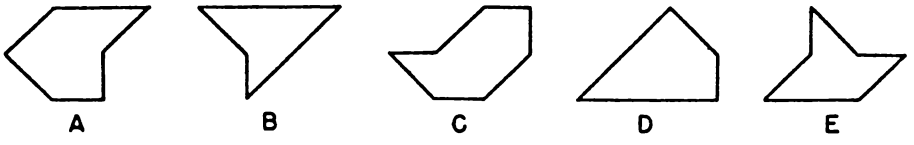
Name: _____

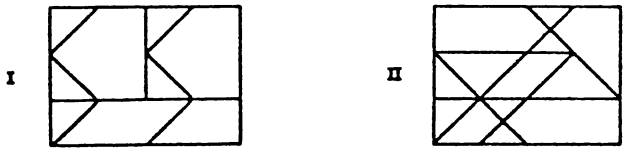
HIDDEN FIGURES TEST — Cf-1

This is a test of your ability to tell which one of five simple figures can be found in a more complex pattern. At the top of each page in this test are five simple figures lettered A, B, C, D, and E. Beneath each row of figures is a page of patterns. Each pattern has a row of letters beneath it. Indicate your answer by putting an X through the letter of the figure which you find in the pattern.

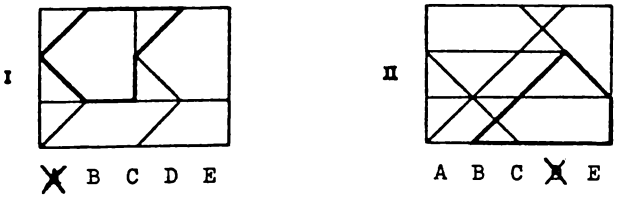
NOTE: There is only one of these figures in each pattern, and this figure will always be right side up and exactly the same size as one of the five lettered figures.

Now try these 2 examples.





The figures below show how the figures are included in the problems. Figure A is in the first problem and figure D in the second.



Your score on this test will be the number marked correctly minus a fraction of the number marked incorrectly. Therefore, it will not be to your advantage to guess unless you are able to eliminate one or more of the answer choices as wrong.

You will have 10 minutes for each of the two parts of this test. Each part has 2 pages. When you have finished Part 1, STOP. Please do not go on to Part 2 until you are asked to do so.

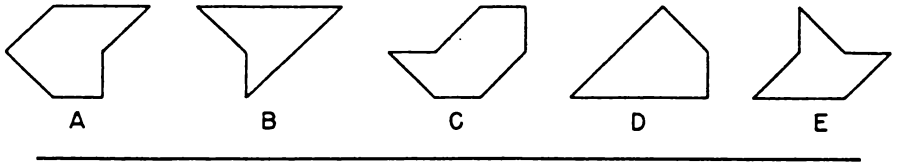
DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO.

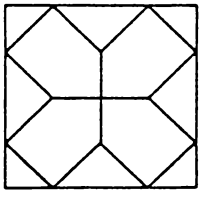
Developed under NIMH Contract M-4186

W.J.B.-ABCD/8765-4321

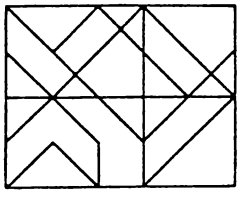
Page 2

Part 1 (10 minutes)

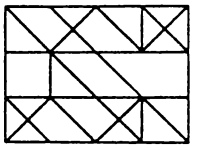


1. 

A B C D E

2. 

A B C D E

3. 

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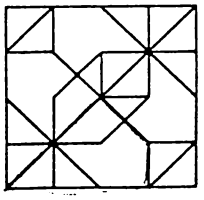
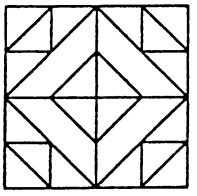
4. 

A B C D E

5. 

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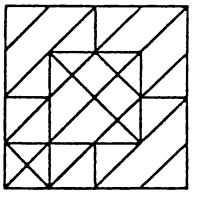
6. 

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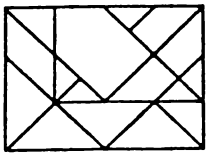
7. 

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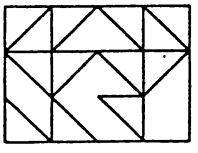
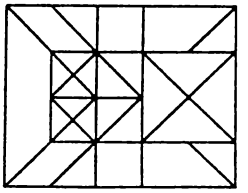
8. 

A B C D E

9. 

A B C D E

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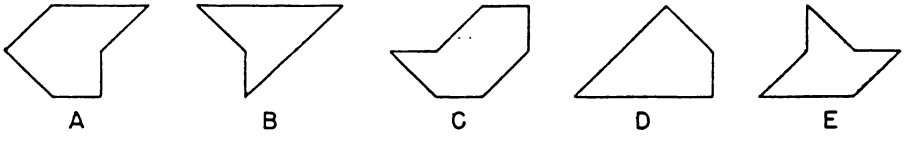
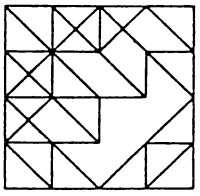
Page 3

Part 1 (continued)



10. 

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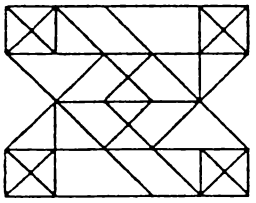
11. 

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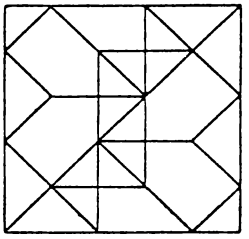
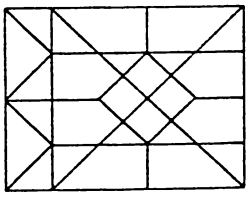
12. 

A B C D E

13. 

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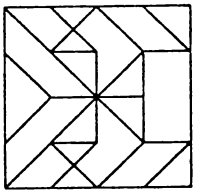
14. 

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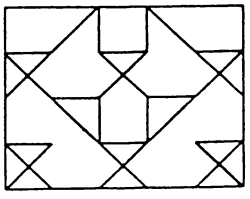
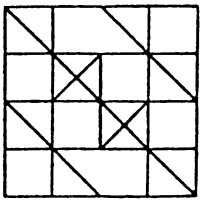
15. 

A B C D E

16. 

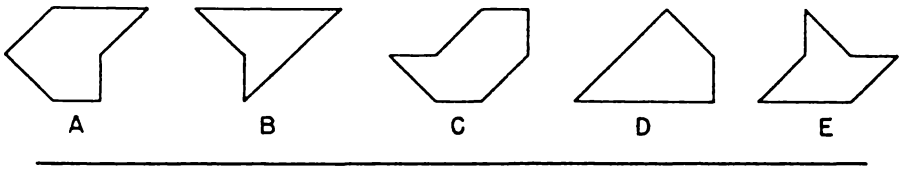
A B C D E

DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO.

STOP.

Page 4

Part 2 (10 minutes)



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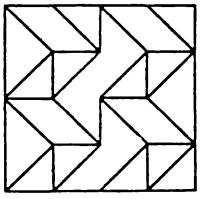

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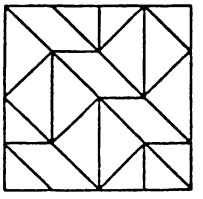

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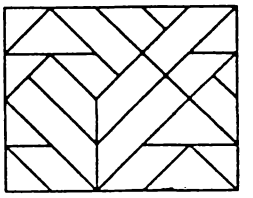

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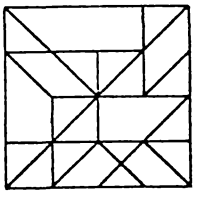

A B C D E

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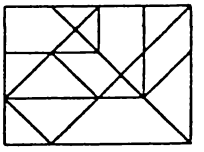

A B C D E

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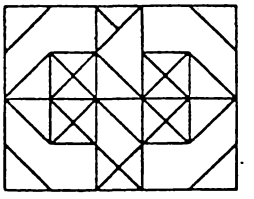

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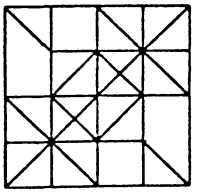

A B C D E

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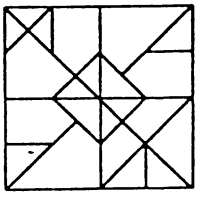

A B C D E

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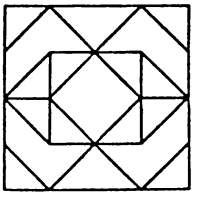
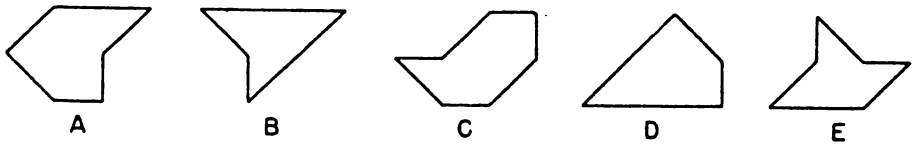


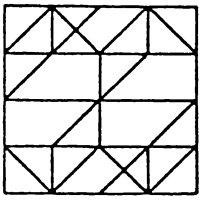
A B C D E

GO ON TO THE NEXT PAGE

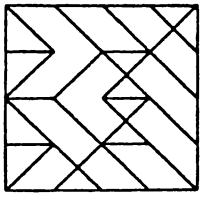
Page 5

Part 2 (continued)

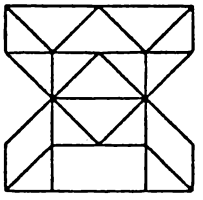


26. 

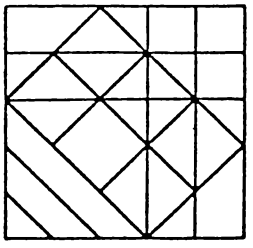
A B C D E

27. 

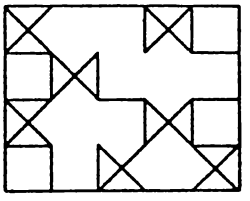
A B C D E

28. 

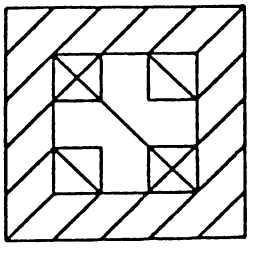
A B C D E

29. 

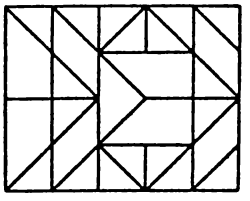
A B C D E

30. 

A B C D E

31. 

A B C D E

32. 

A B C D E

DO NOT GO BACK TO PART 1, AND
DO NOT GO ON TO ANY OTHER TEST UNTIL ASKED TO DO SO.

STOP.

WAIKATO UNIVERSITY

Hidden Figures Response Sheet

Name: ..... School: .....

Date: ..... Class: .....

Computer use only	1-4	5	6	7	8	9	10

PART ONE

1. A B C D E 2. A B C D E 3. A B C D E

4. A B C D E 5. A B C D E 6. A B C D E

7. A B C D E 8. A B C D E 9. A B C D E

10. A B C D E 11. A B C D E 12. A B C D E

13. A B C D E 14. A B C D E

15. A B C D E 16. A B C D E

PART TWO

17. A B C D E 18. A B C D E 19. A B C D E

20. A B C D E 21. A B C D E 22. A B C D E

23. A B C D E 24. A B C D E 25. A B C D E

26. A B C D E 27. A B C D E 28. A B C D E

29. A B C D E 30. A B C D E

31. A B C D E 32. A B C D E

-ooOoo-

APPENDIX 3.12

The Conceptual Style Test

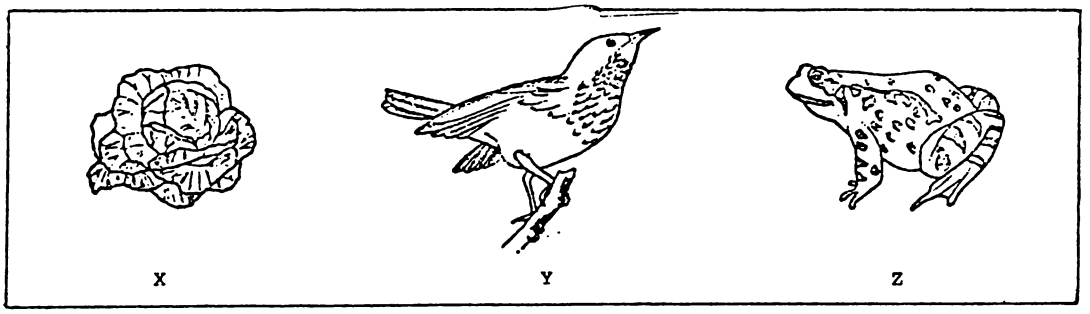
Waikato University

'CS' Survey Material

PLEASE READ CAREFULLY

1. Have you a separate answer sheet as well as this booklet?

2. Look at the set of drawings below and decide which two you think could go together. (Note: There is no 'right' answer).



X Y Z

3. Why did you decide that?

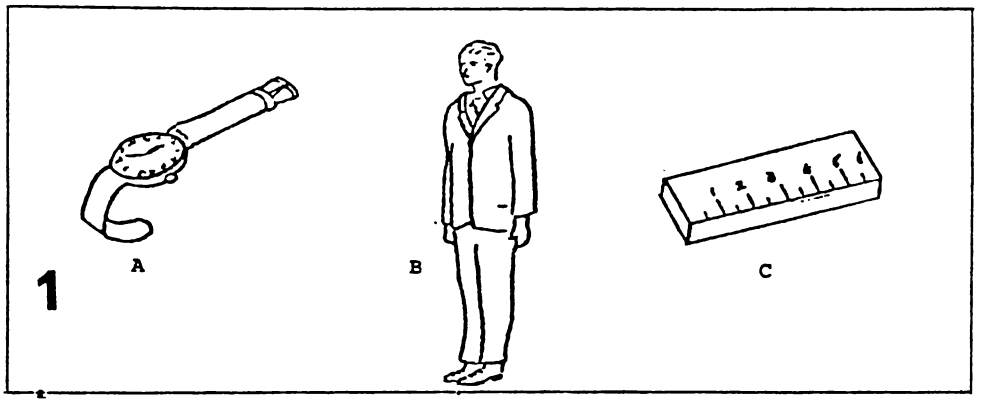
4. The separate answer sheet is set out like this to allow you to write down your choices and reasons:-

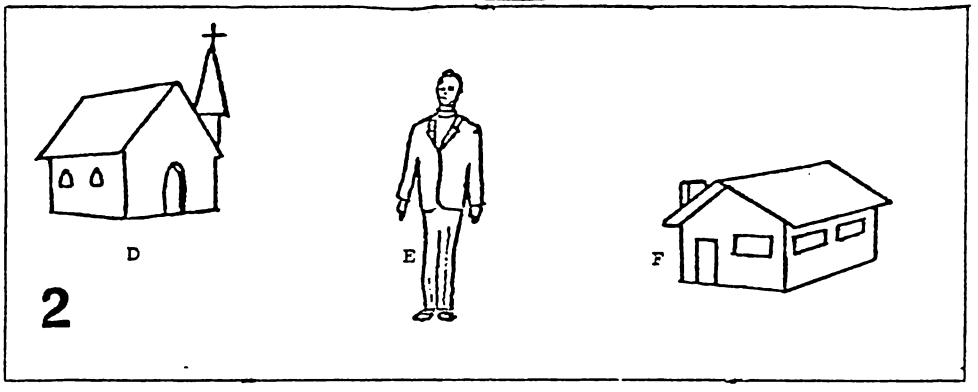
Which two go together?

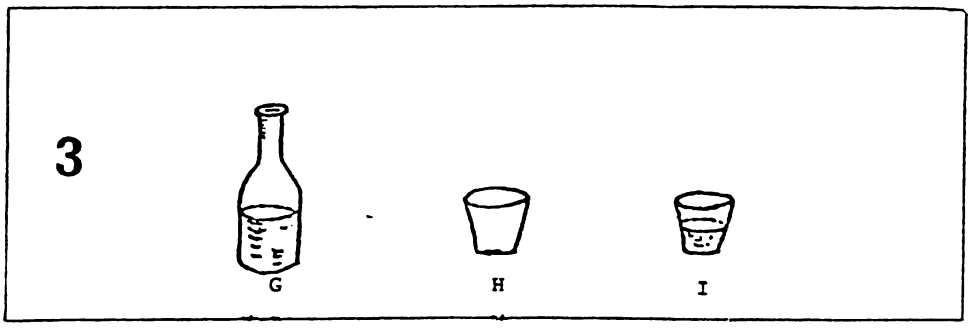
1. ☐ and ☐ ..... Because _____

5. Fill in the top section of the answer sheet.

- 1 -







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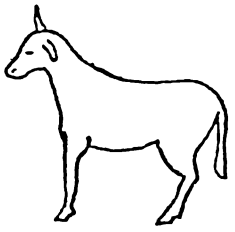

A

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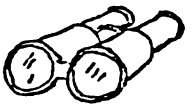

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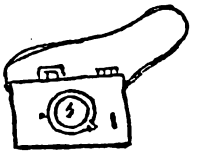

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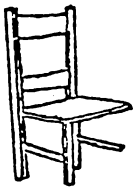
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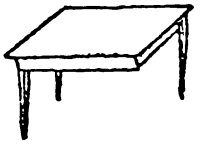
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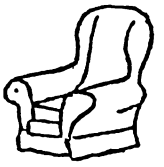
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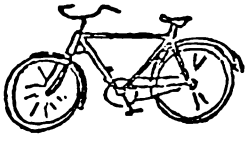
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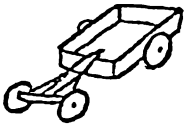
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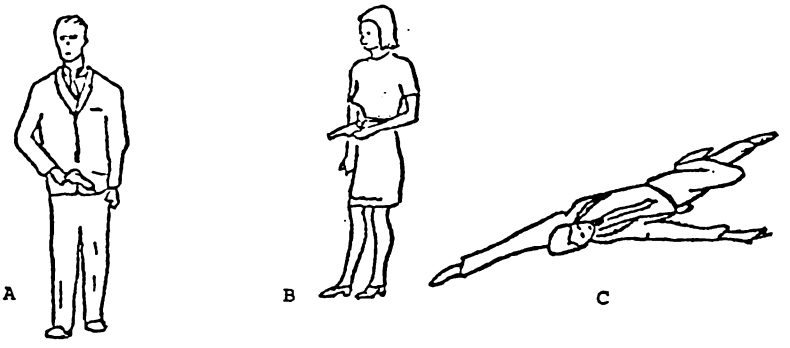

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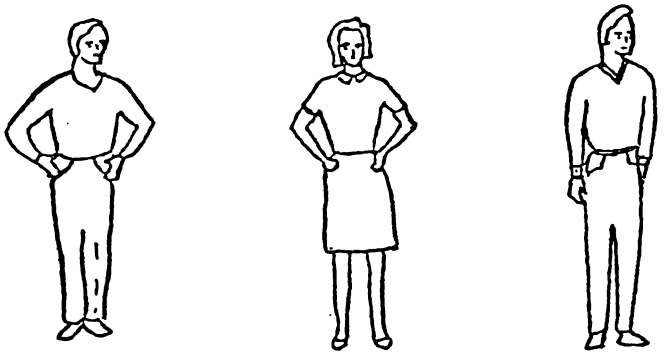

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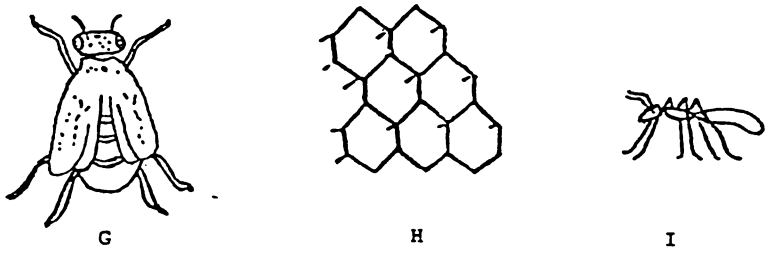

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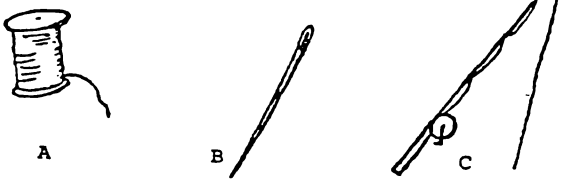

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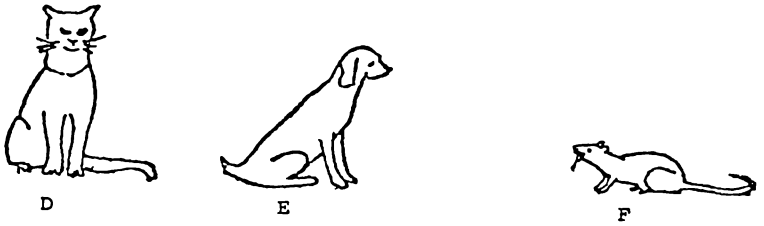

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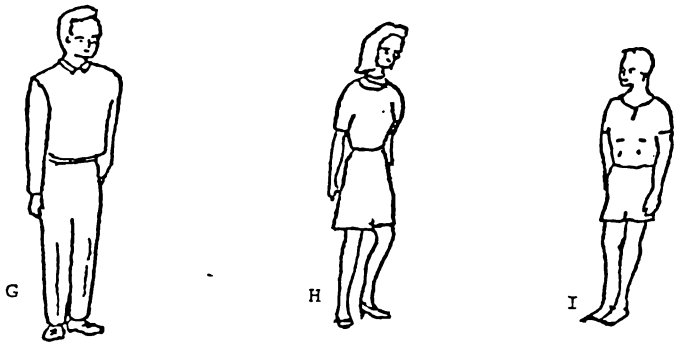
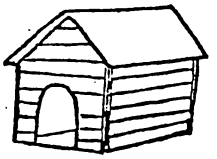


16

A



B

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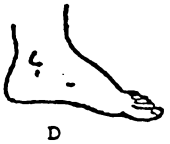

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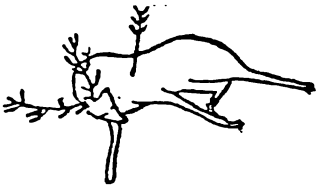

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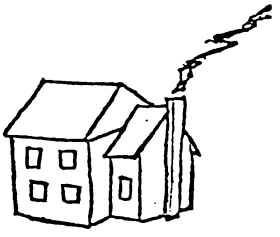

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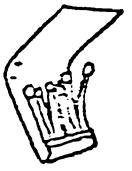

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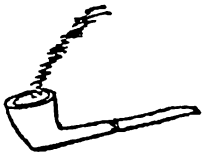

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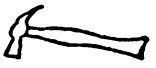

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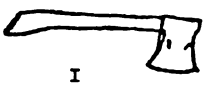

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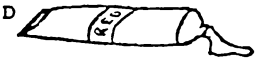
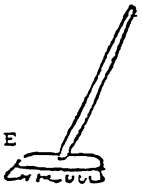
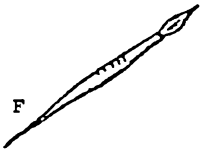
D 

E 

F 

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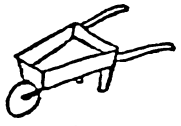
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L

WAIKATO UNIVERSITY

Answer Record
(Cog. Style)

Name:- _____ Age _____ yrs _____ months

Class:- _____ School:- _____

Today's Date:- _____

Computer use only	1-4	5	6	7	8	9	10

Which two go together?

1. [ ] and [ ] ..... Because _____
2. [ ] and [ ] ..... Because _____
3. [ ] and [ ] ..... Because _____
4. [ ] and [ ] ..... Because _____
5. [ ] and [ ] ..... Because _____
6. [ ] and [ ] ..... Because _____
7. [ ] and [ ] ..... Because _____
8. [ ] and [ ] ..... Because _____
9. [ ] and [ ] ..... Because _____
10. [ ] and [ ] ..... Because _____
11. [ ] and [ ] ..... Because _____
12. [ ] and [ ] ..... Because _____
13. [ ] and [ ] ..... Because _____
14. [ ] and [ ] ..... Because _____
15. [ ] and [ ] ..... Because _____
16. [ ] and [ ] ..... Because _____
17. [ ] and [ ] ..... Because _____
18. [ ] and [ ] ..... Because _____
19. [ ] and [ ] ..... Because _____
20. [ ] and [ ] ..... Because _____
21. [ ] and [ ] ..... Because _____
22. [ ] and [ ] ..... Because _____
23. [ ] and [ ] ..... Because _____
24. [ ] and [ ] ..... Because _____
25. [ ] and [ ] ..... Because _____

APPENDIX 3.13

The scoring criteria for the Conceptual Style Test
from Archer (1970)

Scoring criteria for the Conceptual Style Test

"Descriptive

Groupings in this category are based on similarity in objective physical characteristics among a group of stimuli. The concrete attribute shared by objects can be perceived through any of the senses, although visually perceived facets of the stimuli are expected to dominate. All descriptive labels must contain a reference to a commonly-shared, physical attribute of the grouped stimuli. Two sub-classes have been identified (Kagan et. al., 1963) - descriptive-analytic where labels denote observable parts of the figure, and descriptive-global, in which labels refer to similarities based on the total objective manifestations of the stimuli. Examples of descriptive-analytic categorizations referring to animal stimuli are: 'they both have tails, hair, four legs, one ear dropping'; human stimuli are: 'both have guns, wear shoes, have hands on hips, wear skirts'; object stimuli are: 'both contain liquid, have a leg missing, have a lense, have handles'. Examples of descriptive-global labelling ... are: 'both have the same shape, are in the same position, are the same size'.

Inferential-categorical

These concepts classify objects because of some characteristic shared by all, but what they share is not inherent in the physical nature of the stimuli grouped. The labels do not contain a direct reference to an objective, physical attribute of the group of stimuli (unlike "descriptive" labels), and yet each object is an individual instance of the

label (unlike "relational" concepts). The classifications frequently fall into the area of location, useage or superordinate class which subsumes the particular instances. Location examples would include: 'both are found near water', 'both live in water'; usage examples are: 'for eating', 'both are for travelling on or in'; superordinate classification is exemplified by: 'both are animate', 'both are forms of footwear'.

Relational-contextual

The distinguished characteristic of these conceptual labels is that they grow out of the relationship between or among the stimuli grouped together, and then serve as a kind of umbrella over the collection. Because of this, no stimulus is an independent instance of the concept, and some have greater weight in determining what the concept became than did others. These relationships among the stimuli grouped together are functional, and build on connections of a temporal, spatial or complementary nature. The temperal-spatial complexes are concrete or situational in nature, generally thematic. Typical examples are: 'a dog lives in a kennel', 'the father and mother had a baby', ' the thread goes through the needle'. Sigel et. al. (1967, p. 2) sum up by defining these responses as "indicating interdependence in <u>that</u> particular situation expressed in functional or thematic labels."

(Archer, 1970:74)

APPENDIX 3.14

The Intellectual Achievement Responsibility Test

Waikato University

'IAR' Questionnaire

PLEASE READ CAREFULLY

1. For each question pick the answer that best describes what happens to you or how you feel.

2. There are no "right" answers so give your best answer

3. Simply put a tick in the box which indicates your answer.

4. There is no time limit but do not spend too much time on each question.

5. Make sure you have filled in your name, and other details, on the Response Sheet.

THANKS FOR YOUR ASSISTANCE

1

If a teacher moves you to the next higher class or form, would it probably be

a. because she liked you, or

b. because of the work you did?

2

When you do well on a test at school, is it more likely to be

c. because you studied for it, or

d. because the test was especially easy?

3

When you have trouble understanding something in school, is it usually

a. because the teacher didn't explain it clearly, or

b. because you didn't listen carefully?

4

When you read a story and can't remember much of it, is it usually

c. because the story wasn't well written, or

d. because you weren't interested in the story?

5

Suppose your parents say you are doing well in school. Is this likely to happen

a. because your school work is good, or

b. because they are in a good mood?

6

Suppose you did better than usual in a subject at school. Would it probably happen

c. because you tried harder, or

d. because someone helped you?

7

When you lose at a game of cards you are playing, does it usually happen

a. because the other player is good at the game, or

b. because you don't play well?

8

Suppose a person doesn't think you are very bright or clever

c. can you make him change his mind if you try to, or

d. are there some people who will think you're not very bright no matter what you do?

9

If you solve a puzzle quickly, is it

a. because it wasn't a very hard puzzle, or

b. because you worked on it carefully?

10

If a boy or girl tells you that you are dumb, is it more likely that they say that

c. because they are mad at you, or

d. because what you did really wasn't very bright.

11

Suppose you study to become a teacher, scientist, or doctor and you fail. Do you think this would happen

a. because you didn't work hard enough, or

b. because you needed some help, and other people didn't give it to you?

12

When you learn something quickly in school, is it usually

c. because you paid close attention, or

d. because the teacher explained it clearly?

13

If a teacher says to you, "Your work is fine," is it

a. something teachers usually say to encourage pupils, or

b. because you did a good job?

14

When you find it hard to work arithmetic or maths problems at school, is it

c. because you didn't study well enough before you tried them, or

d. because the teacher gave problems that were too hard?

15

When you forget something you heard in class, is it

a. because the teacher didn't explain it very well, or

b. because you didn't try very hard to remember?

16

Suppose you weren't sure about the answer to a question your teacher asked you, but your answer turned out to be right. Is it likely to happen

c. because she wasn't as particular as usual, or

d. because you gave the best answer you could think of?

17

When you read a story and remember most of it, is it usually

a. because you were interested in the story, or

b. because the story was well written?

18

If your parents tell you you're acting silly and not thinking clearly, is it more likely to be

c. because of something you did, or

d. because they happen to be feeling cranky?

19

When you don't do well on a test at school, is it

a. because the test was especially hard, or

b. because you didn't study for it?

20

When you win at a game you are playing, does it happen

c. because you play really well, or

d. because the other person doesn't play well?

21

If people think you're bright and clever, is it

a. because they happen to like you, or

b. because you usually act that way?

22 If a teacher didn't move you to the next highest class or form, would it probably be

c. because she "had it in for you," or

d. because your school work wasn't good enough?

23 Suppose you don't do as well as usual in a subject at school. Would this probably happen

a. because you weren't as careful as usual, or

b. because somebody bothered you and kept you from working?

24 If a boy or girl tells you that you are bright, is it usually

c. because you thought up a good idea, or

d. because they like you?

25 Suppose you became a famous teacher, scientist or doctor. Do you think this would happen

a. because other people helped you when you needed it, or

b. because you worked very hard?

26 Suppose your parents say you aren't doing well in your school work. Is this likely to happen more

c. because your work isn't very good, or

d. because they are feeling cranky?

27 Suppose you are showing a friend how to play a game and he has trouble with it. Would that happen

a. because he wasn't able to understand how to play, or

b. because you couldn't explain it well?

28 When you find it easy to work arithmetic or maths problems at school, is it usually

c. because the teacher gave you especially easy problems, or

d. because you studied your book well before you tried them?

29	When you remember something you heard in class, is it usually a. because you tried to remember it, or b. because the teacher explained it well?
30	If you can't work a puzzle, is it more likely to happen c. because you are not especially good at working puzzles, or d. because the instructions weren't written clearly enough?
31	If your parents tell you that you are bright or clever, is it more likely a. because they are feeling good, or b. because of something you did?
32	Suppose you are explaining how to play to a friend and he learns quickly. Would that happen more often c. because you explained it well, or d. because he was able to understand it?
33	Suppose you're not sure about the answer to a question your teacher asks you and the answer you give turns out to be wrong. Is it likely to happen a. because she was more particular than usual, or b. because you answered too quickly?
34	If a teacher says to you, "Try to do better," would it be c. because this is something she might say to get her pupils to try harder, or d. because your work wasn't as good as usual?

Have you written your name at the top of the Response Sheet?

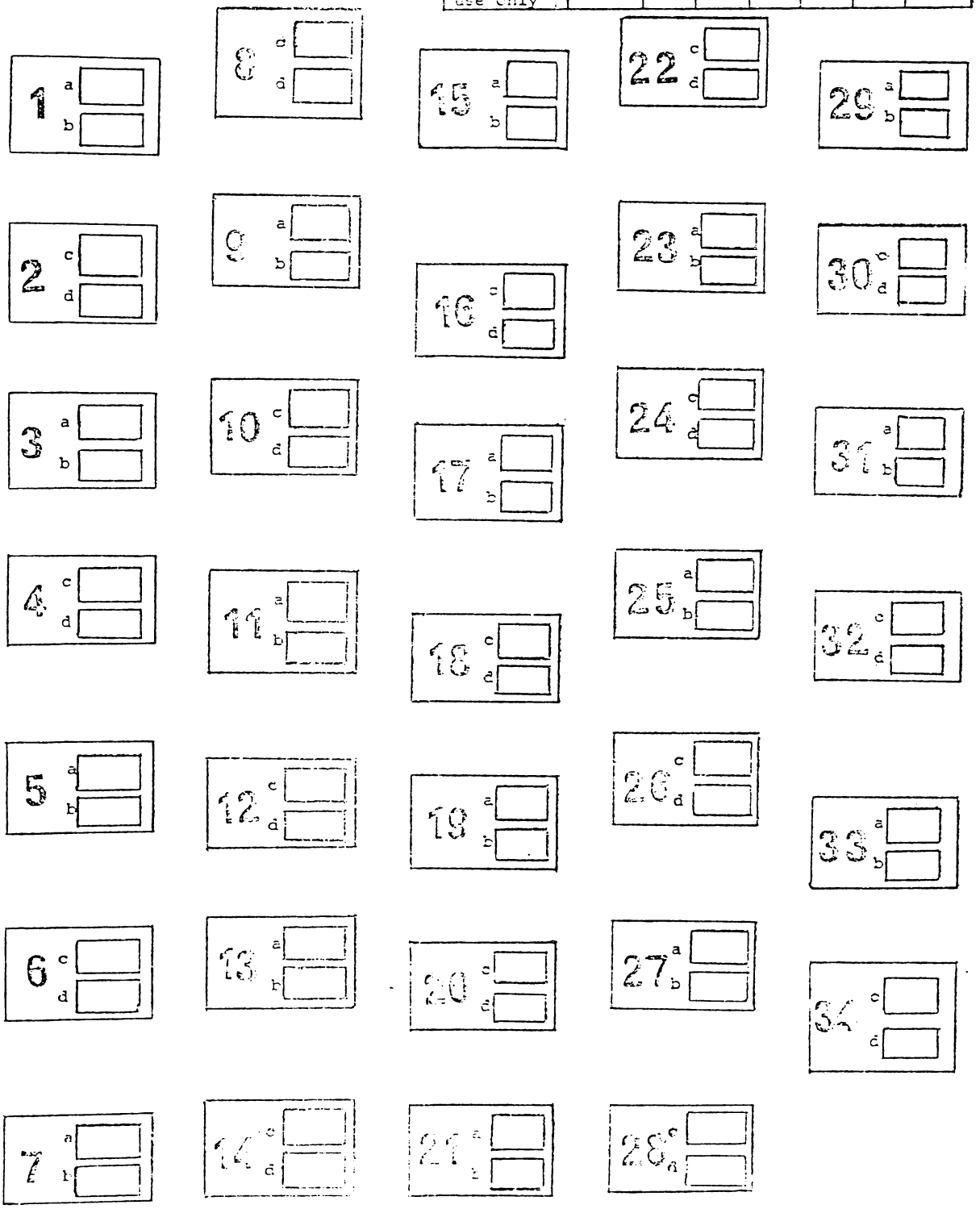
LANCASTER UNIVERSITY

IAP Response Sheet

Name: ..... Date: .....

School: ..... Class: .....

Computer use only	1-4	5	6	7	8	9	10



APPENDIX 3.15

Background Data Sheet

Background data sheet

Name..... Form ..... School..... Race....

D.O.B..... Family Position..... Siblings: brothers .....
sisters .....

Previous School..... M.A. .....
IQ.....

Father..... Occupation..... Address.....

Mother..... Occupation..... Address.....

Phone.....

Most difficult subject..... Best subject.....

Friends names.....

Sports/hobbies/clubs.....

Vocational preference.....

Academic record:

Language.....

Mathematics.....

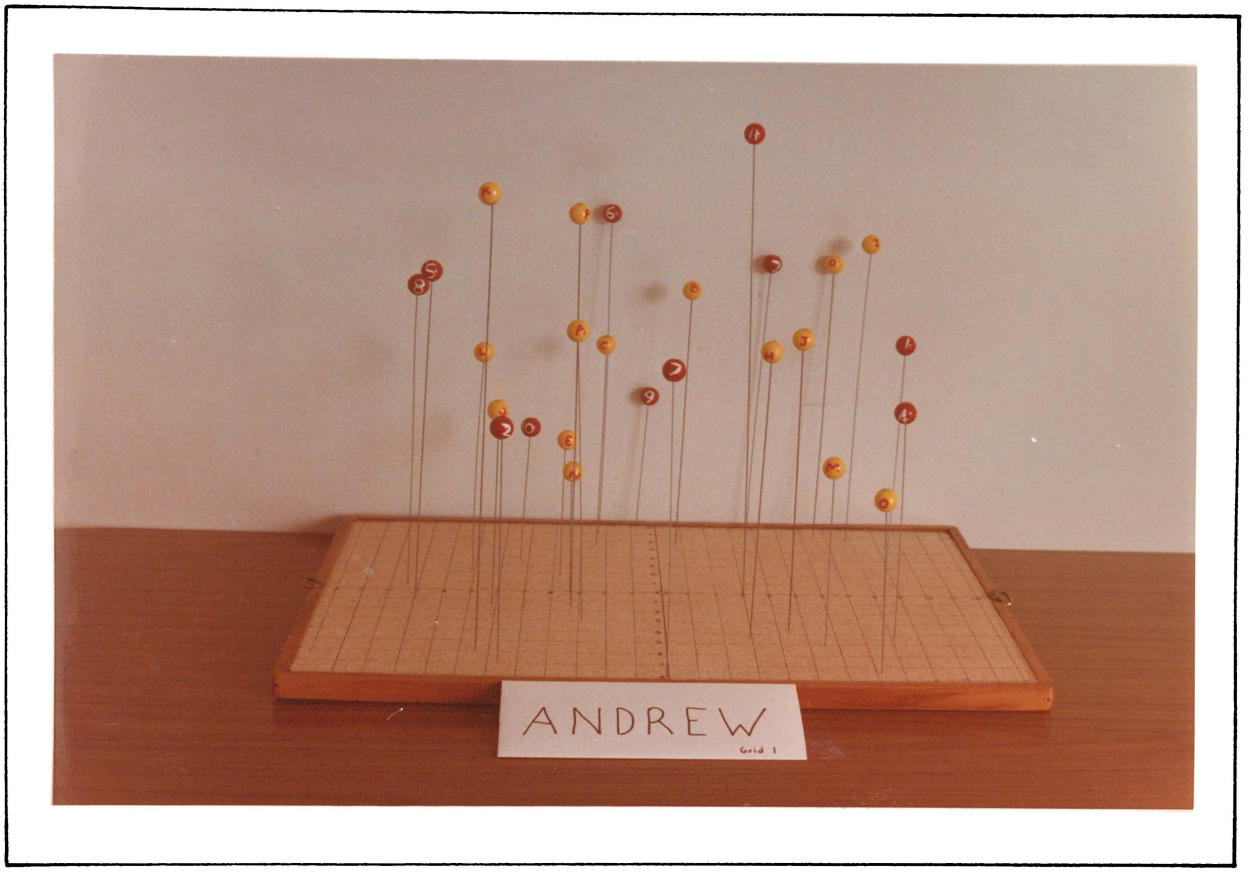
Science.....

Comments:

APPENDIX 3.16

A photograph of the kitset model

The kitset model



APPENDIX 3.17

Letter sent to parents

Letter sent to parents

16 June, 1981.

Parent's Name
Address

Dear Parents,

As (child's name) may have told you, he/she has been helping us with a research project which is looking at the teaching and learning of science in schools.

The project has been developed to seek ways of improving students' understanding of scientific ideas and procedures. Already we have devised several ways and some material to assist teachers and students achieve this.

However, one large area of interest is that to do with the individual attitudes to, and beliefs about, science. For example, do you think, "A study of science is necessary for all students anyway?" "Is science providing for a better world or are its products lowering the quality of life?" What is it about science that is sometimes found to be difficult, or of no use?"

These, and similar other questions, have no final and 'correct' answers, but the variety of answers given to them does influence what students, parents, teachers, and others, think should be taught in schools. This is where we feel you, as parents, can be of real assistance to us as, so far, we have heard only a few comments from parents on what they think about science.

Consequently, I would like very much to have the opportunity to meet and talk with you, in a very informal way, about your feelings and ideas about it. Please do not think I would be trying to discover what you don't know about science!! The idea is to have a free general discussion, lasting around thirty minutes, or so. After now having had several pleasant interviews with (child's name), I am sure this is possible and hope you will be able to spare me a little of your time.

I would like to phone you in a day or two about this possibility, and to perhaps arrange a time for such a meeting. I hope so.

Yours sincerely,

Keith Stead
(Researcher)

APPENDIX 3.18

The open-ended, preliminary TRA questionnaire

WAIKATO UNIVERSITY

Preliminary Survey of Science Attitudes

Name ..... Form Level ..... Date . .....

In order to develop a more comprehensive survey we are seeking your reasons why you wish to study science subjects, or not to study science subjects, at school.

You are asked simply to list your own reasons in the appropriate places below.

1. What are the advantages, for you personally, in studying science in the Fifth form?

.....

.....

.....

.....

.....

2. What are the disadvantages, for you, in studying science in the Fifth form?

.....

.....

.....

.....

.....

3. What are the reasons why you might want to study Biology in the Sixth form?

.....

.....

.....

.....

.....

2.

4. What are the reasons why you might not want to study Biology in the Sixth form?

.....

.....

.....

.....

.....

5. What are the reasons why you might want to study Chemistry in the Sixth form?

.....

.....

.....

.....

.....

6. What are the reasons why you might not want to study Chemistry in the Sixth form?

.....

.....

.....

.....

.....

7. What are the reasons why you might want to study Physics in the Sixth form?

.....

.....

.....

.....

.....

3.

8. What are the reasons why you might not want to study Physics in the Sixth form?

.....

.....

.....

.....

.....

Think hard about the people, or groups of people, who are most important to you in your life (perhaps relations, friends, teachers, possible employers, etc).

9. List those who you believe would think science is an important subject for you to study. Indicate who they are after their name. eg. Brian (best friend).

.....

.....

.....

.....

.....

10. List those who you believe would think science is not an important subject for you to study. Indicate who they are beside their name.

.....

.....

.....

.....

.....

Finally, if any of these people above would, or would not, like you to study a particular science subject (Biology, Chemistry, or Physics) write it alongside their name also. eg. Robyn (neighbour) (Biology).

We thank you for your assistance.

APPENDIX 3.19

The final TRA questionnaires,
and the scoring transformations

WAIKATO UNIVERSITY

Science Attitude Questionnaire (Form 4 Students)

Name ..... Sex: M F

School ..... Date: .....

Do you consider yourself to be:

Pakeha/European
Maori
Pacific Islander
Other (please state) .....

Section A

In this section you are asked to place a tick in the place which best describes your opinion.

1. My intention to be successful in science next year in the fifth form is

strong						weak
	extremely	quite	neither	quite	extremely	

2. For me, studying science next year in the fifth form will be

		extremely	quite	neither	quite	extremely	
(a)	interesting						boring
(b)	worthless						worthwhile
(c)	wise						foolish
(d)	necessary						unnecessary
(e)	difficult						easy
(f)	a lot of work						little work
(g)	useful						useless
(h)	feminine						masculine

2.

3. I believe that

		strongly agree	quite agree	neither	quite disagree	strongly disagree
(a)	obtaining scientific knowledge is worthwhile					
(b)	we need to know about our world					
(c)	we need to learn about ourselves					
(d)	we need to improve the world					
(e)	I need to find a job when I leave school					
(f)	I need to understand school subjects better					
(g)	practical work is important					
(h)	school work should be enjoyable					

4. I believe that by studying science next year in the fifth form I will

		strongly agree	quite agree	neither	quite disagree	strongly disagree
(a)	obtain worthwhile scientific knowledge					
(b)	know more about our world					
(c)	learn more about myself					
(d)	be able to help improve the world					
(e)	be able to find a job when I leave school					
(f)	be able to understand school subjects better					
(g)	experience important practical work					
(h)	find my school work enjoyable					

3.

5. Most people who are important to me think I should study science next year in the fifth form.

agree _____ _____ _____ _____ _____ disagree
strongly quite neither quite strongly

6. The following people, or groups of people, think I should study science next year in the fifth form:

		strongly agree	quite agree	neither	quite disagree	strongly disagree
(a)	Myself					
(b)	My father					
(c)	My mother					
(d)	My brother					
(e)	My sister					
(f)	My relations					
(g)	My friends					
(h)	My teachers					
(i)	My possible employers					

7. I usually do what these people want me to do:

		strongly agree	quite agree	neither	quite disagree	strongly disagree
(a)	Myself					
(b)	My father					
(c)	My mother					
(d)	My brother					
(e)	My sister					
(f)	My relations					
(g)	My friends					
(h)	My teachers					
(i)	My possible employers					

4.

Section B

Biology is a study of plants and animals (which includes ourselves).

Chemistry is a study of solids, liquids, gases, and how they react.

Physics is a study of mechanics, electricity, light, heat, sound, and so on.

These branches of science are taught separately in the sixth form.

8. How likely is it that you will study:

		extremely likely	quite likely	neither	quite unlikely	extremely unlikely
(a)	Biology					
(b)	Chemistry					
(c)	Physics					

9. Briefly explain why you ticked where you did for each science subject:

(a) I ticked Biology there because .....

.....

(b) I ticked Chemistry there because .....

.....

(c) I ticked Physics there because .....

.....

10. (a) What job, or career, do you hope to have when you leave school?

.....

(b) What job, or career, do you think you will have when you leave school?

.....

5.

11. (a) How much thought have you given to your future courses at school?

Put a circle around the appropriate option:-

a very considerable amount quite a lot very little none

(b) Who, or what, helped you to decide what courses you should take?

.....

.....

12. (a) What will be the three most important subjects you will be studying next year?

(i) .....

(ii) .....

(iii) .....

(b) Why do you think these subjects are important for you?

I think (i) is important for me because .....

.....

I think (ii) is important for me because .....

.....

I think (iii) is important for me because .....

.....

If you have any comments you would like to make about your school science, please add them here:-

-ooOoo-

WAIKATO UNIVERSITY

Science Attitude Questionnaire (Form 5 Students)

Name ..... Sex: M F

School ..... Date: .....

Do you consider yourself to be:

Pakeha/European

Maori

Pacific Islander

Other (please state) .....

Section A

1. Circle the science options you would be studying next year if you return to school in the sixth form.

Mathematics Biology Chemistry Physics

For the following three questions (numbers 2,3, and 4) indicate with a B (for Biology), a C (for Chemistry), a P (for Physics) how you would rate each science option (even if you do not intend actually studying any, or all, of them!)
You may place more than one option in any one space, but place each option only once on each line.

2. For me, studying science options next year in the sixth form would be

		extremely	quite	neither	quite	extremely	
(a)	interesting						boring
(b)	worthless						worthwhile
(c)	wise						foolish
(d)	necessary						unnecessary
(e)	difficult						easy
(f)	a lot of work						little work
(g)	useful						useless
(h)	feminine						masculine

2.

3. I believe that by studying science options next year in the sixth form I would

		strongly agree	quite agree	neither	quite disagree	strongly disagree
(a)	obtain worthwhile scientific knowledge					
(b)	know more about our world					
(c)	learn more about myself					
(d)	be able to help improve the world					
(e)	be able to find a job when I leave school					
(f)	be able to understand school subjects better					
(g)	experience important practical work					
(h)	find my school work enjoyable					

4. The following people, or groups of people, think I should study science options next year in the sixth form:

		strongly agree	quite agree	neither	quite disagree	strongly disagree
(a)	Myself					
(b)	My father					
(c)	My mother					
(d)	My brother					
(e)	My sister					
(f)	My relations					
(g)	My friends					
(h)	My teachers					
(i)	My possible employers					

3.

In the following four questions (numbers 5,6,7, and 8) place a tick in the place which best describes your opinion:

5. (a) My intention to be successful in Biology next year in the sixth form is

strong					weak
extremely	quite	neither	quite	extremely	

(b) My intention to be successful in Chemistry next year in the sixth form is

strong					weak
extremely	quite	neither	quite	extremely	

(c) My intention to be successful in Physics next year in the sixth form is

strong					weak
extremely	quite	neither	quite	extremely	

6. I believe that

		strongly agree	quite agree	neither	quite disagree	strongly disagree
(a)	obtaining scientific knowledge is worthwhile					
(b)	we need to know about our world					
(c)	we need to learn about ourselves					
(d)	we need to improve the world					
(e)	I need to find a job when I leave school					
(f)	I need to understand school subjects better					
(g)	practical work is important					
(h)	school work should be enjoyable					

4.

7. (a) Most people who are important to me think I should study Biology next year in the sixth form.

agree _____ _____ _____ _____ _____ disagree
strongly quite neither quite strongly

(b) Most people who are important to me think I should study Chemistry next year in the sixth form.

agree _____ _____ _____ _____ _____ disagree
strongly quite neither quite strongly

(c) Most people who are important to me think I should study Physics next year in the sixth form.

agree _____ _____ _____ _____ _____ disagree
strongly quite neither quite strongly

8. I usually do what these people want me to to do:

		strongly agree	quite agree	neither	quite disagree	strongly disagree
(a)	Myself					
(b)	My father					
(c)	My mother					
(d)	My brother					
(e)	My sister					
(f)	My relations					
(g)	My friends					
(h)	My teachers					
(i)	My possible employers					

5.

Section B

9. (a) How much thought have you given to your future courses at school?

Put a circle around the appropriate option:-

a very considerable amount quite a lot very little none

(b) Who, or what, helped you to decide what courses you should take?

.....

.....

(c) What job, or career, do you hope to have when you leave school?

.....

(d) What job, or career, do you think you will have when you leave school?

.....

10. (a) What will be the three most important subjects you will be studying next year?

(i) .....

(ii) .....

(iii) .....

(b) Why do you think these subjects are important for you?

I think (i) is important for me because .....

.....

I think (ii) is important for me because .....

.....

I think (iii) is important for me because .....

.....

-ooOoo-

Appendix 3.19 (Continued) The TRA scoring transformations

Each response to the Likert-type scales in Section A of both F4 and F5 questionnaires (other than than the first in the F5 questionnaire) was scored 1 to 5, from left to right, and entered into a computer data file.

The values for each component of the TRA models were obtained by linear transformations of these data as follows. Note: Only the TRA (F4) transformations are illustrated here, but the same principles were applied to each separate science option in the F5 questionnaire so as to provide separate TRA models for each.

1. Intention to study science next year (INT)

Question 1:

$$INT = (\text{cell value}) \times (-1) + 5$$

range = 0 to 4

2. Attitude toward studying science (ATT)

Question 2:

$$ATT = [(a) + (b)(-1) - (c) + (d) + (g)](-1) + 9$$

range = -10 to +10

Note: Scales (e), (f) and (g) were omitted from these transformations because it was considered they would not contribute consistently to this dimension.

3. Objective beliefs about studying science (and outcome evaluations of these beliefs) (OBJ)

Questions 3 and 4:

$$OBJ = \sum_{x=a}^{x=h} [6 + r_x(-1)]_{Q3} [3 + r_x(-1)]_{Q4}$$

where r_x = raw response value on scale x for each statement

range = -80 to +80

4. Social standard with respect to studying science (SOS)

Question 5:

$$SOS = (\text{cell value})(-1) + 3$$

range = -2 to +2

Appendix 3.19 (Continued)

5. Social beliefs about studying science (and motivation to comply with referents identified as holding these beliefs) (SOB)

Questions 6 and 7:

$$SOB = \sum_{x=b}^{x=i} [3 + r_x(-1)]_{Q6} [6 + r_x(-1)]_{Q7}$$

where r_x = raw response value on scale x for each statement

range = -80 to +80

Note: The '(a)' response values (for 'myself') were not used in the calculation of this component's value.

APPENDIX 5.1

Graphical representations of the students' final analysed grids

The graphical representations of the analysed final grids

The first of the following figures provides a synoptic overview of all the graphical representations of the science-related elements plotted on the first and second principal components extracted from the students' final grids.

The subsequent figures give fuller graphical representations of these grids with the loadings of all elements and explicit construct poles plotted against the first three principal components extracted by the INGRID analysis.

Notes: 1. The percentages expressed at the right-hand-side, or at the bottom, of each graph give the proportion of the total variance accounted for by the corresponding principal component.

2. The data from each raw grid have been 'normalised' (Slater, 1976) to produce the loadings depicted in in these figures.

3. Brief descriptors of the elements and the explicit construct poles follow each figure.

4. The order of these representations follow that depicted in consecutive columns of the first figure. That is:-

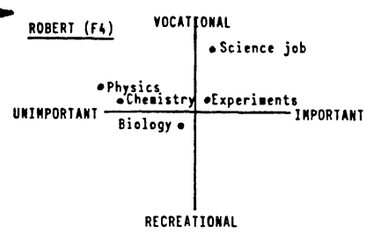
Student	page	Student	page
Robert	428	Peter	430
Sharon	432	Leanne	434
Jocelyn	436	Andrew	438
Sean	440	Amanda	442
Lynda	444	Jackie L	446
John	448	Lei	450
Ruth	452	Jackie B	454
Susan	456	Wayne	458
Murphy	460	Sandra (a)	462
Sandra (b)	464	Aroha	466
Mihi	468	Maurice	470
Russell	472	Louana	474
Angela	476	Janis	478

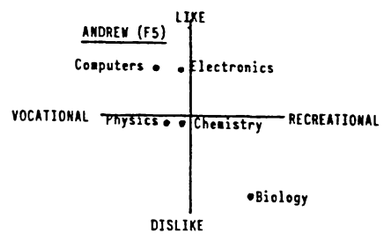
Figure 1: Synoptic graphical representations of each student's analysed final grid showing the positions of the science-related elements, with respect to the first two principal components (* = axes rotated to facilitate intergrid comparisons).

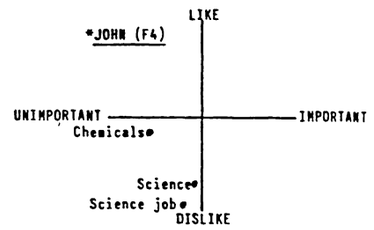
NON-POLYNESIAN STUDENTS

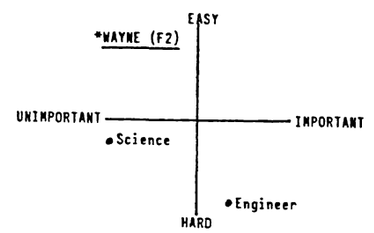
POLYNESIAN STUDENTS

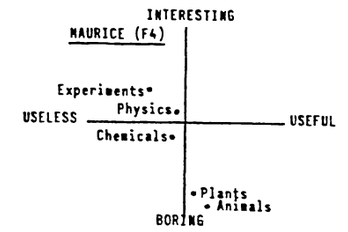
BOYS

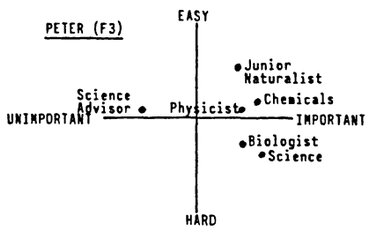


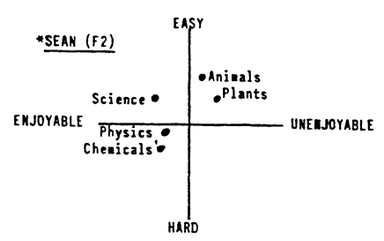


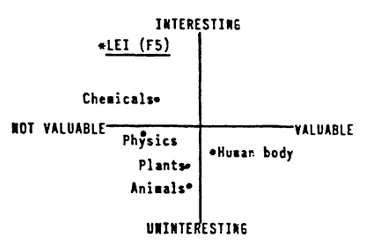


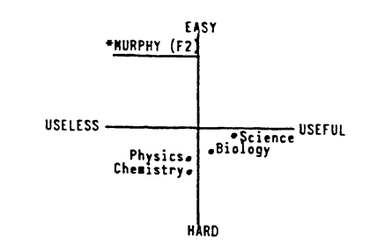


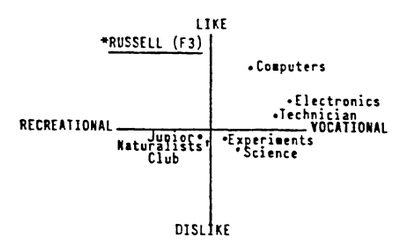




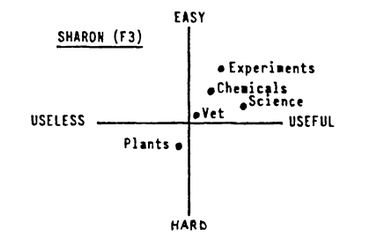


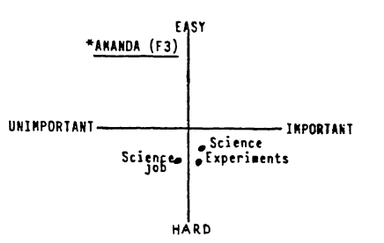


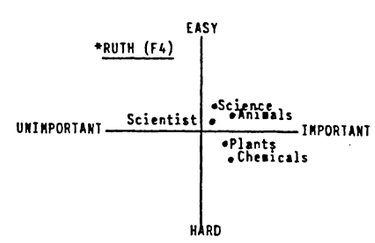


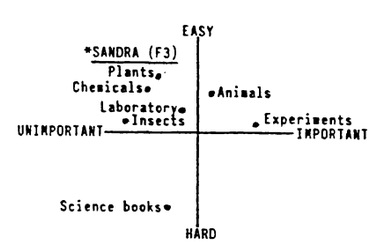


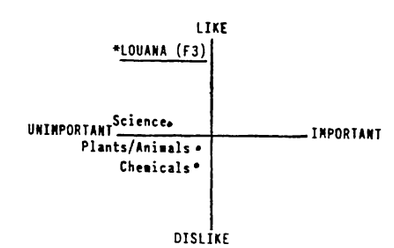
GIRLS

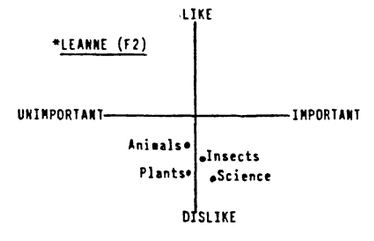


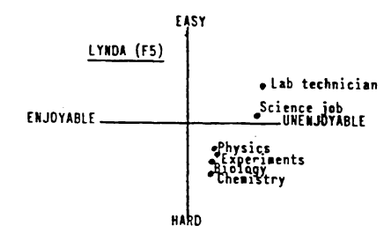


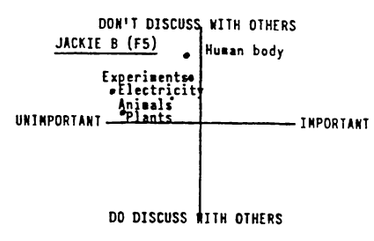


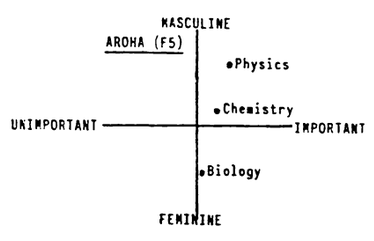


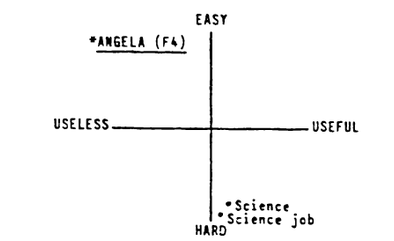


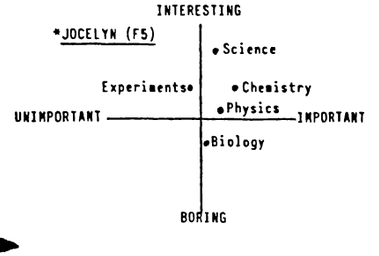


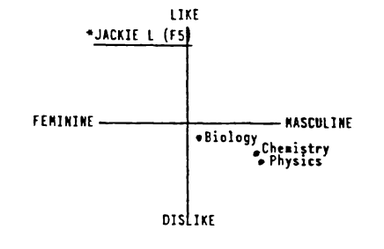


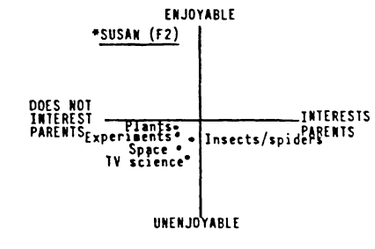


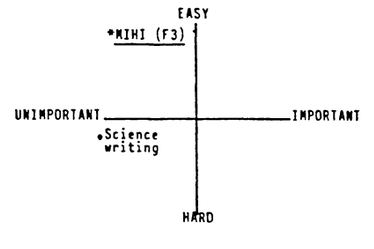












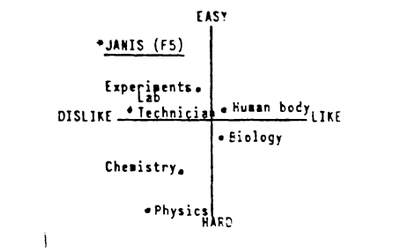
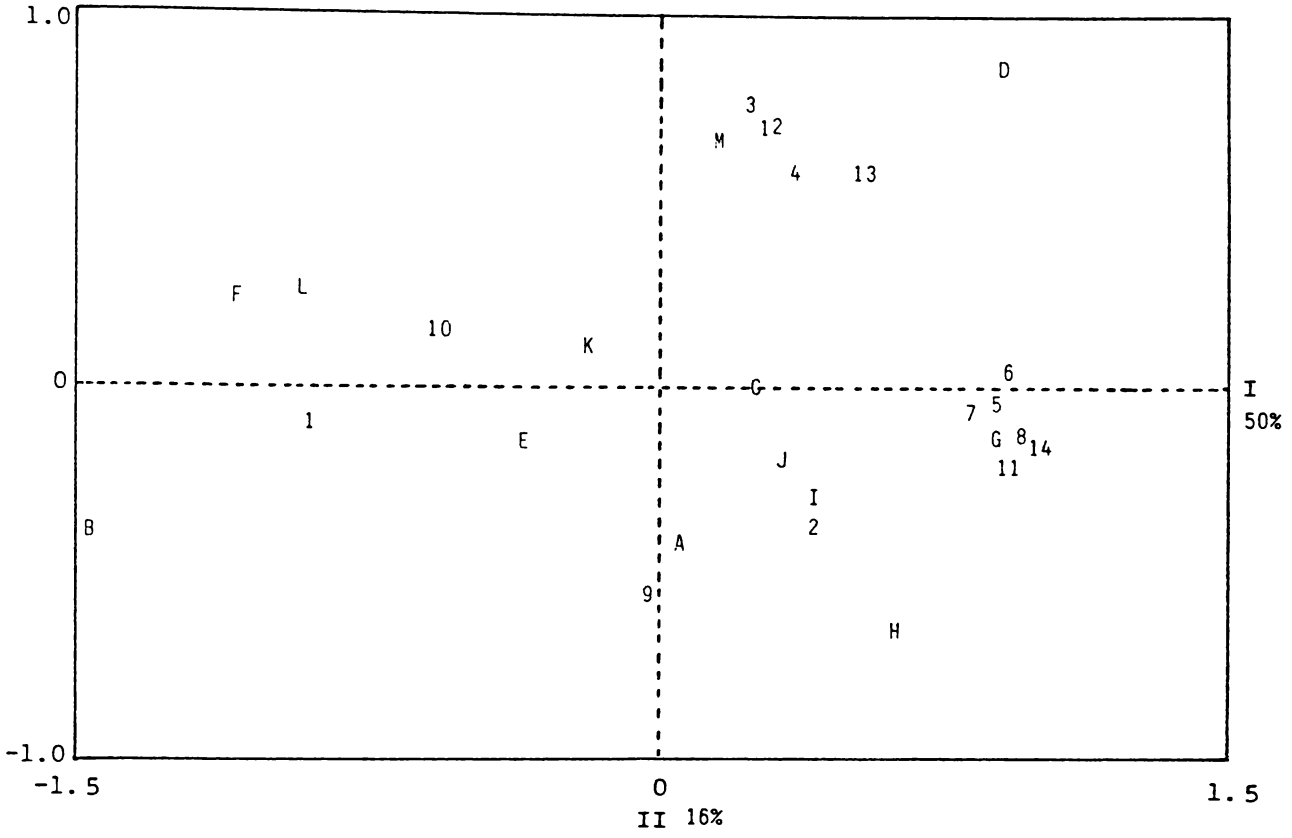


Figure 2: Robert



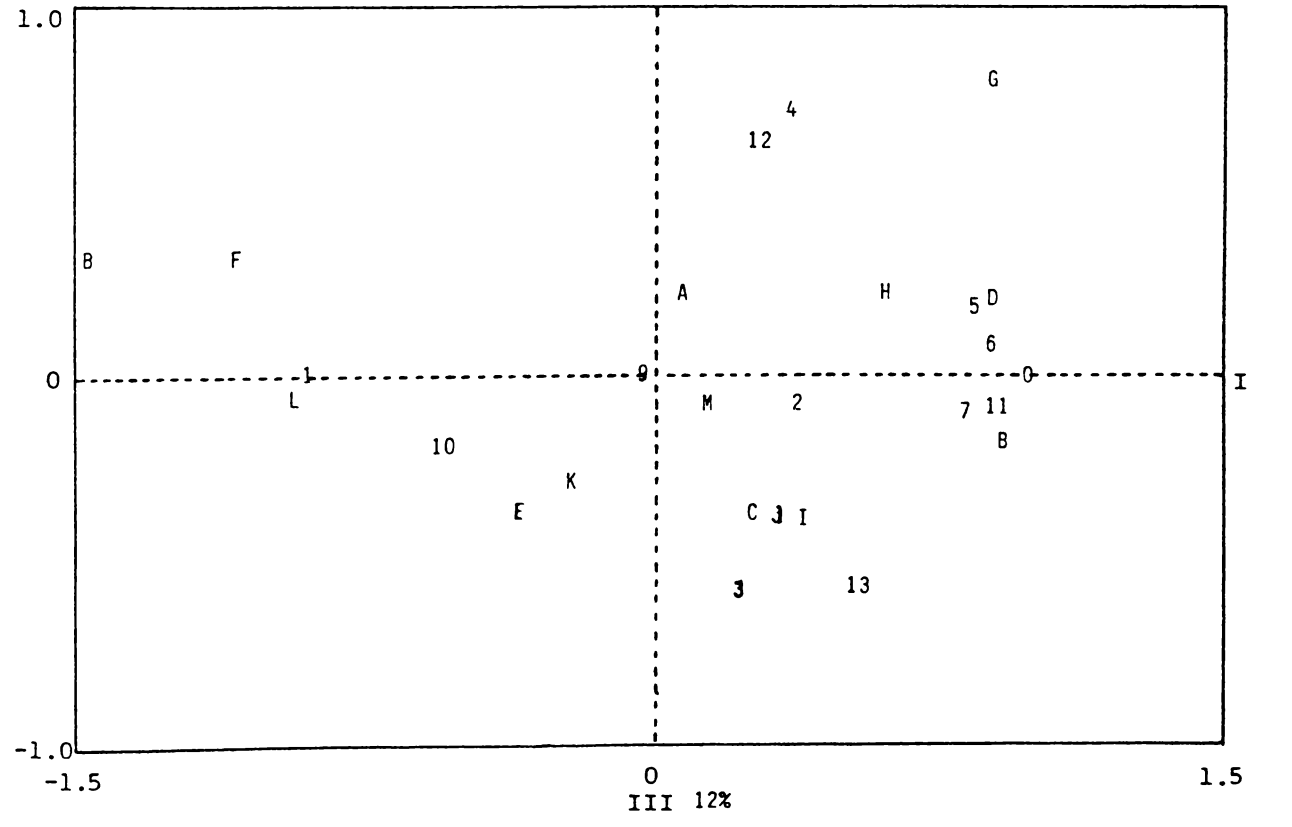


Figure 2 (Continued): **Robert**

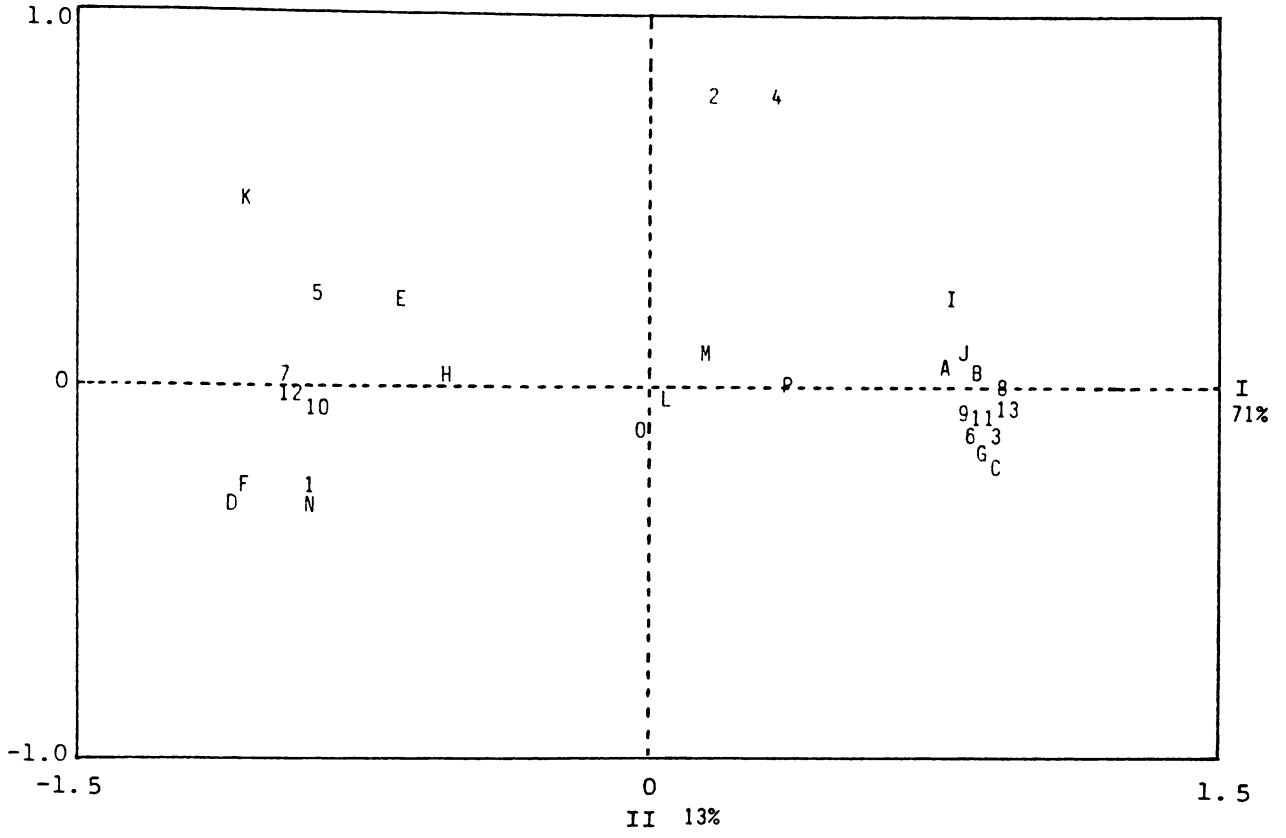
Elements

A Playing the guitar
B Working on maths problems
C Reading books
D Working as a farmer
E Doing biology
F Doing physics
G Playing rugby
H Horse riding
I Studying English
J Studying social studies
K Doing science experiments
L Doing chemistry
M Working in a scientific job

Constructs

1 Things I dislike
2 Things I do get involved in
3 Things that are (or would be) helpful in my life
4 Things that I consider are masculine
5 Things I think are valuable
6 Things that I think are important
7 I find interesting
8 What I am (or could be) good at
9 Things that are encouraged by my parents
10 Things that do not challenge me
11 Clear - easy to understand
12 Things that most people think are masculine
13 Things I feel I need to know much about
14 Thing I find satisfying

Figure 3: Peter



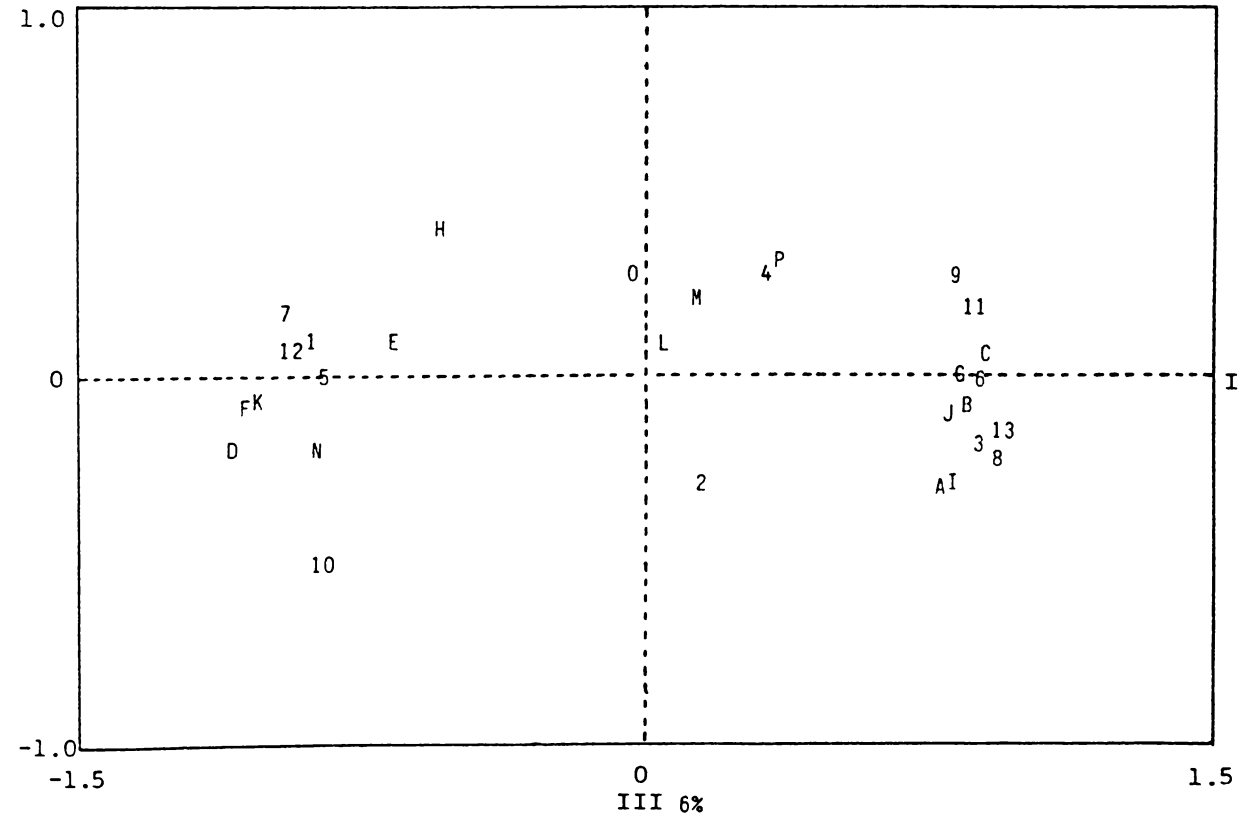


Figure 3 (Continued): **Peter**

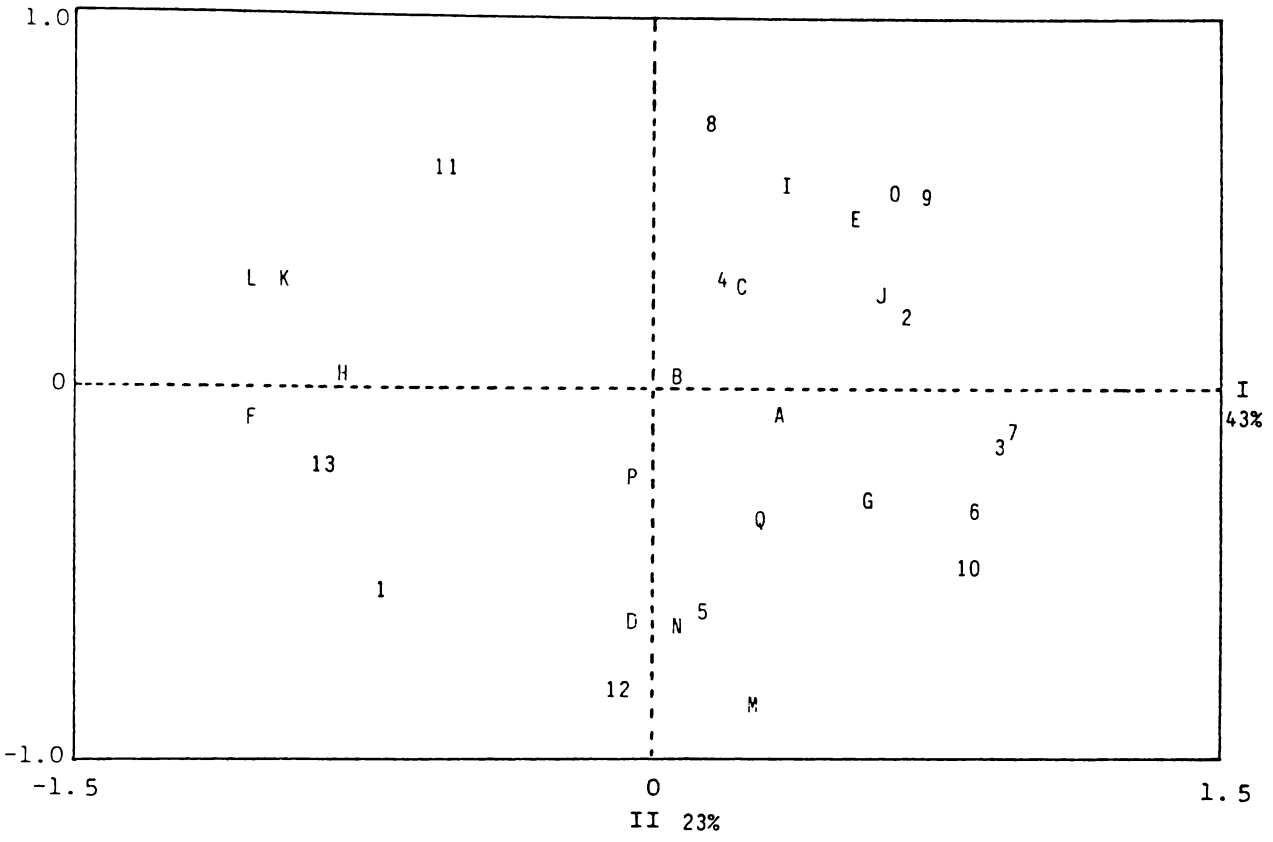
Elements

A Working as a physicist
B Working with chemicals
C Studying science
D Working as a draughtsman (or architect)
E Working as a teacher
F Working as a mechanic
G Working as a biologist
H Working as a science adviser
I Attending Junior Naturalists' Club
J Playing sport (harriers, swimming)
K Studying music
L Studying social studies
M Studying English
N Studying techical drawing
O Studying German
P Studying mathematics

Constructs

1 Things I dislike
2 I find easy
3 I am (or could be) good at
4 Feminine things
5 Things that are not encouraged by my parents
6 Things that do (or will) help me in my life
7 Things I find boring
8 Things that are good to do
9 Things I spend a lot of time doing
10 Things that we do not talk about at home
11 Things that are important
12 Things that do challenge me

Figure 4: Sharon



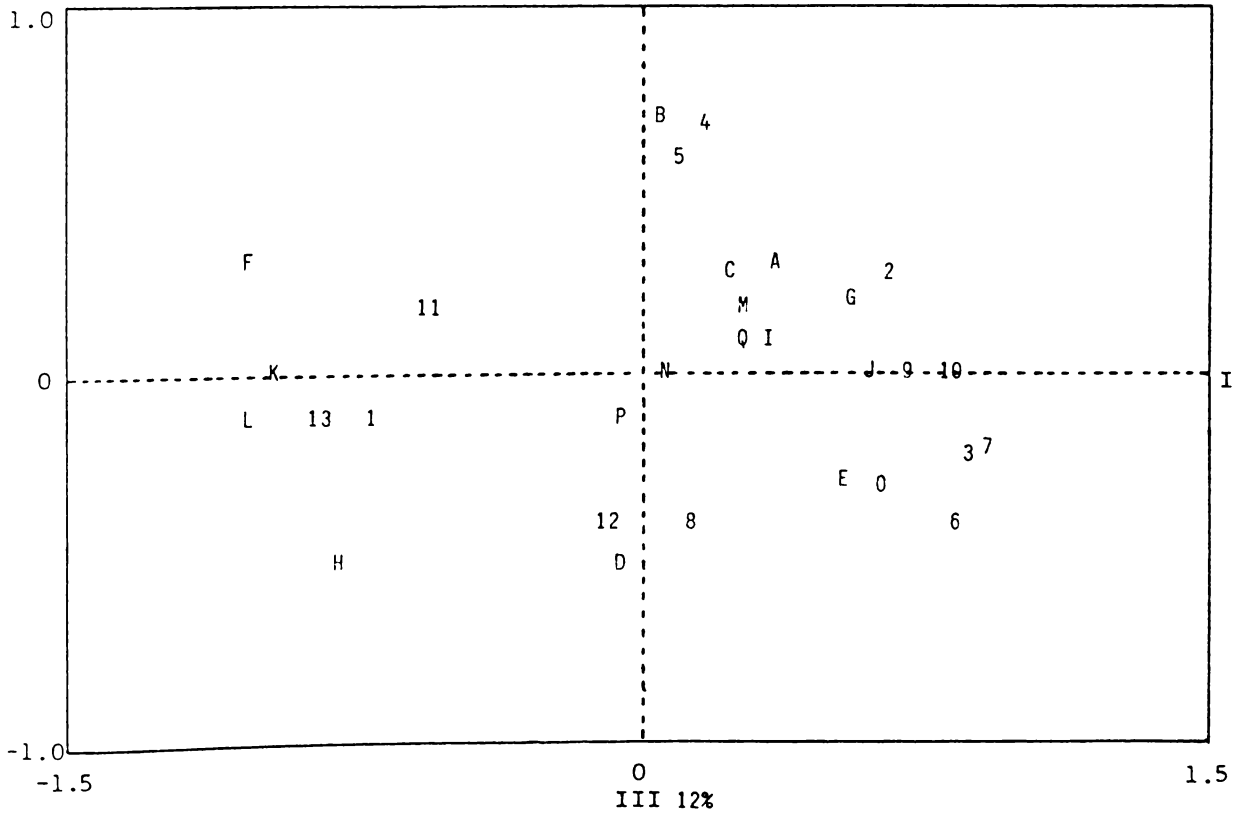


Figure 4 (Continued): **Sharon**

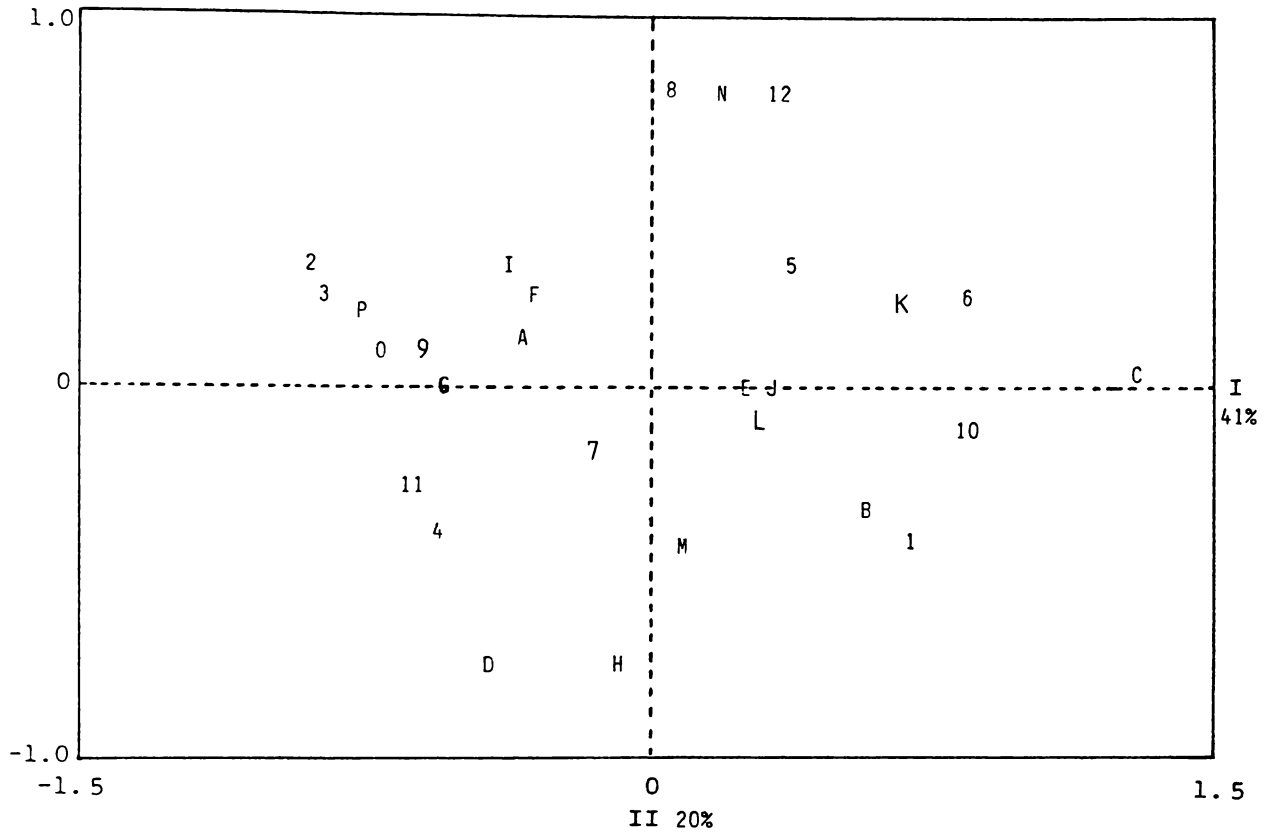
Elements

A Studying about animals
B Being a vet
C Studying about chemicals
D Learning typing
E Studying English
F Studying French
G Doing economic studies
H Being a housewife
I Doing science experiments
J Studying science
K Doing physical education
L Playing sport
M Studying maths
N Being a nurse
O Studying social studies
P Studying about plants
Q Teaching kindergarten/primary

Constructs

1 I dislike
2 I find exciting
3 I think is useful
4 I think is more for boys
5 I find hard
6 I think is worthwhile
7 I think is important
8 I'm good at
9 I get involved in
10 I think is for a job
11 Things I don't have to work at
12 I think are encouraged by my parents
13 I think is bad

Figure 5: Leanne



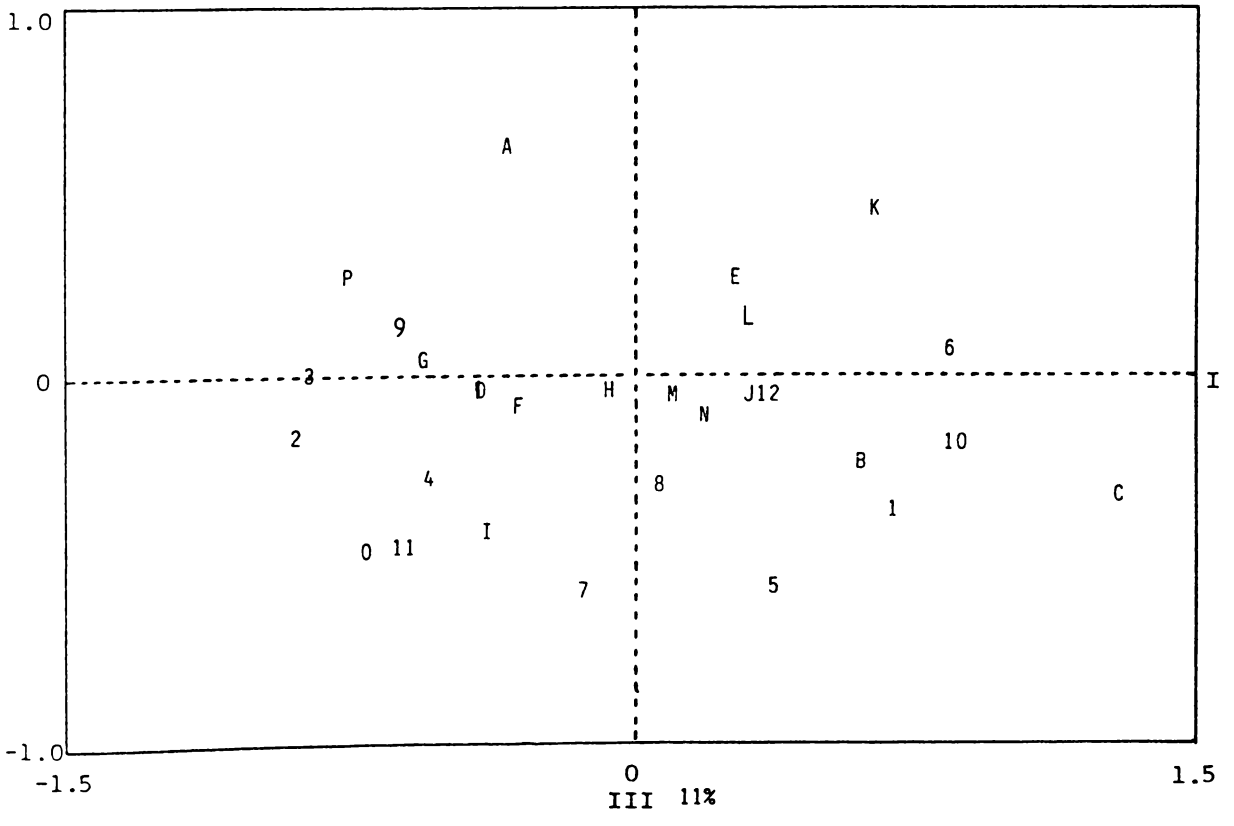


Figure 5 (Continued): **Leanne**

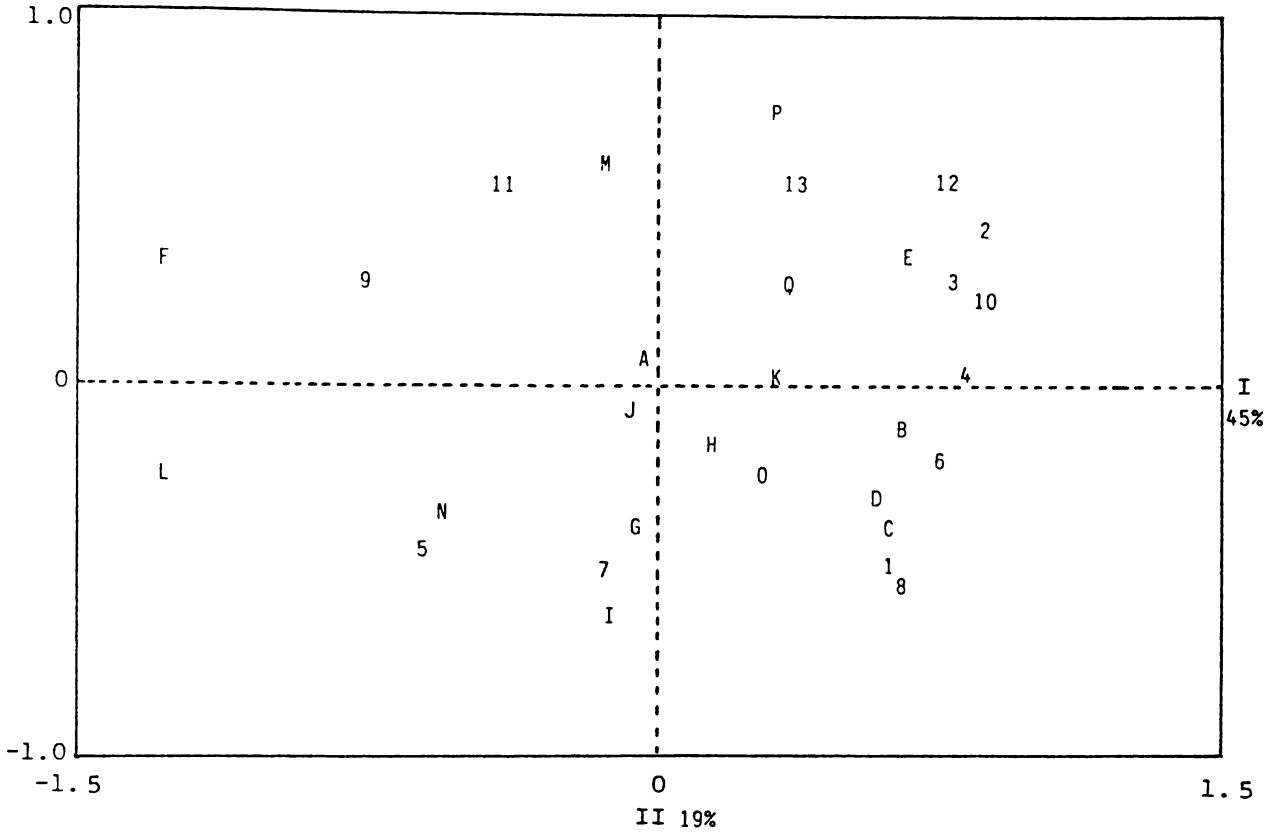
Elements

A Hairdressing job
B Doing science
C Working with computers
D Reading books
E Studying animals
F Playing netball
G Watching TV
H Doing homework
I Reading comics
J Studying plants
K Doing office work
L Studying insects
M Doing maths
N Doing a science job
O Drawing
P Doing jig-saw puzzles

Constructs

1 Things I dislike
2 I find easy to understand
3 Enjoyable
4 Encouraged by my parents
5 What Mum is not interested in
6 I know nothing about
7 What Dad is (or might be) interested in
8 Unimportant
9 I think is a girl's thing
10 What I am not (or won't be) good at
11 Usually for kids
12 Don't talk about at home

Figure 6: Jocelyn



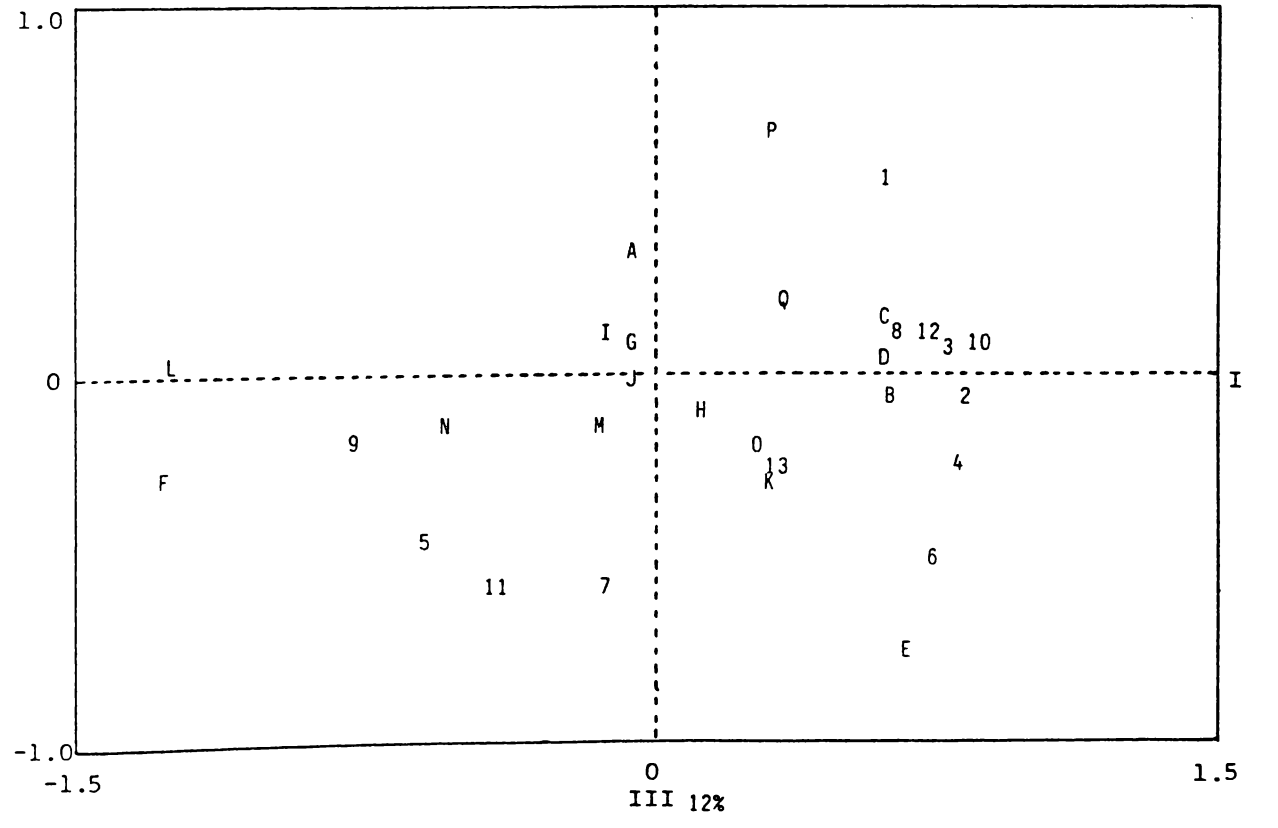


Figure 6 (Continued): **Jocelyn**

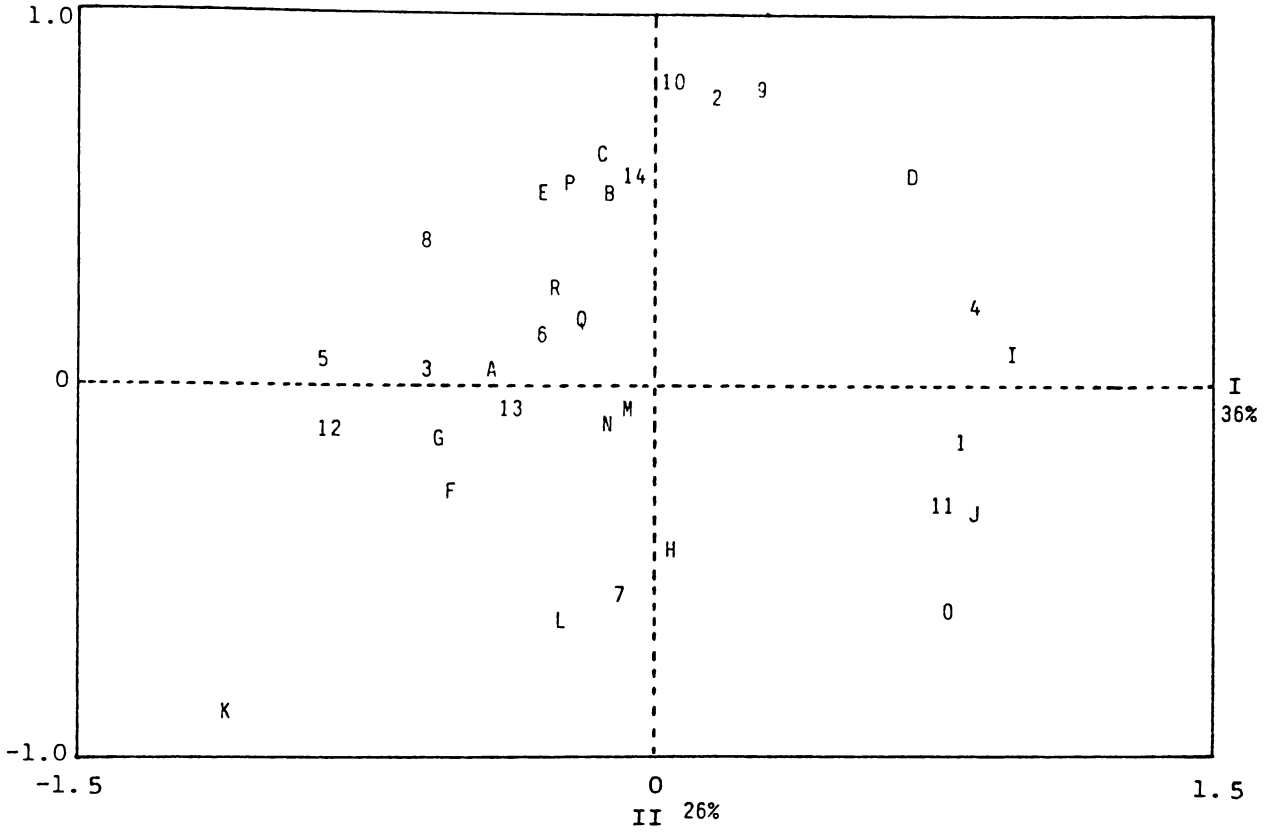
Elements

A Being a housewife
B Studying science
C Reading books
D Studying maths
E Riding horses
F Making music
G Studying economic studies
H Studying physics
I Studying English
J Studying biology
K Doing science experiments
L Working in a shop
M Working as a lab technician
N Studying history
O Studying chemistry
P Working as a vet
Q School teaching

Constructs

1 Things that are important now
2 Things I enjoy
3 Things I do get involved in
4 Things we do talk about at home
5 Things that are theoretical
6 I know a lot about
7 Things I think are for females
8 Things that are encouraged by my parents
9 I find hard
10 I find interesting
11 Not useful when I leave school
12 What I am (or could be) good at
13 Things that challenge me

Figure 7: Andrew



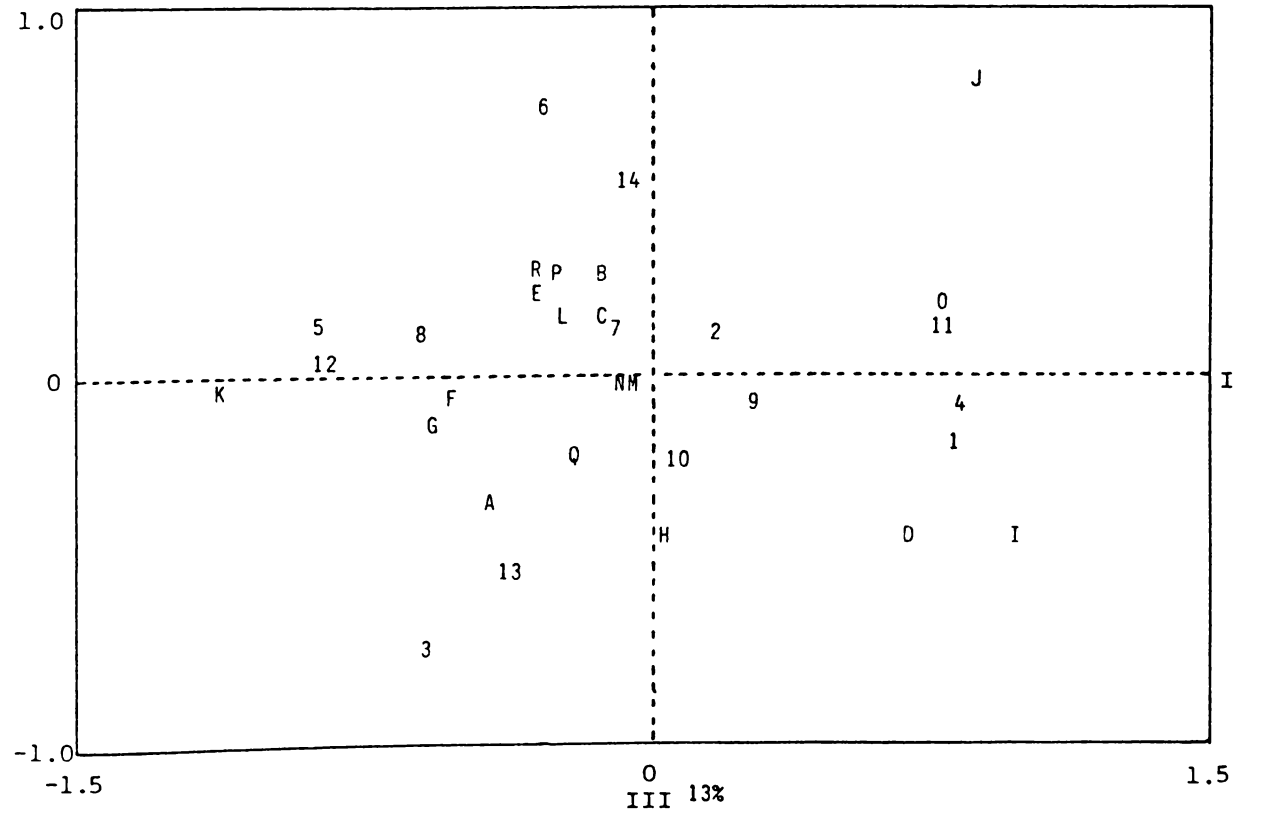


Figure 7: **Andrew**

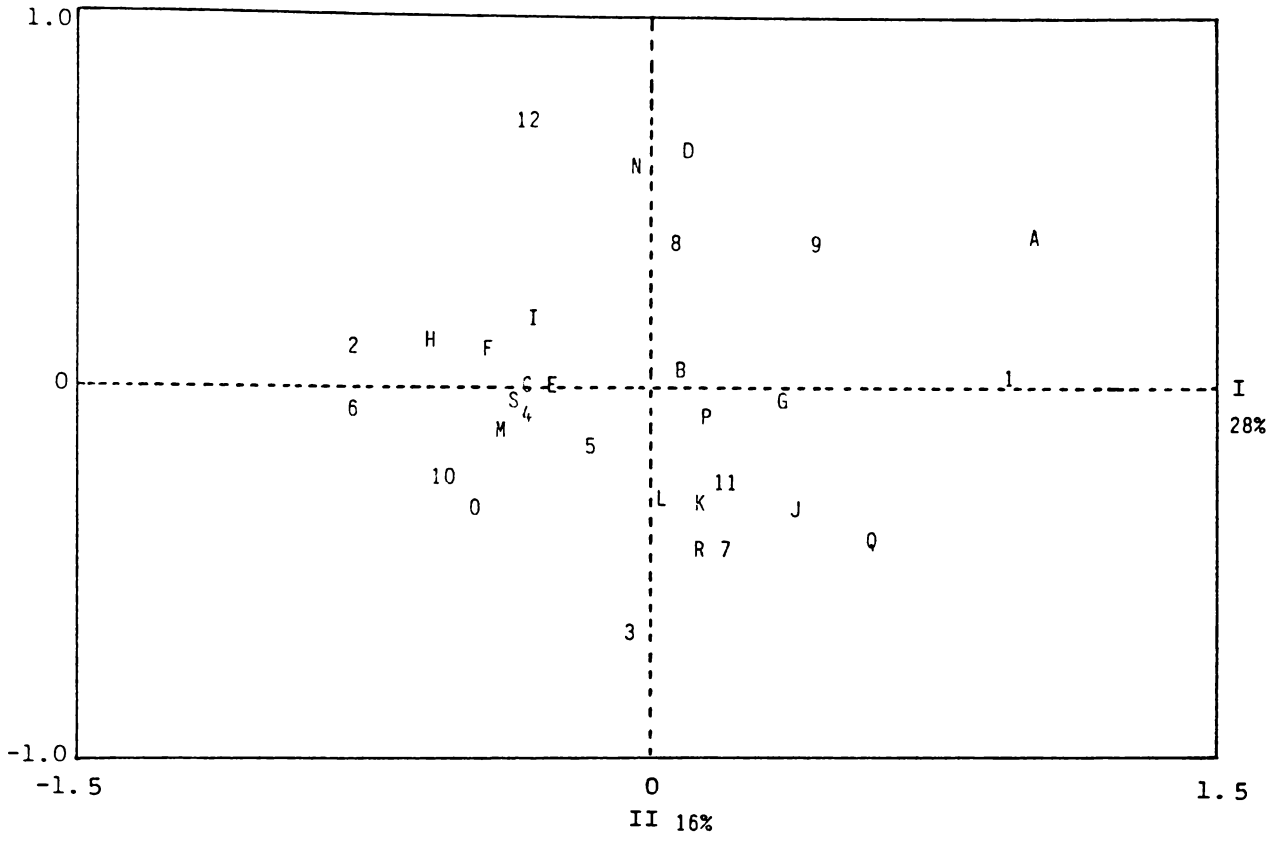
Elements

A Studying at the Technical Institute
B Studying technical drawing
C Working with and studying electronics
D Sailing
E Working with computers
F School
G Studying maths
H Studying at university
I Cycling
J Watching TV
K Studying for School Certificate
L Studing English
M Studying chemistry
N Studying physics
O Studying biology
P Working as an architect
Q Working as a vet
R Working as a draughtsman

Constructs

1 Of no practical use
2 Masculine
3 Hard
4 Useless
5 Necessary for a job
6 Doesn't give an understanding of what's around you
7 Boring
8 Important (now)
9 I like
10 Important (later on)
11 Doesn't need to be taught
12 Vocational
13 Encouraged by parents
14 I am good at (or would be)

Figure 8: Sean



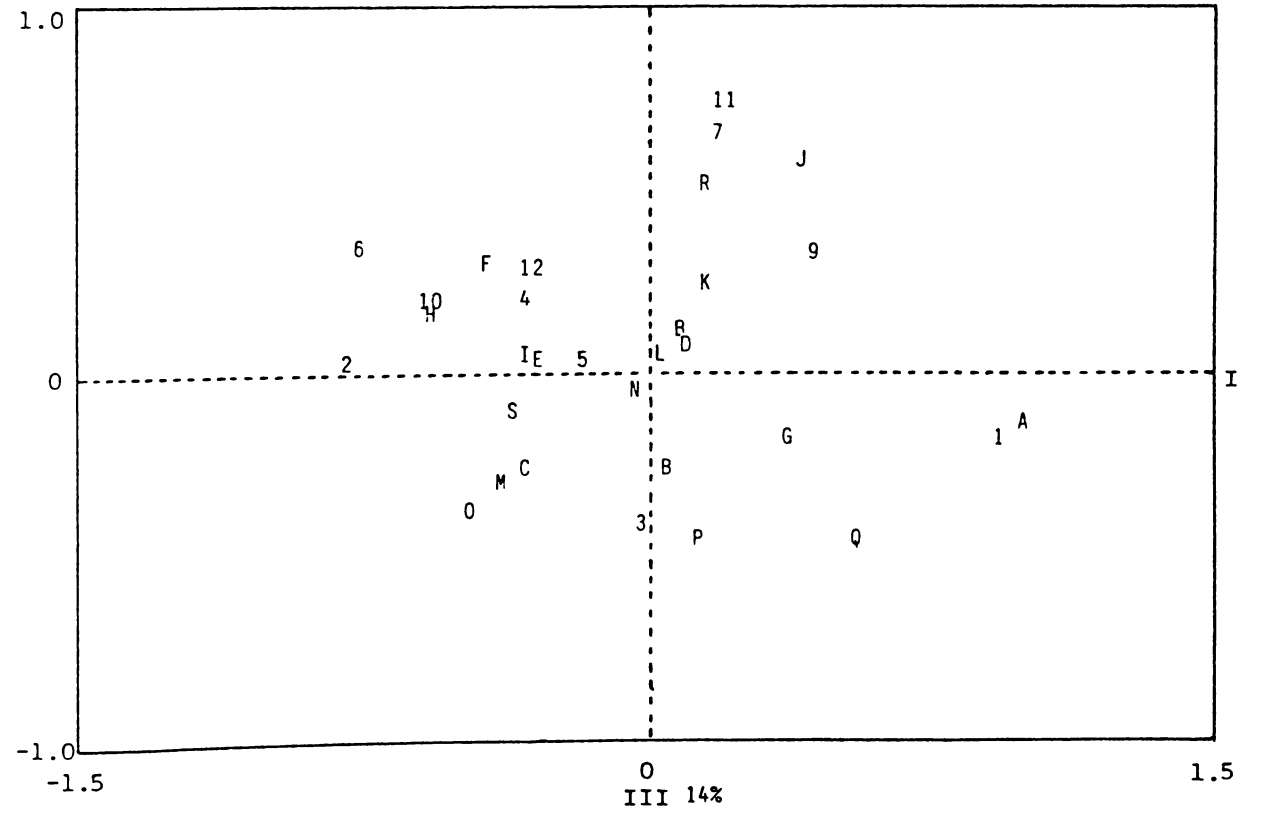


Figure 8 (Continued): **Sean**

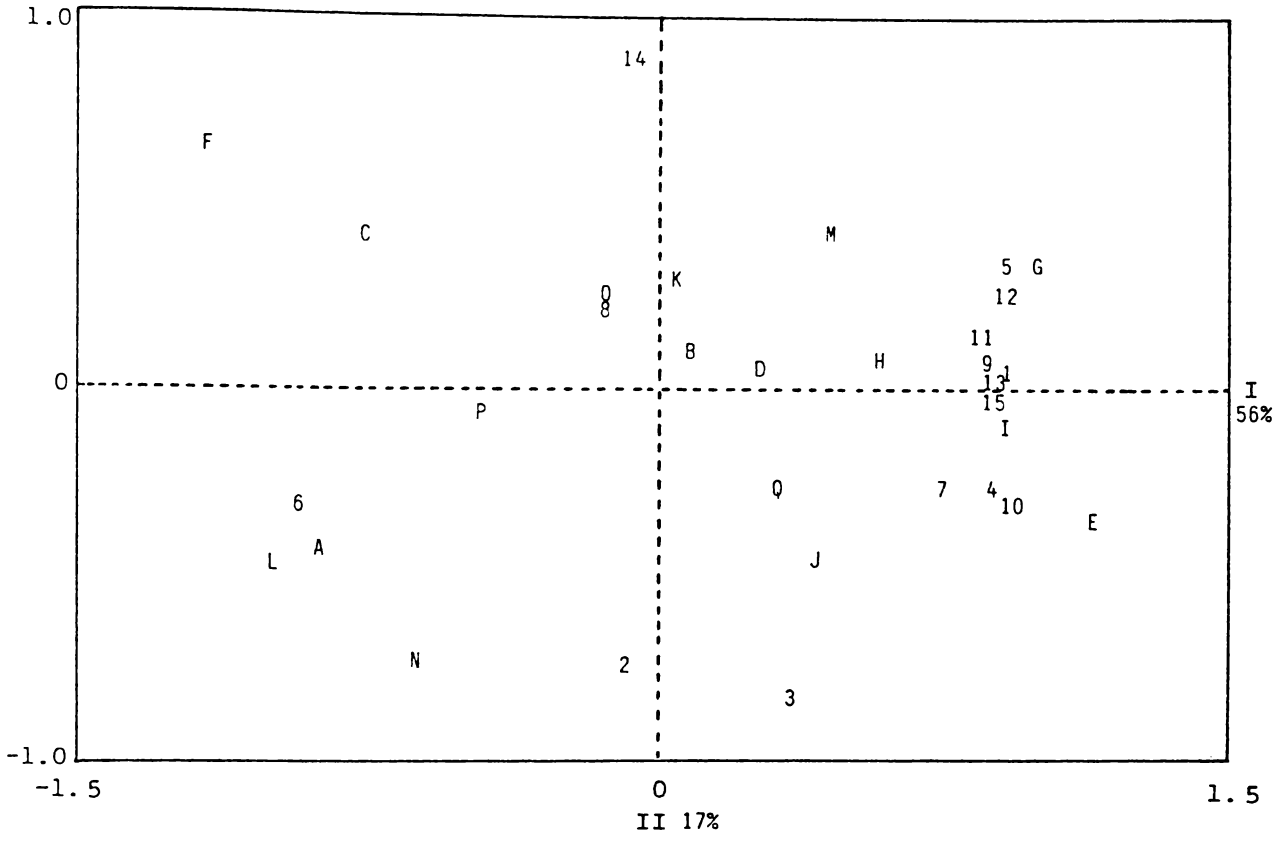
Elements

A Doing spelling
B Playing soccer
C Rug making
D Being at Intermediate School
E Studying physics
F Working with chemicals
G Studying at High School
H Being a mechanic
I Studying at Technical Institute
J Studying plants
K Doing office work
L Studying social studies
M Doing science
N Being a nurse
O Collecting stamps
P Reading a book
Q Doing maths
R Studying about animals
S Attending scouts

Constructs

1 I find unenjoyable
2 I think is (or would be) enjoyable
3 I find (or would find) easy
4 I think are more for boys
5 I think are unimportant
6 I have a lot of enthusiasm for
7 What my parents don't (or wouldn't) encourage me to do
8 What Mum is interested in
9 What Dad is not interested in
10 I am (or would be) good at
11 What we don't talk about at home
12 What we do talk about with friends

Figure 9: Amanda



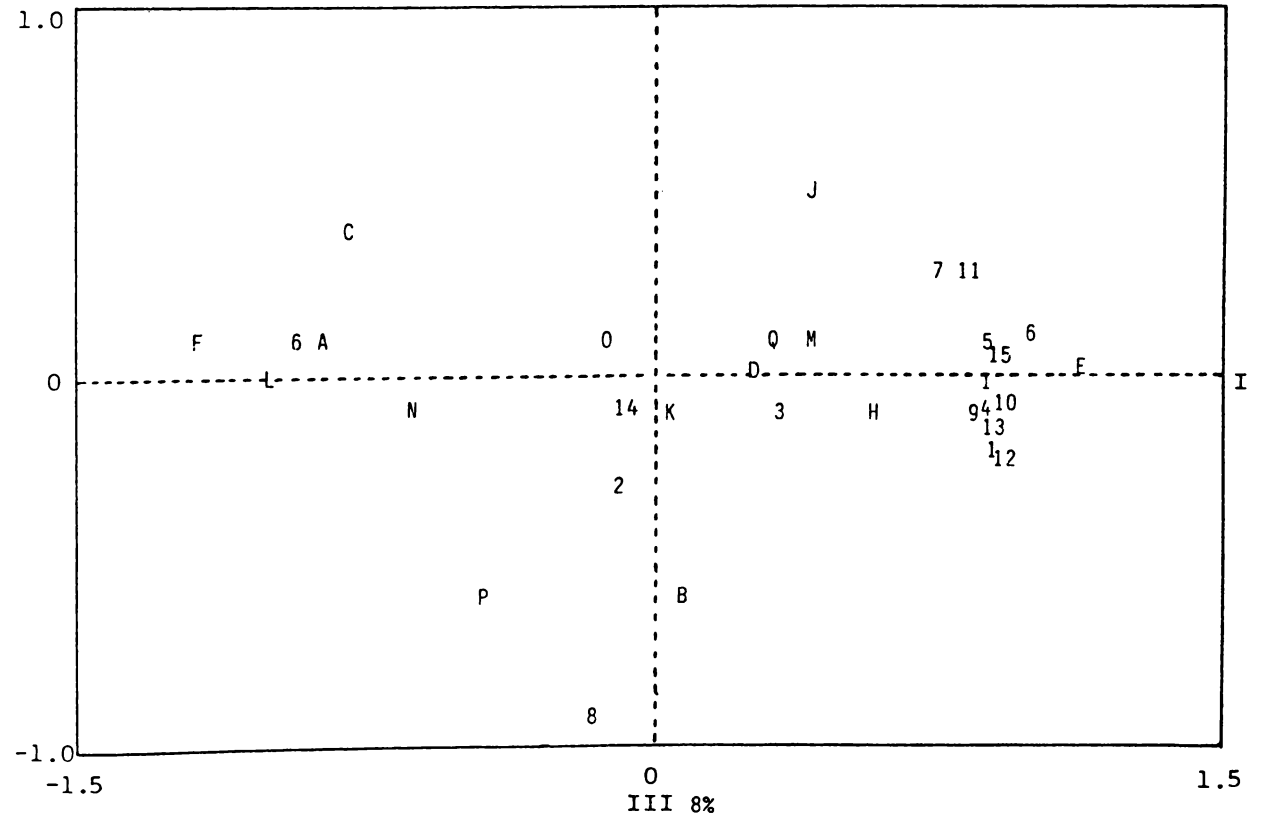


Figure 9 (Continued): **Amanda**

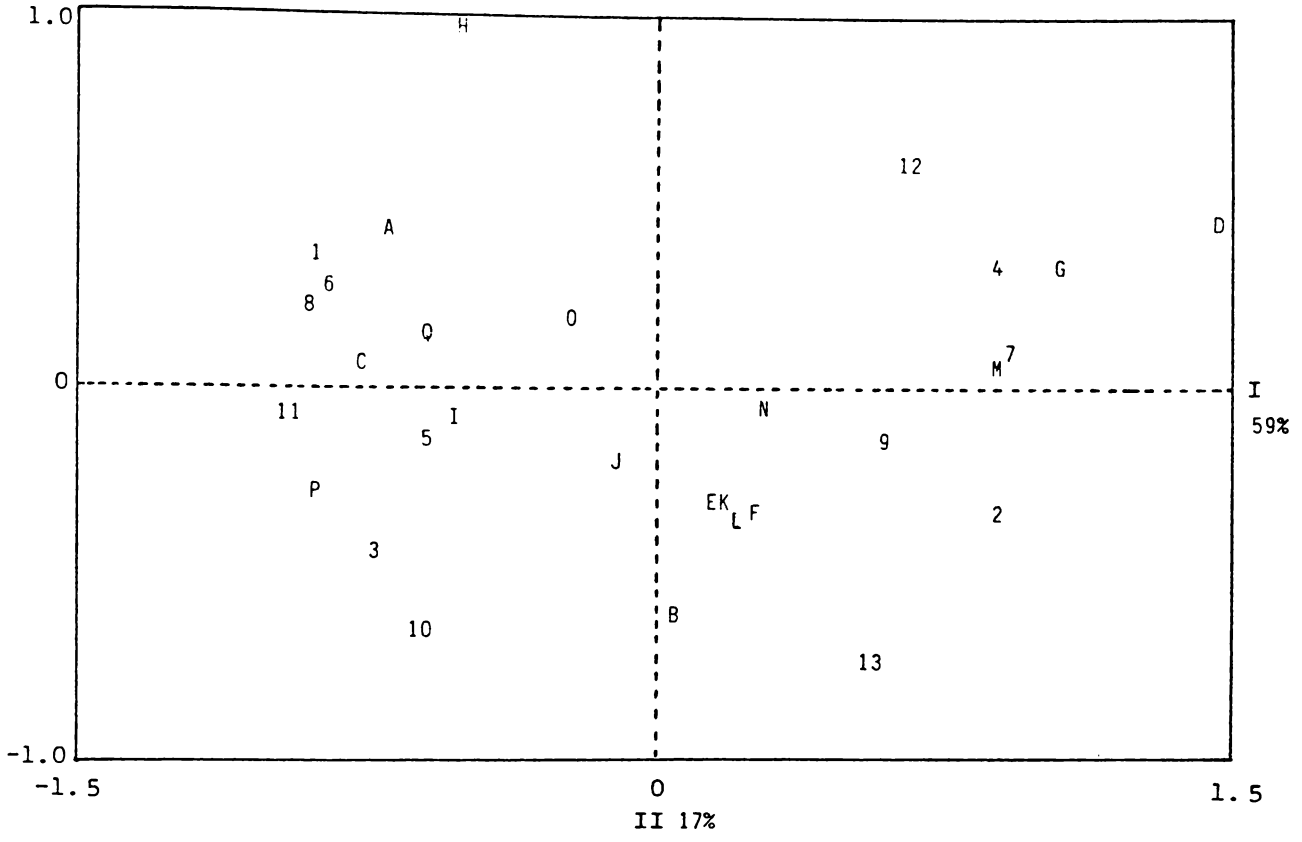
Elements

A Being a housewife
B Studying science
C Doing art
D Studying maths
E Reading books
F Making music
G Studying German
H Doing typing
I Studying English
J Writing stories
K Doing science experiments
L Working in a shop
M Working as a translator
N Doing Mum's job
O Working in a scientific job
P Playing a favourite sport
Q Studying social studies

Constructs

1 Things that are important
2 I find easy
3 I know a lot about
4 Things that are encouraged by my parents
5 I find exciting
6 Not useful when I leave school
7 I think I am good at
8 More for boys
9 I like doing
10 Things we talk about at home
11 Things that are theoretical
12 Things I am keen on
13 I find enjoyable
14 Things that are complicated
15 Necessary for a job

Figure 10: Lynda



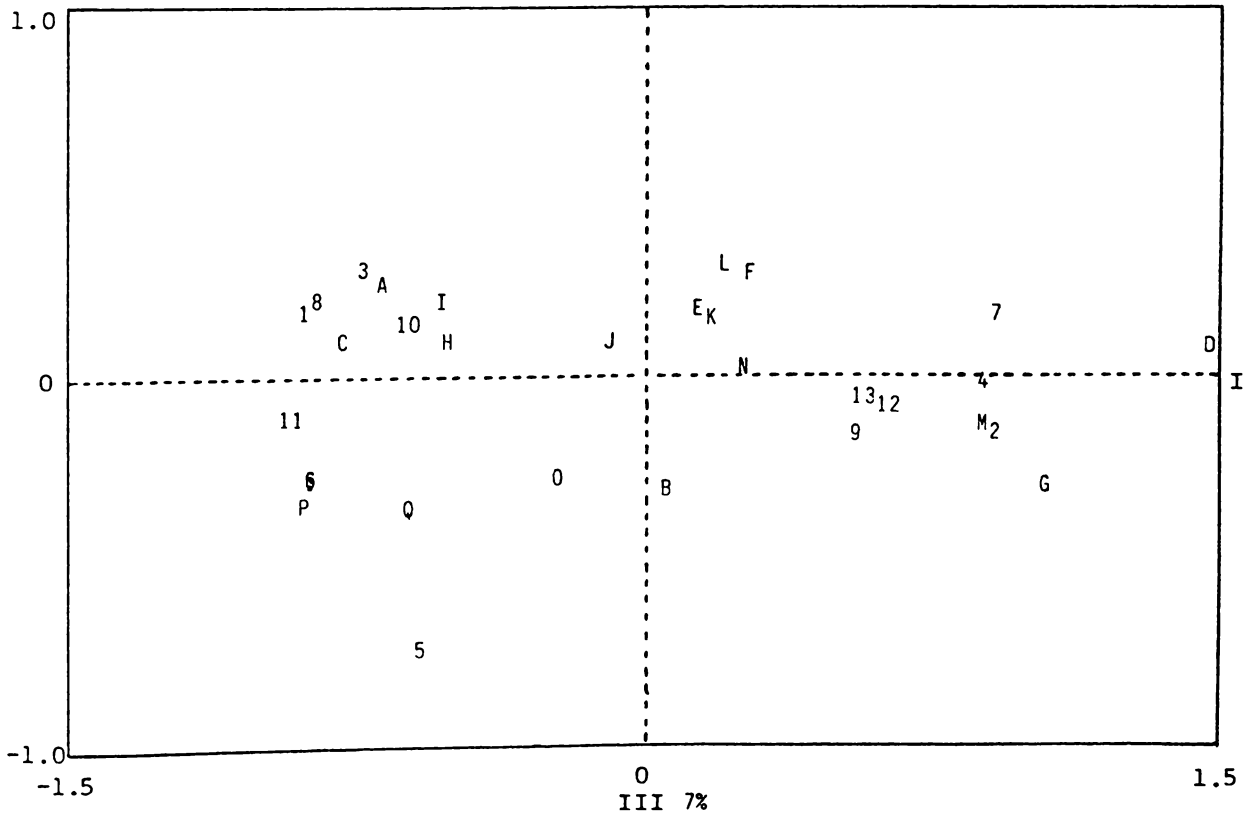


Figure 10 (Continued): **Lynda**

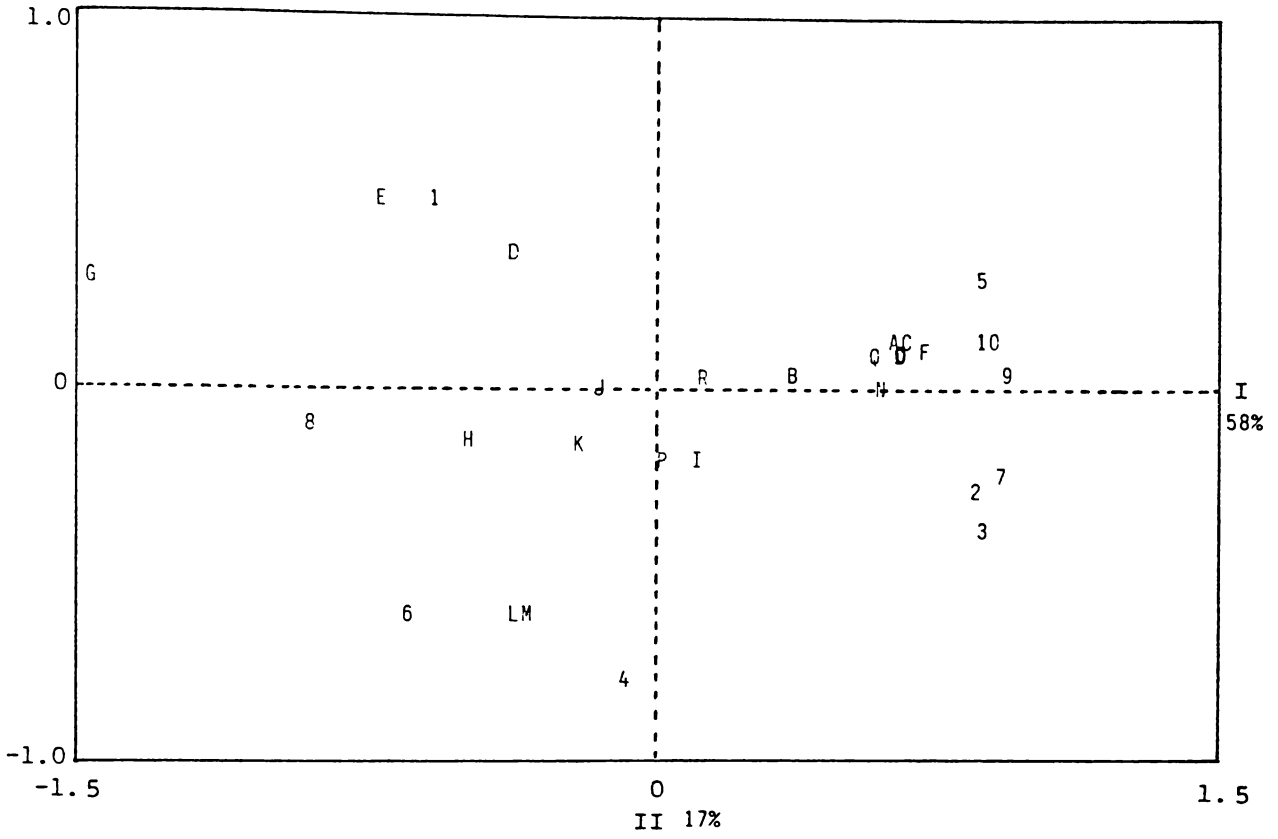
Elements

A Being a housewife
B Working maths problems
C Reading books
D Working as a mechanic
E Doing biology
F Doing physics
G Working as a lab technician
H Watching TV
I Studying English
J Studying geography
K Doing science experiments
L Doing chemistry
M Working in a scientific job
N Studying French
O Being an air hostess
P Being a hair dresser
Q Playing sport

Constructs

1 I find easy
2 Things that I'm not confident with
3 Are (or will be) useful in my life
4 Are not important in my world
5 Things we do talk about at home
6 Things I find interesting
7 Things that do not (or will not) help me in my life
8 I am (or would be) good at
9 Masculine things
10 Things that are encouraged by my parents
11 Things I enjoy
12 Not useful for a job
13 Makes me think

Figure 11: Jackie L



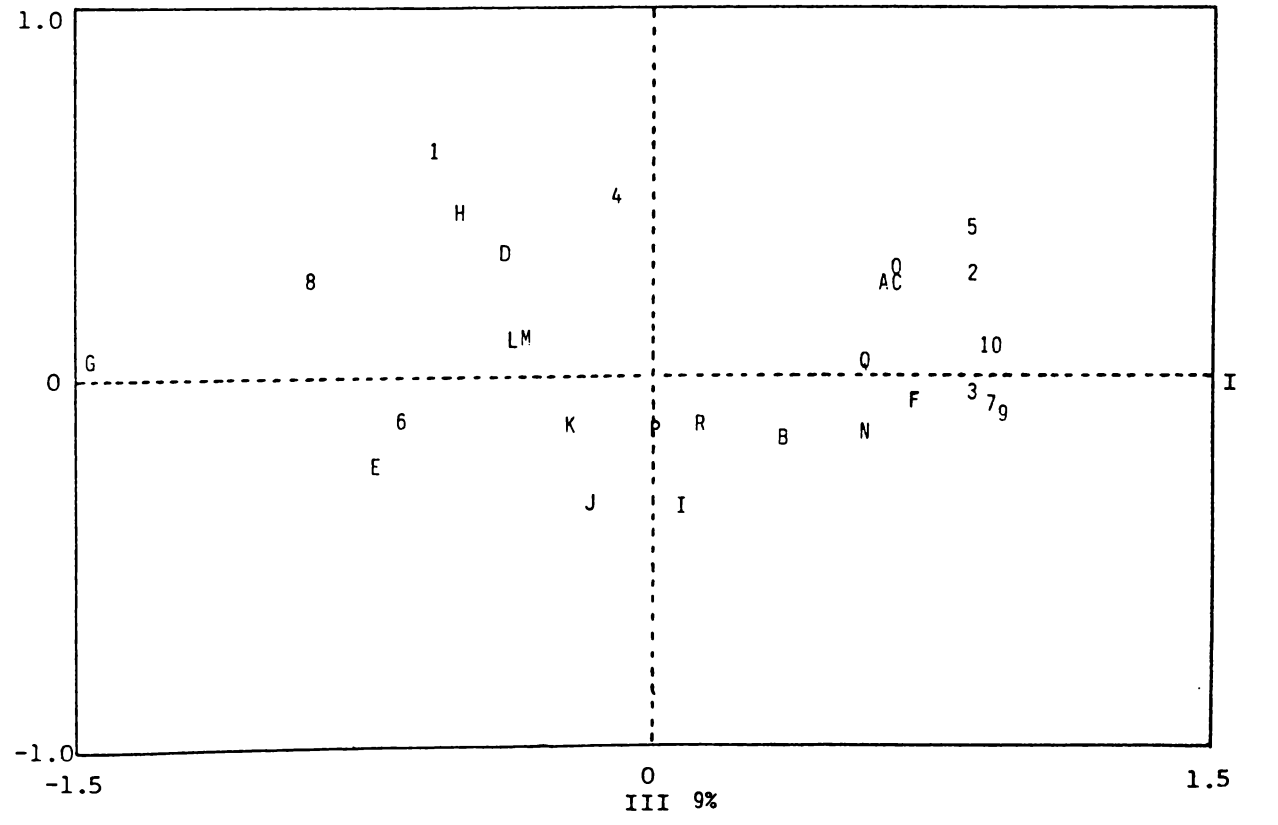


Figure 11 (Continued): **Jackie L**

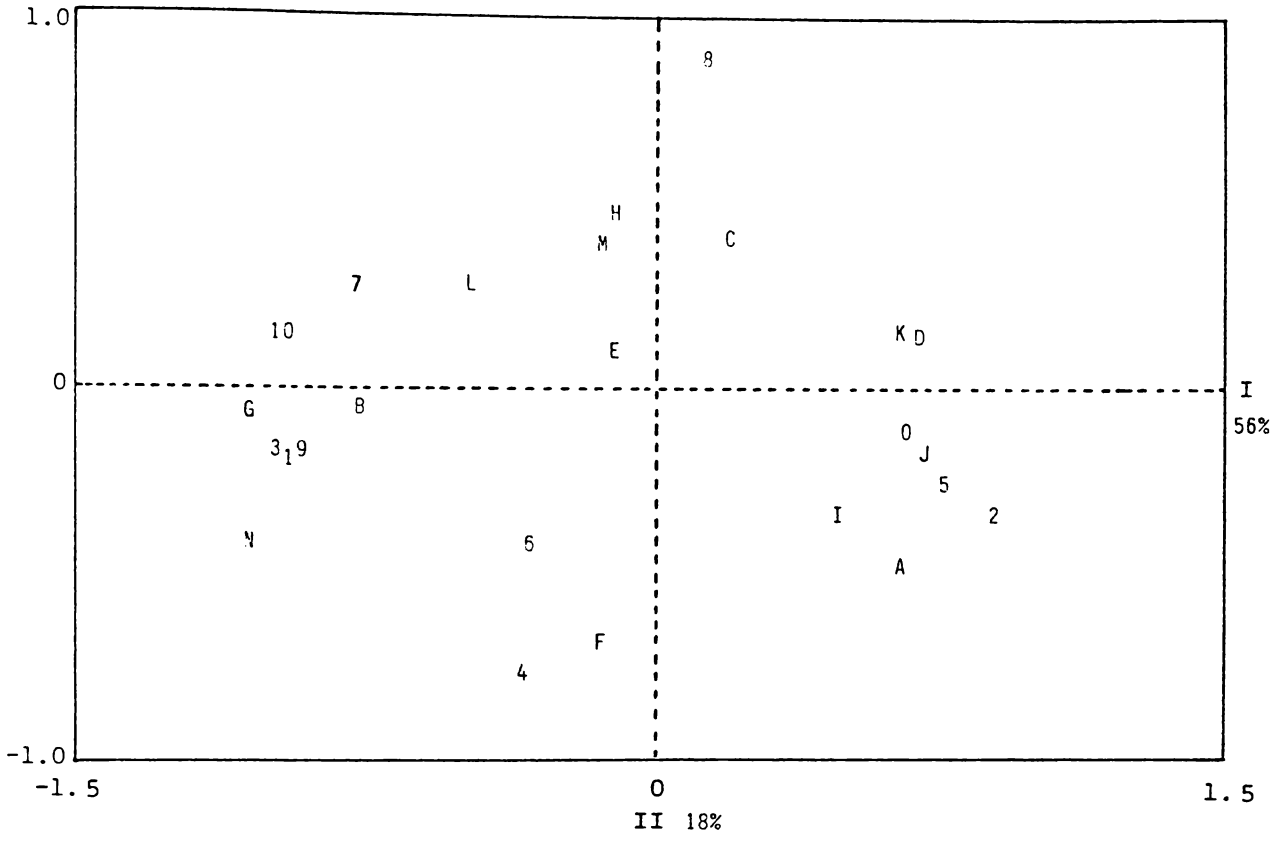
Elements

A Playing sport (tennis/netball)
B Studying English
C Working on a farm
D Working as a secretary
E Being a nurse
F Being a housewife
G Working in a factory
H Being in the navy
I Studying maths
J Studying health education
K Studying biology
L Studying chemistry
M Studying physics
N Studying Maori
O Singing
P Doing economic studies
Q Doing typing
R Studying social studies

Constructs

1 Are not important in my world
2 I find easy
3 Things I find interesting
4 Things are for males
5 What Mum finds interesting
6 I find confusing
7 Things I enjoy
8 Are not (or will not be) of use
9 Things that turn me on
10 What I am (or could be) good at

Figure 12: John



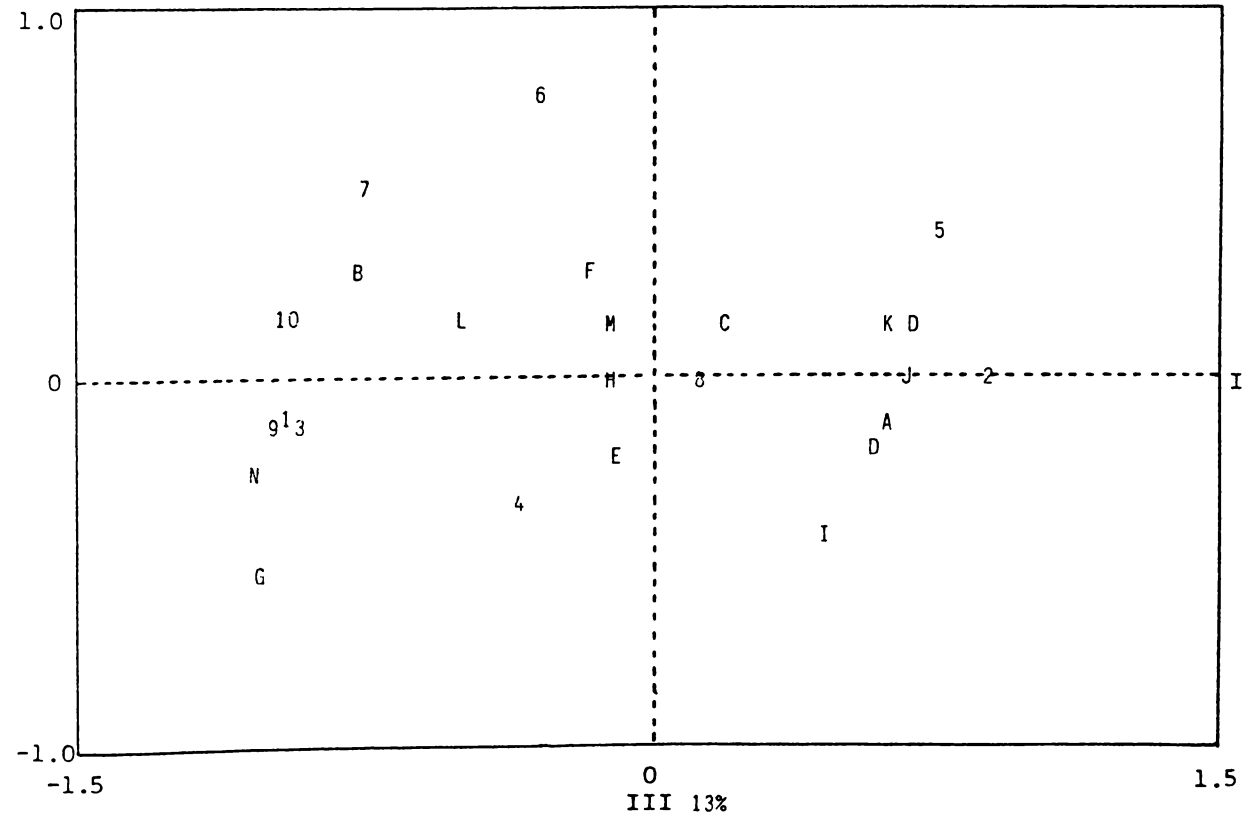


Figure 12 (Continued): **John**

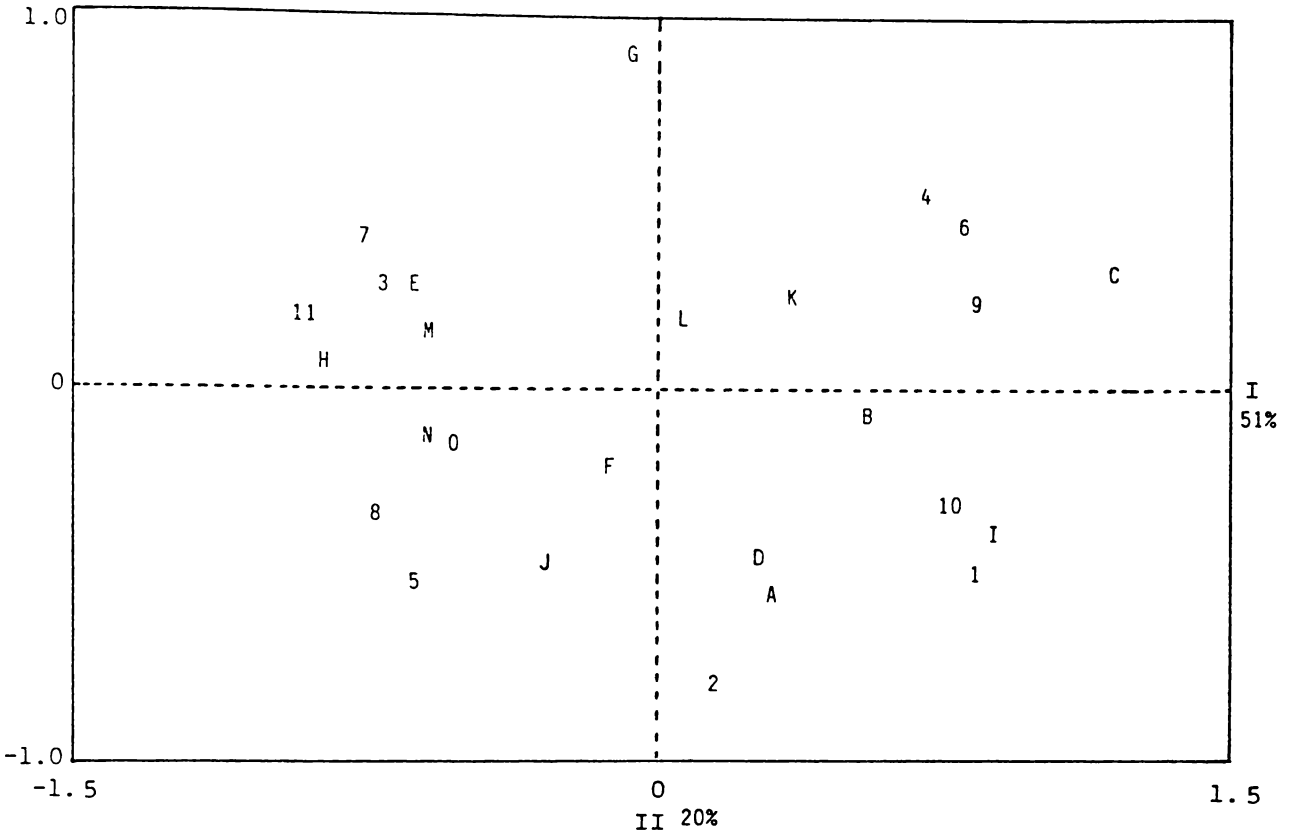
Elements

A Riding motor bikes
B Doing science
C Doing English
D Doing a carpentry job
E Going to night class
F Working with chemicals
G Doing Appi's job (i.e. sister's)
H Doing homework
I Reading comics
J Playing rugby
K Doing Dad's job
L Studying social studies
M Doing maths
N Doing a science job
O Playing the guitar

Constructs

1 I find useless
2 I find easy
3 I dislike
4 Not encouraged by my parents
5 I think is a boy's thing
6 I think are palangi (i.e. European) things
7 I find hard to understand
8 Important
9 I find boring
10 I think I am not (or won't be) good at

Figure 13: Lei



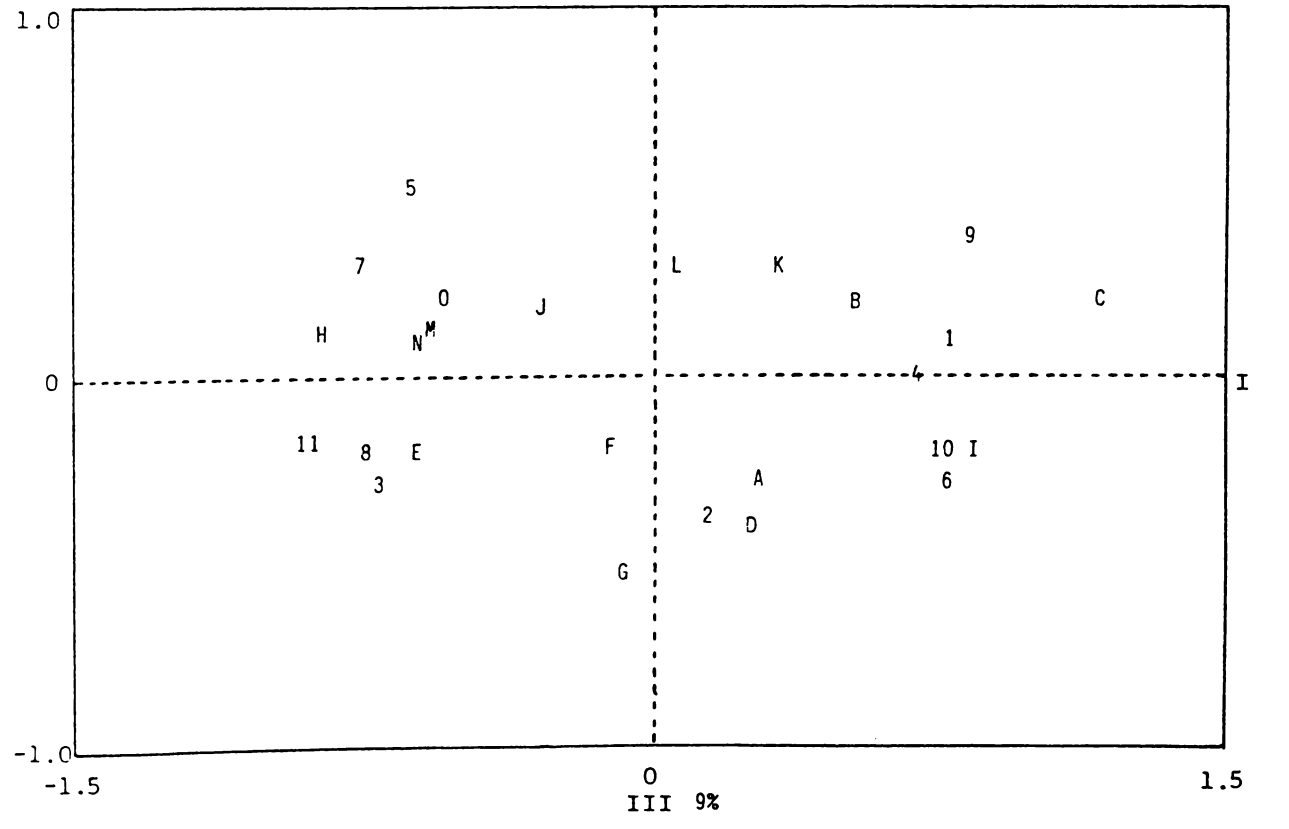


Figure 13 (Continued): **Lei**

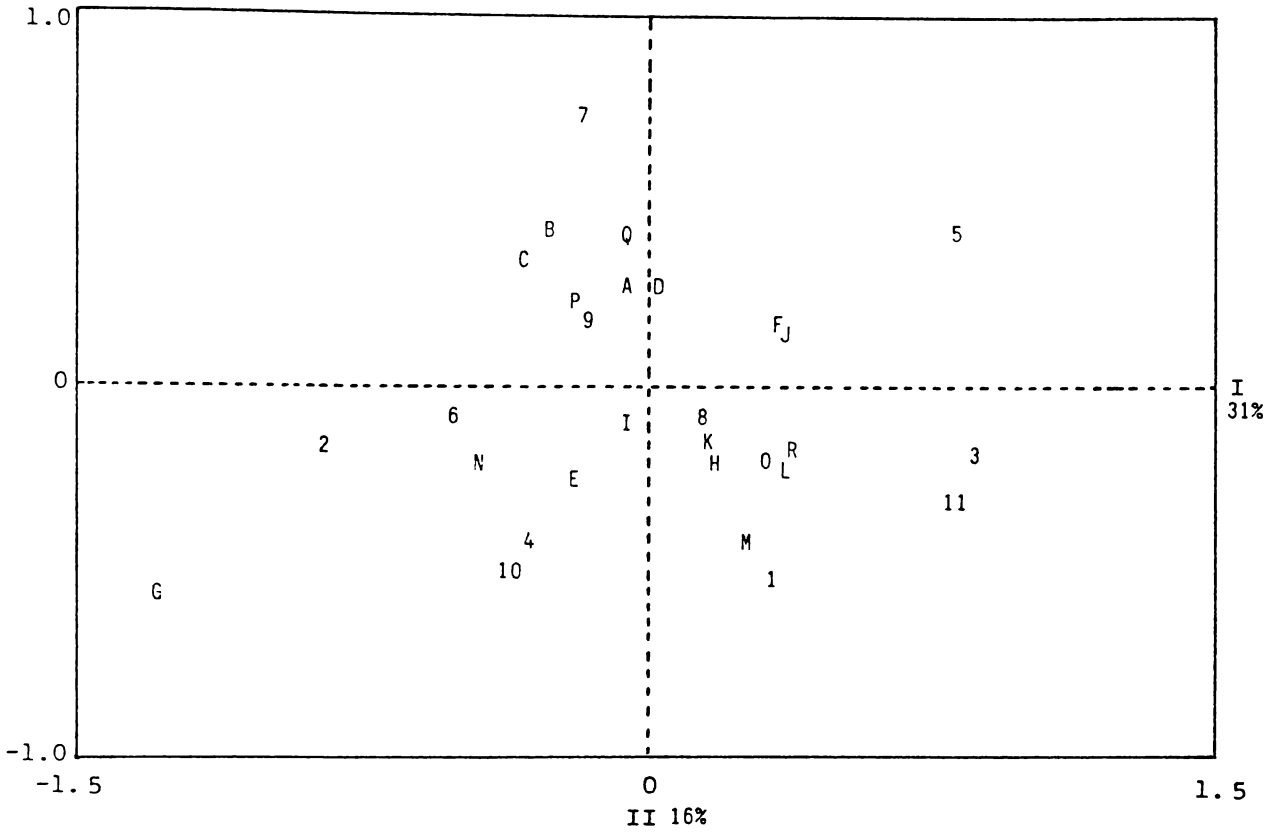
Elements

A Studying animals
B Studying physics
C Doing Dad's job
D Studying plants
E Playing a favourite sport
F Studying the human body
G Making music
H Studying English
I Studying at the Technical Institute
J Sitting School Certificate
K Working with chemicals
L Studying history
M Studying art
N Doing homework
O Doing maths

Constructs

1 I find hard to understand
2 I find boring
3 I like
4 I think is unecessary in my life
5 Things I reckon are good to know about
6 I think are unimportant
7 I think I know a lot about
8 Will be handy later on in life
9 What my parents don't (or wouldn't) encourage me to do
10 I don't get involved in
11 What I am (or could be) good at

Figure 14: Ruth



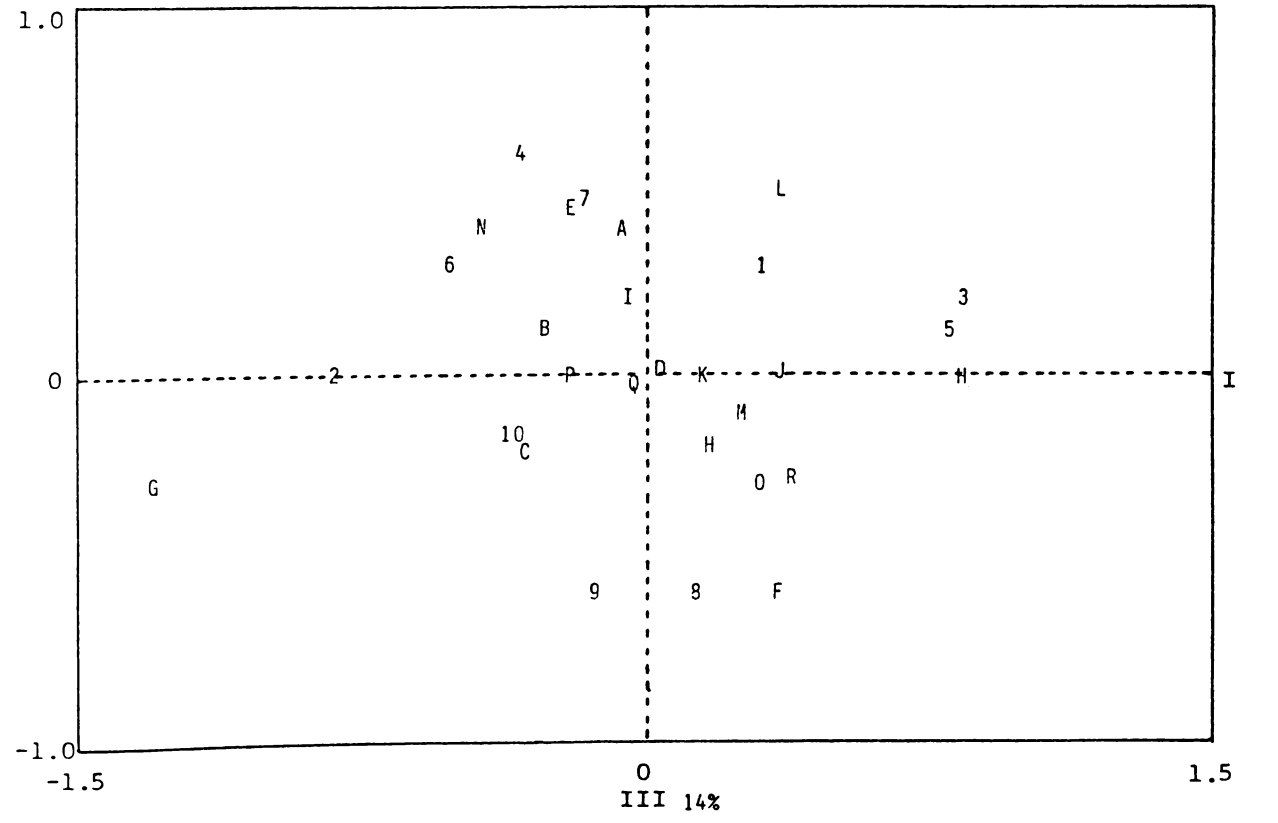


Figure 14: **Ruth**

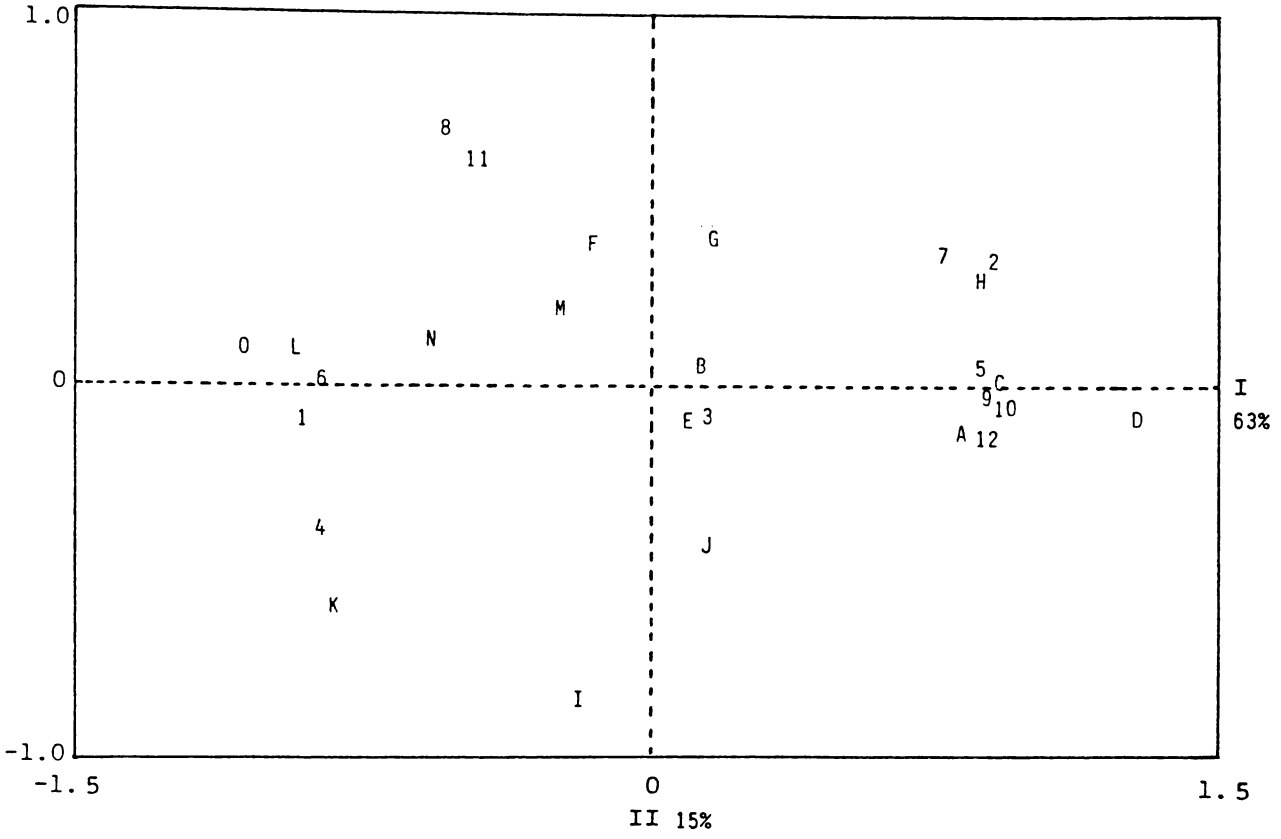
Elements

A Hairdressing job
B Studying Maori
C Doing English
D Doing typing
E Playing sport
F Working with chemicals
G Delivering pamphlets
H Being a scientist
I Doing a housewife's job
J Studying physics
K Doing Dad's job
L Air hostessing job
M Going to boarding school
N Cooking
O Studying science
P Reading a book
Q Doing maths
R Studying about animals

Constructs

1 I find easy
2 I think are unimportant
3 I like
4 Not encouraged by my parents
5 I find useful
6 Not necessary for a job
7 I think I am not (or will not be) good at
8 I think are Pakeha things
9 I think is a boy's thing
10 What we talk about at home
11 Worthwhile

Figure 15: Jackie B



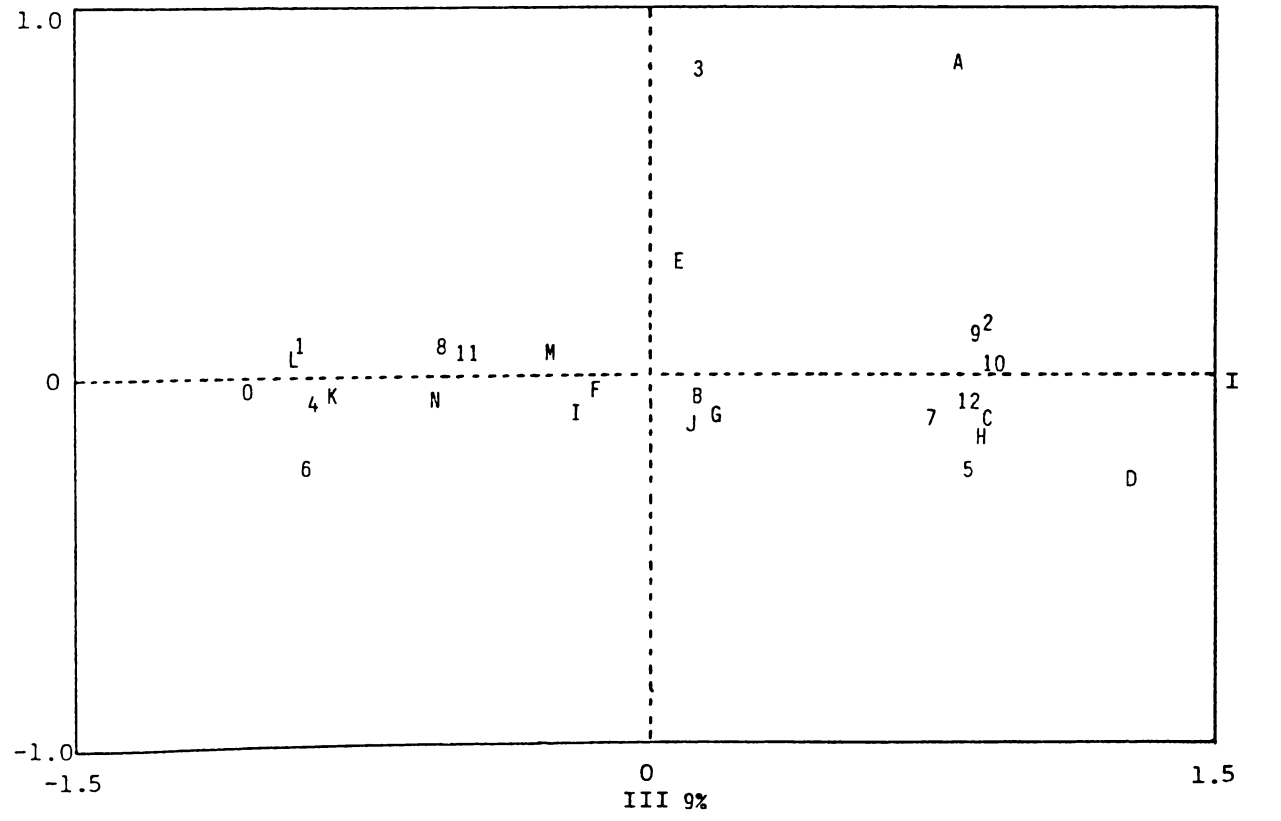


Figure 15 (Continued): **Jackie B**

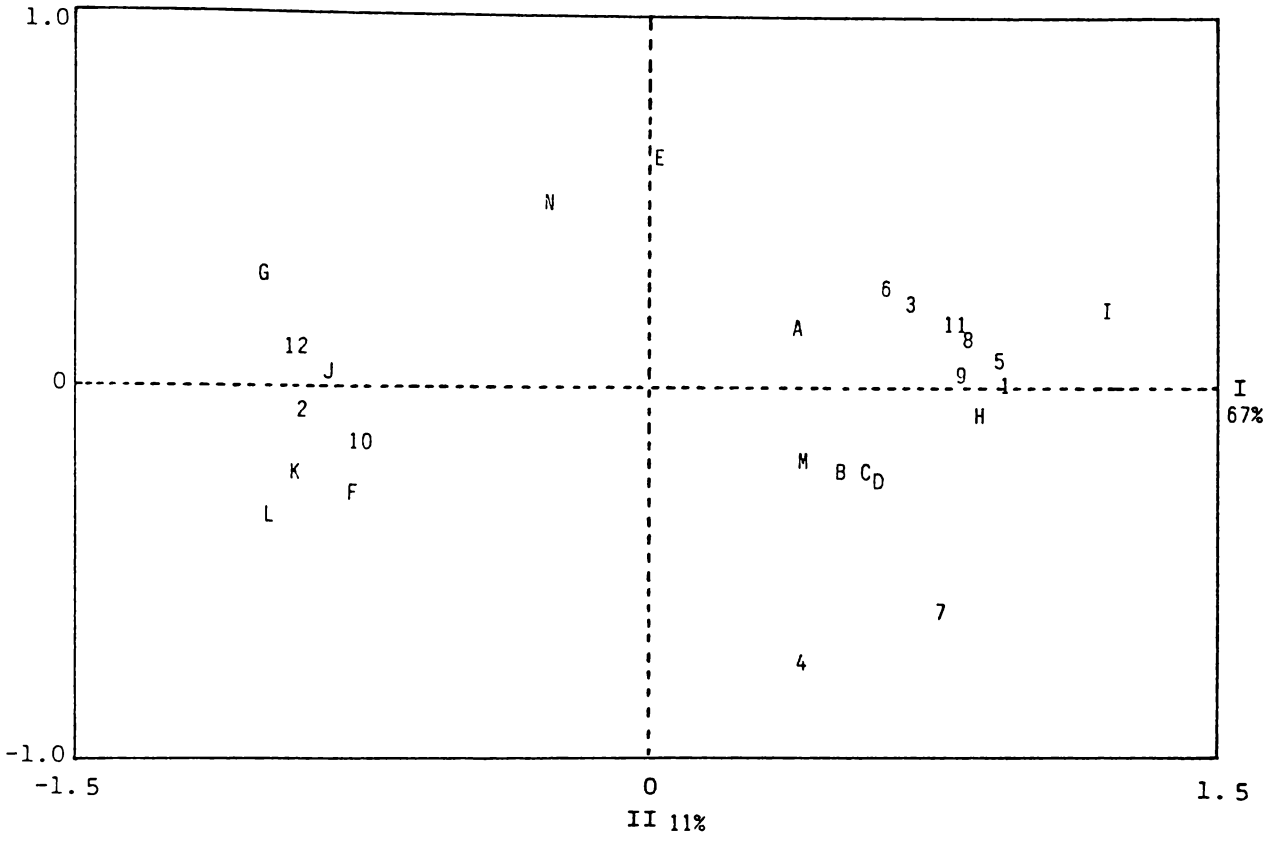
Elements

A Playing netball
B Playing indoor basketball
C Instructing marching
D Hairdressing
E Doing typing
F Studying about the human body
G Studying economic studies
H Studying English
I Coming to school
J Sitting School Certificate
K Studying maths
L Studying plants
M Doing science experiments
N Studying animals
O Studying electricity

Constructs

1 I think are important
2 I find interesting
3 I think is a woman's thing
4 I dislike
5 I find useful
6 I find hard
7 I find exciting
8 I don't talk about with my parents
9 I find easy to understand
10 I think is necessary
11 What we don't talk about with friends
12 Is encouraged by my family

Figure 16: Susan



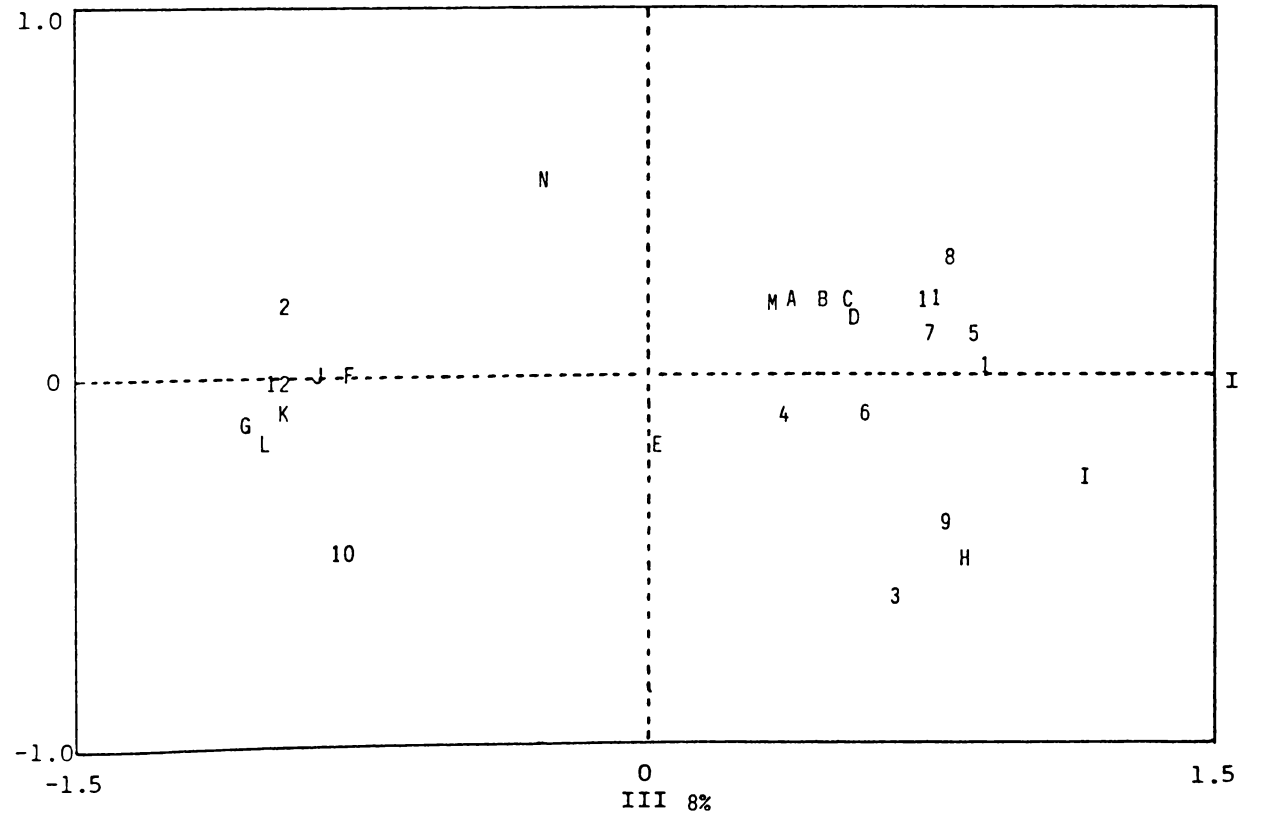


Figure 16 (Continued): **Susan**

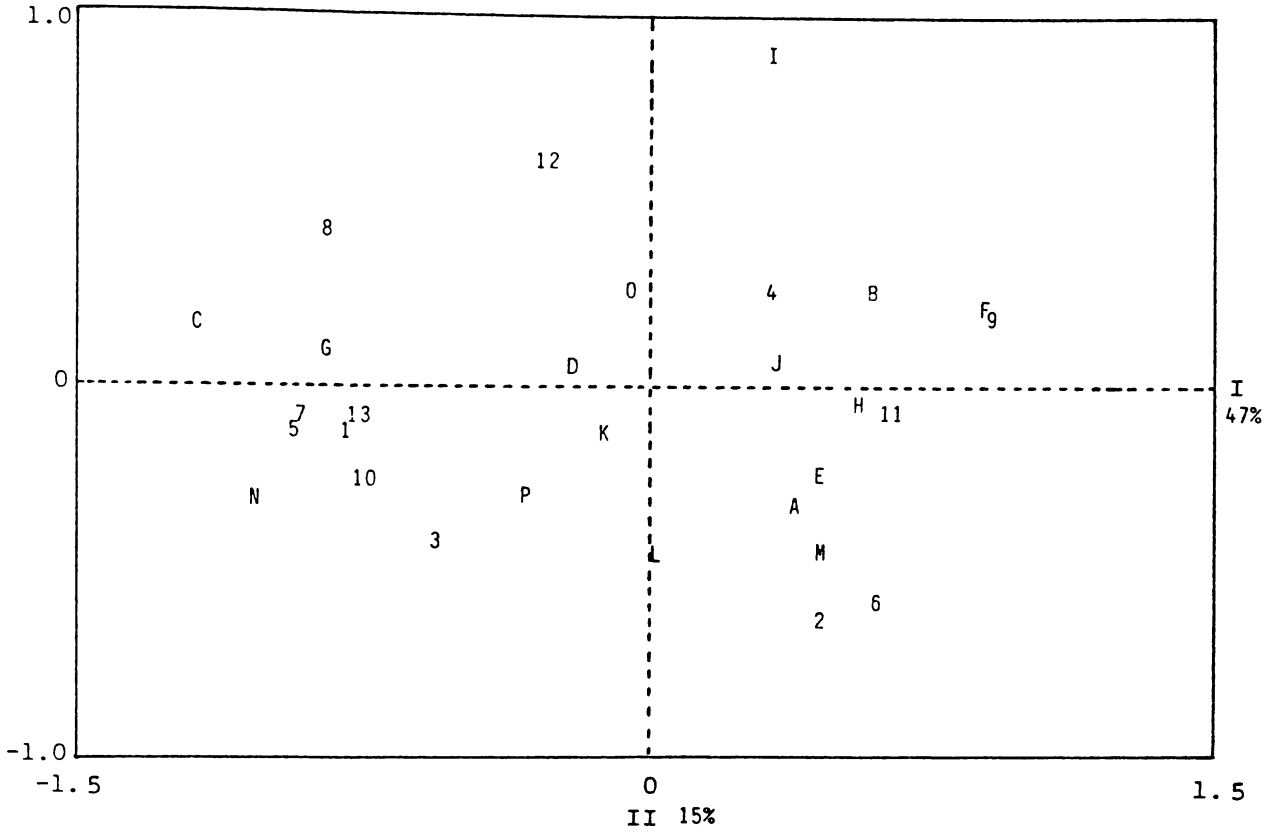
Elements

A Studying about plants
B Studying about insects
C Studying about spiders
D Doing science experiments
E Working in a factory
F Doing maths
G Reading a book
H Watching science programmes on TV
I Being a scientist
J Doing spelling
K Going to High School
L Playing netball
M Studying about space
N Coming to school

Constructs

1 I find hard
2 I find interesting
3 I think are unimportant
4 What Dad is not interested in
5 What we don't talk about at home
6 I think is a boy's thing
7 What doesn't interest Mum
8 What I don't talk to my friends about
9 What I don't want to know much about
10 I find neat
11 I don't like doing
12 I think I am (or will be) good at

Figure 17: Wayne



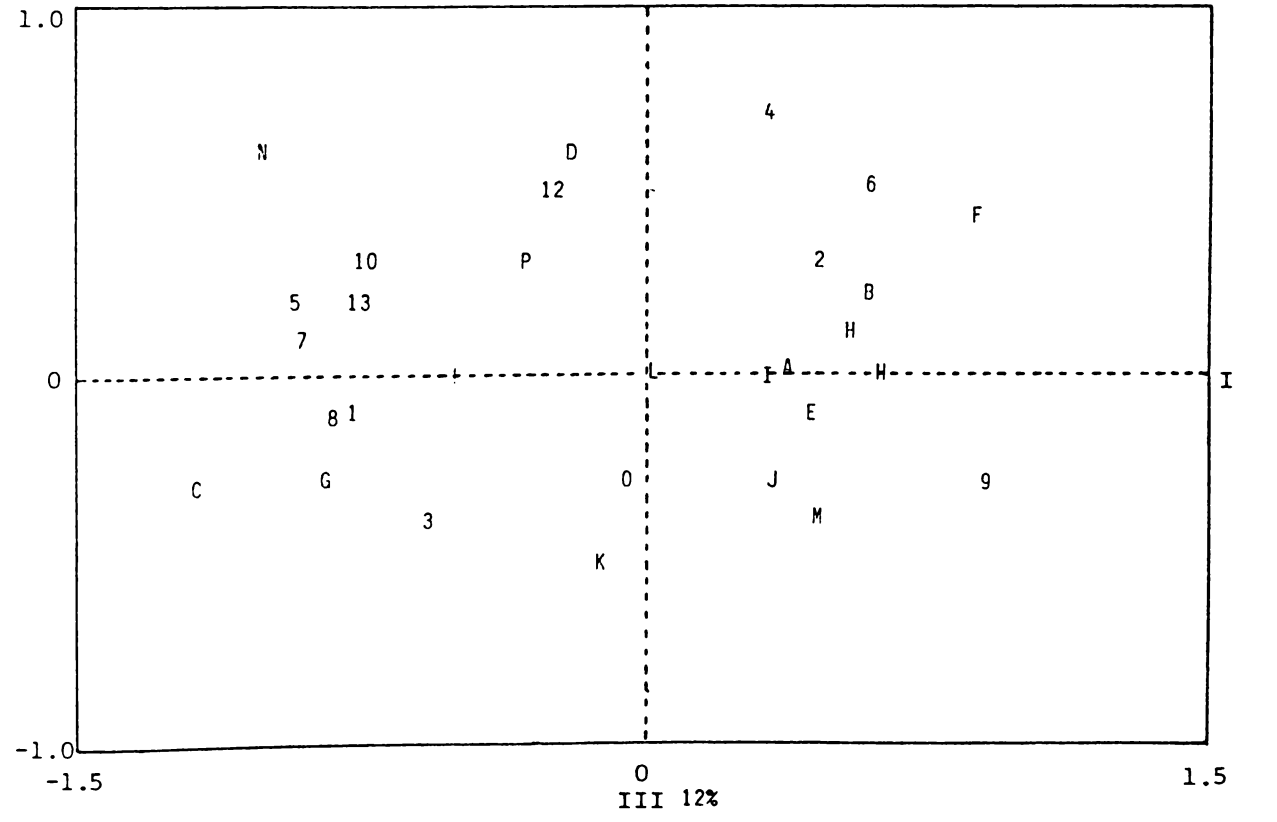


Figure 17 (Continued): **Wayne**

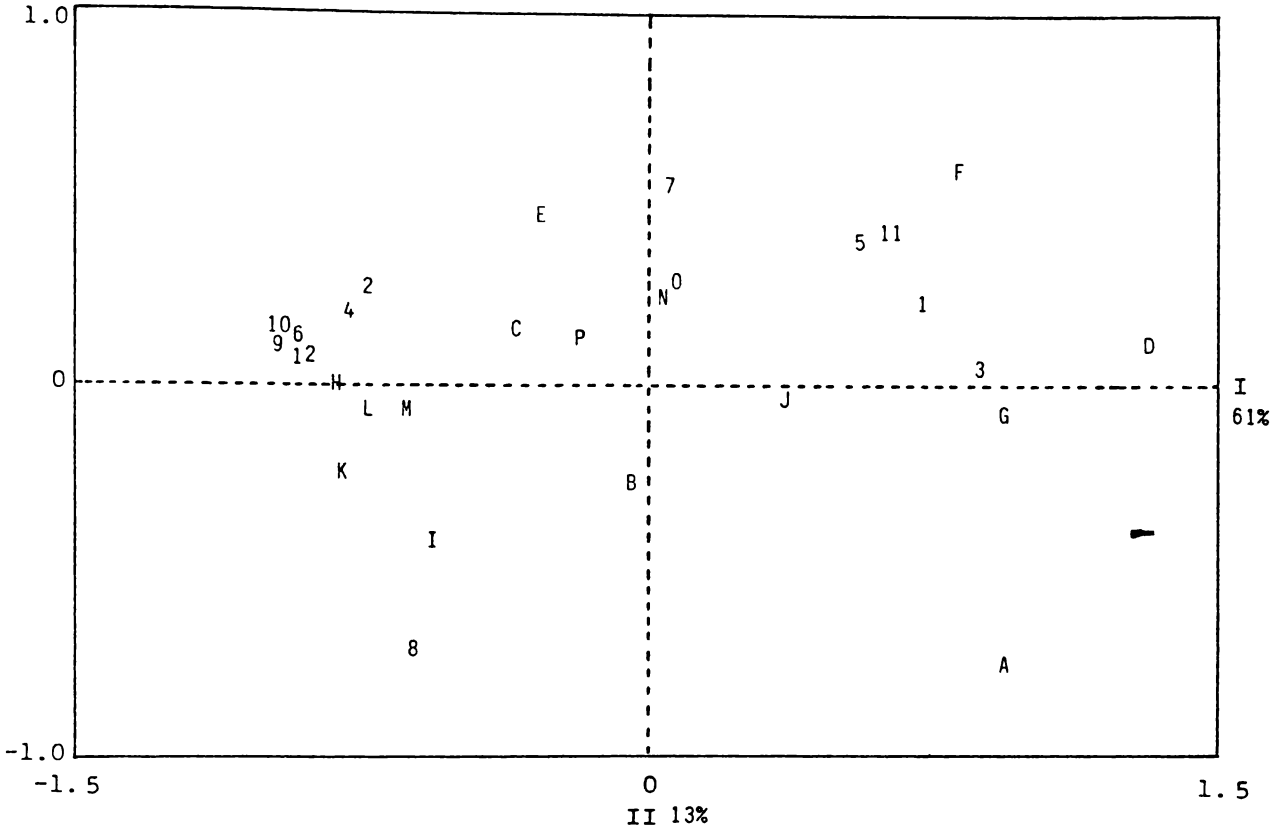
Elements

A Reading a book
B Doing woodwork
C Doing science
D Attending scouts
E Doing physical education
F Doing metalwork
G Doing language
H Doing maths
I Being an engineer
J Doing social studies
K Doing spelling
L Doing art
M Playing sport
N Doing music
O Going to High School
P Coming to Intermediate School

Constructs

1 I dislike doing
2 I know a lot about
3 I think is a girl's thing
4 What Dad knows a lot about
5 I think are unimportant
6 I find easy
7 What my parents think is unimportant
8 I am no good at
9 I do need to know a lot about
10 What we don't talk about at home
11 What I talk about with my friends
12 What Mum is not interested in
13 What Dad is not interested in

Figure 18: Murphy



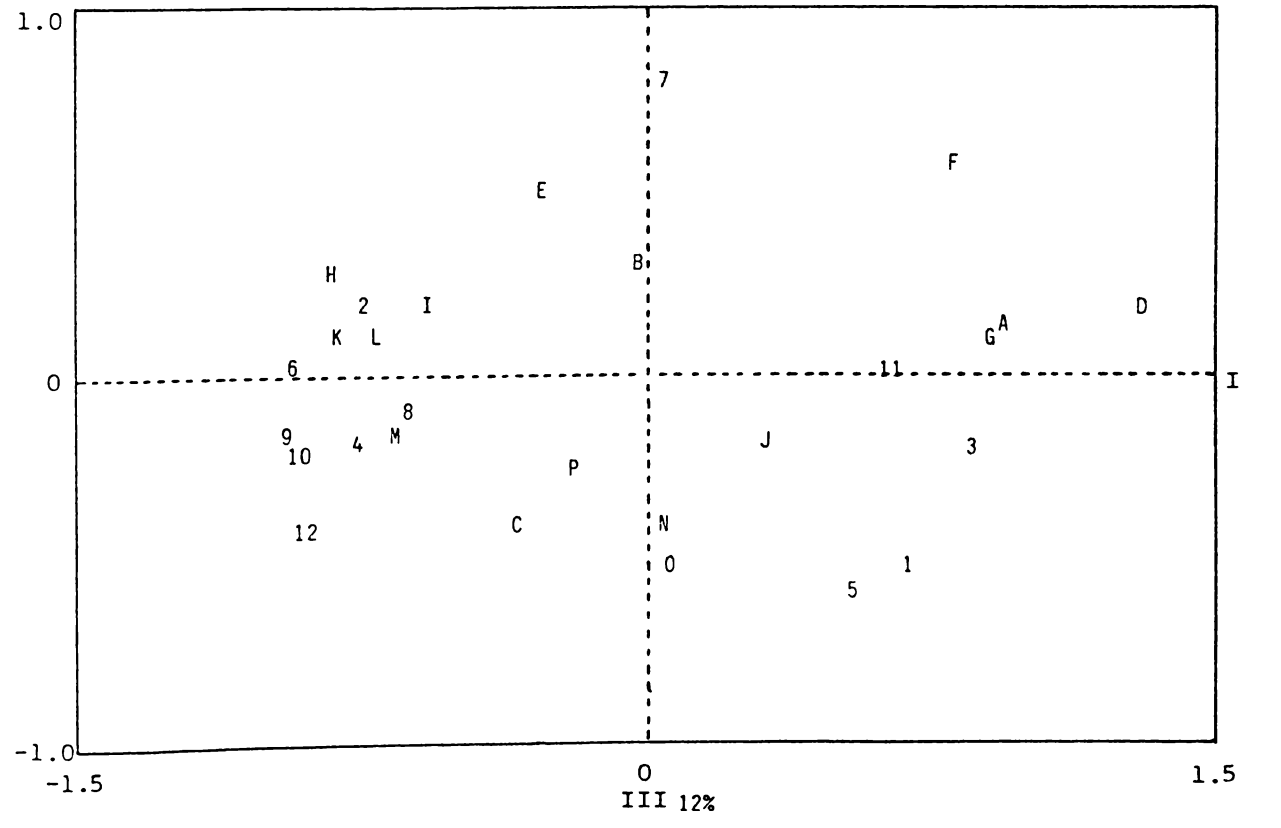


Figure 18 (Continued) **Murphy**

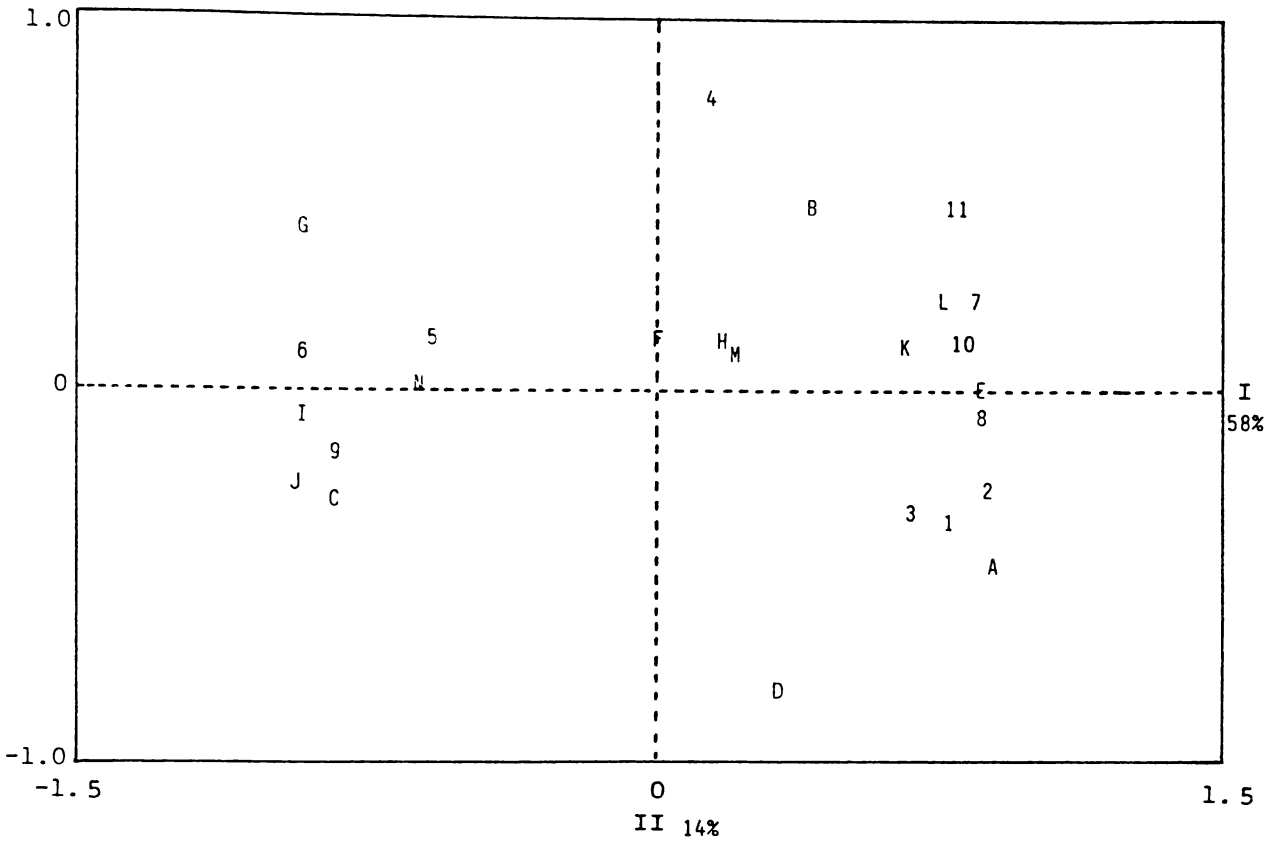
Elements

A Watching TV
B Doing woodwork
C Studying science
D Working as a post office clerk
E Being a lawyer
F Working as a mechanic
G Modelling aeroplanes
H Doing environmental studies
I Playing sports (e.g. golf)
J Being a doctor
K Studying maths
L Studying social studies
M Studying English
N Studying physics
O Studying chemistry
P Studying biology

Elements

1 Things I dislike
2 Is necessary in my life
3 Things I find boring
4 Things that do (or will) help me in my life
5 I'm not confident with
6 What I am (or could be) good at
7 Things I think are for males
8 I know a lot about
9 Things that are important
10 Are encouraged by my parents
11 I find hard
12 Useful for a job

Figure 19: Sandra (a)



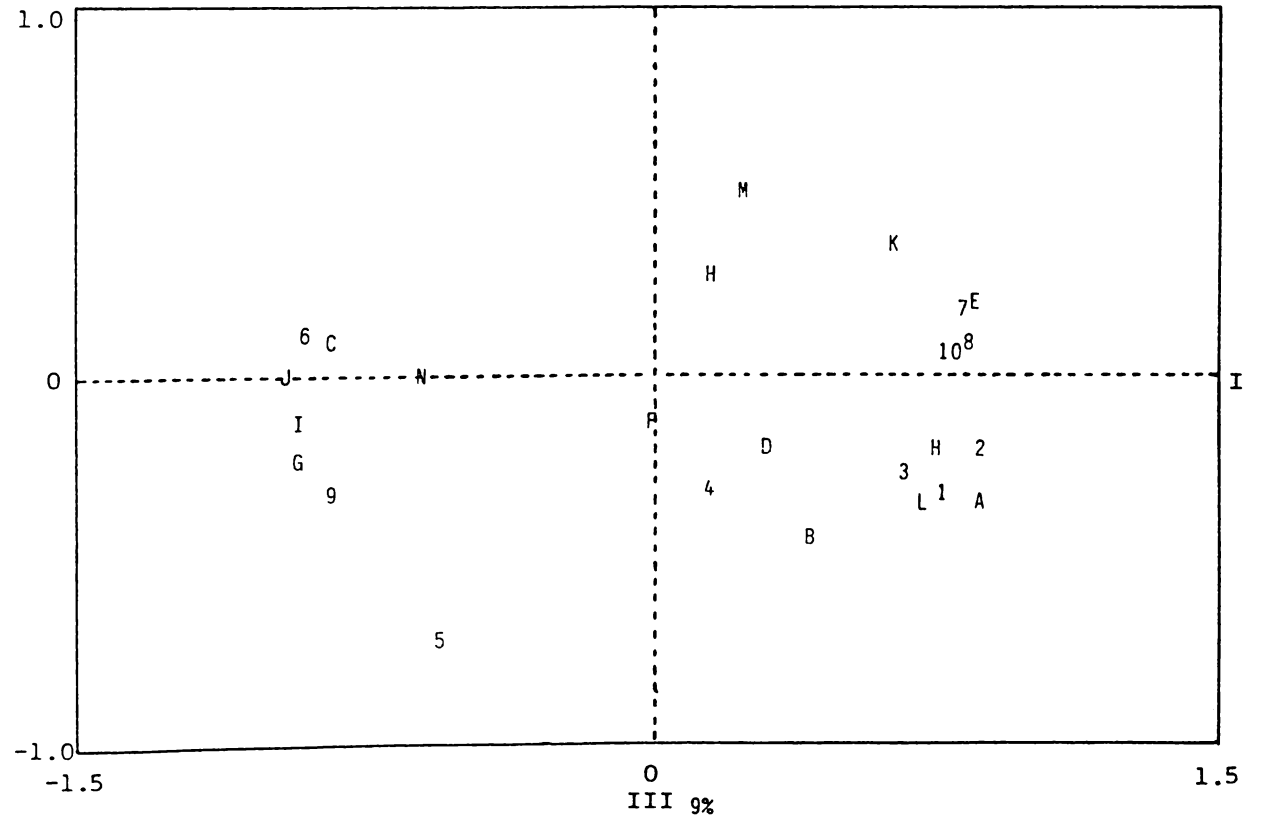


Figure 19 (Continued): **Sandra (a)**

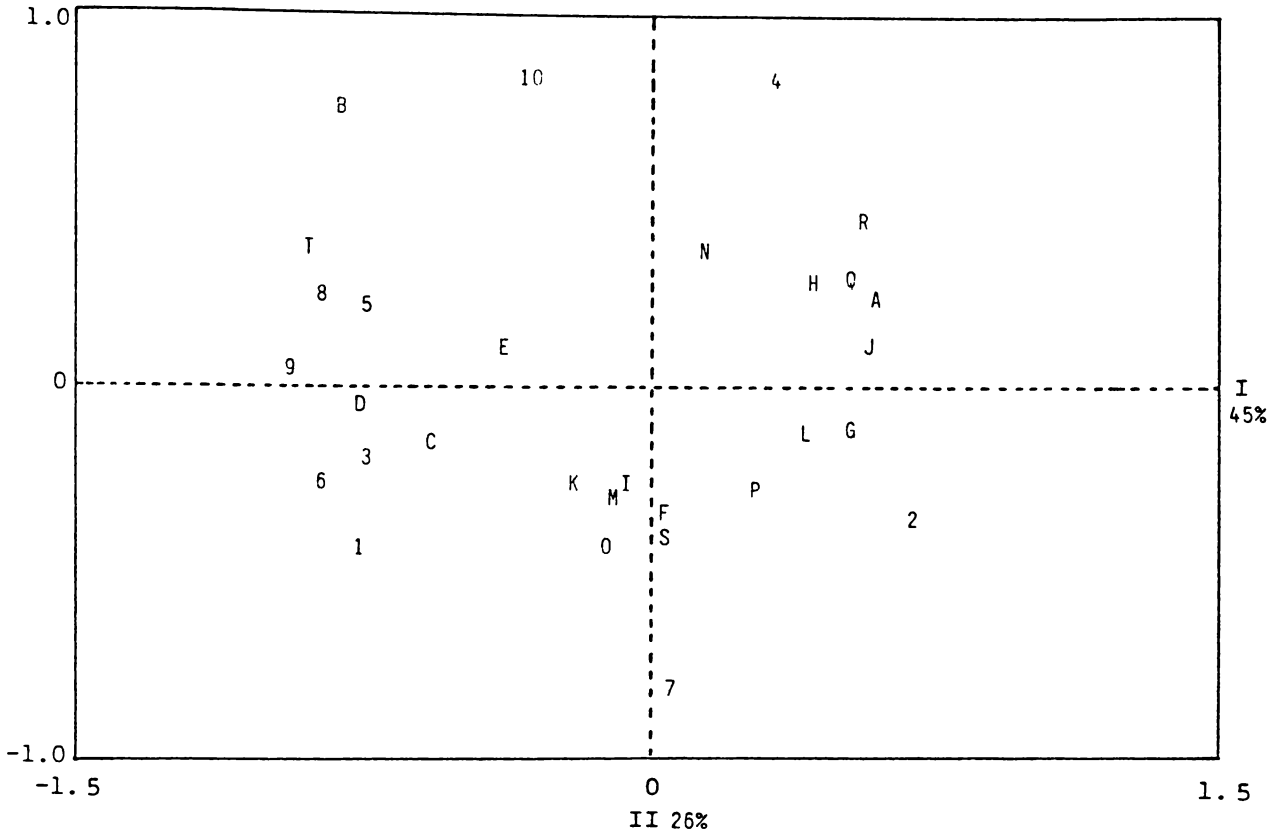
Elements

A Studying maths
B Studying about plants
C Learning Maori
D Reading science books
E Studying about insects
F Studying about animals
G Doing cooking
H Playing sport
I Doing typing
J Coming to High School
K Watching science programmes on TV
L Working with chemicals
M Working in the science lab
N Doing science experiments

Constructs

1 I dislike
2 I find boring (i.e. I don't find exciting)
3 I find hard
4 Needs no patience
5 I think is alright
6 Easy to understand
7 Is very unhelpful
8 Boring (i.e. is not lots of fun)
9 Useful for jobs
10 Don't talk about at home
11 I think is unimportant

Figure 20: Sandra (b)



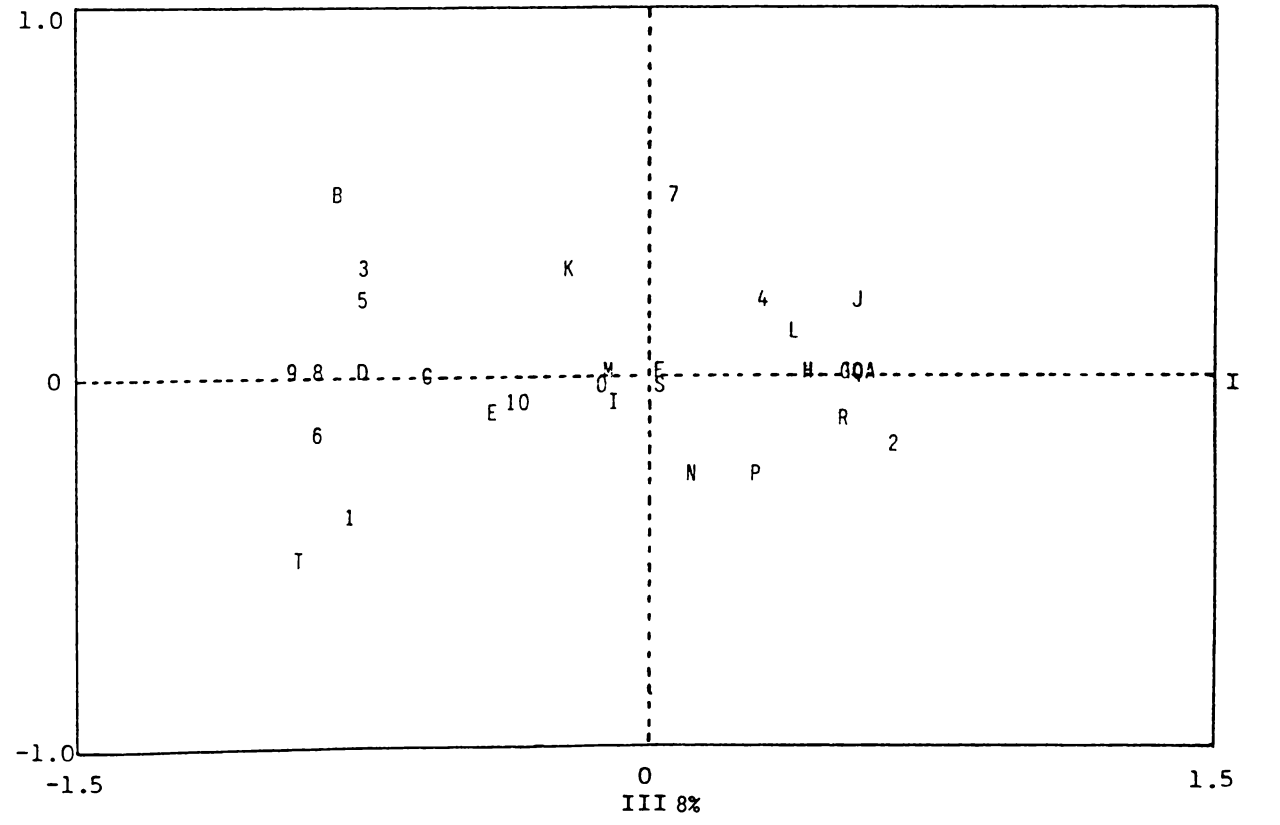


Figure 20 (Continued): **Sandra (b)**

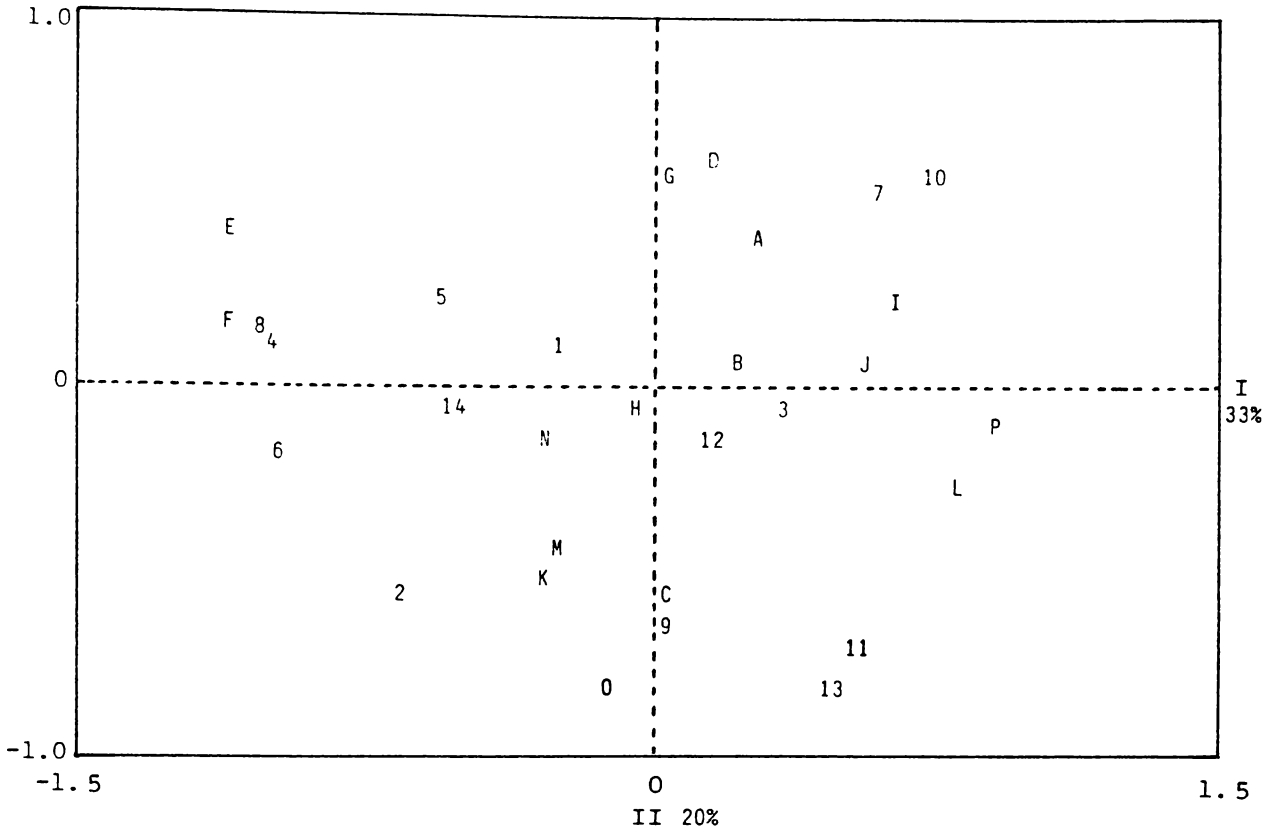
Elements - people

A Mum
B Myself
C Secretary
D Driver
E Shop keeper
F My economics teacher
G My tutor teacher
H Toki (brother)
I My physical education teacher
J Dad
K Scientist
L My Maori teacher
M My science teacher
N Air hostess
O My maths teacher
P My typing teacher
Q Mihi (sister)
R Herata (friend)
S My social studies teacher
T Housewife

Constructs

1 I think are unimportant
2 I think are patient
3 I think are not like me (i.e. are not nice to know)
4 I think are like me (i.e. are not unlike me)
5 People who don't (or wouldn't) listen to me
6 Are boring
7 Are masculine
8 Are not helpful
9 I dislike
10 I think are dumb

Figure 21: Aroha



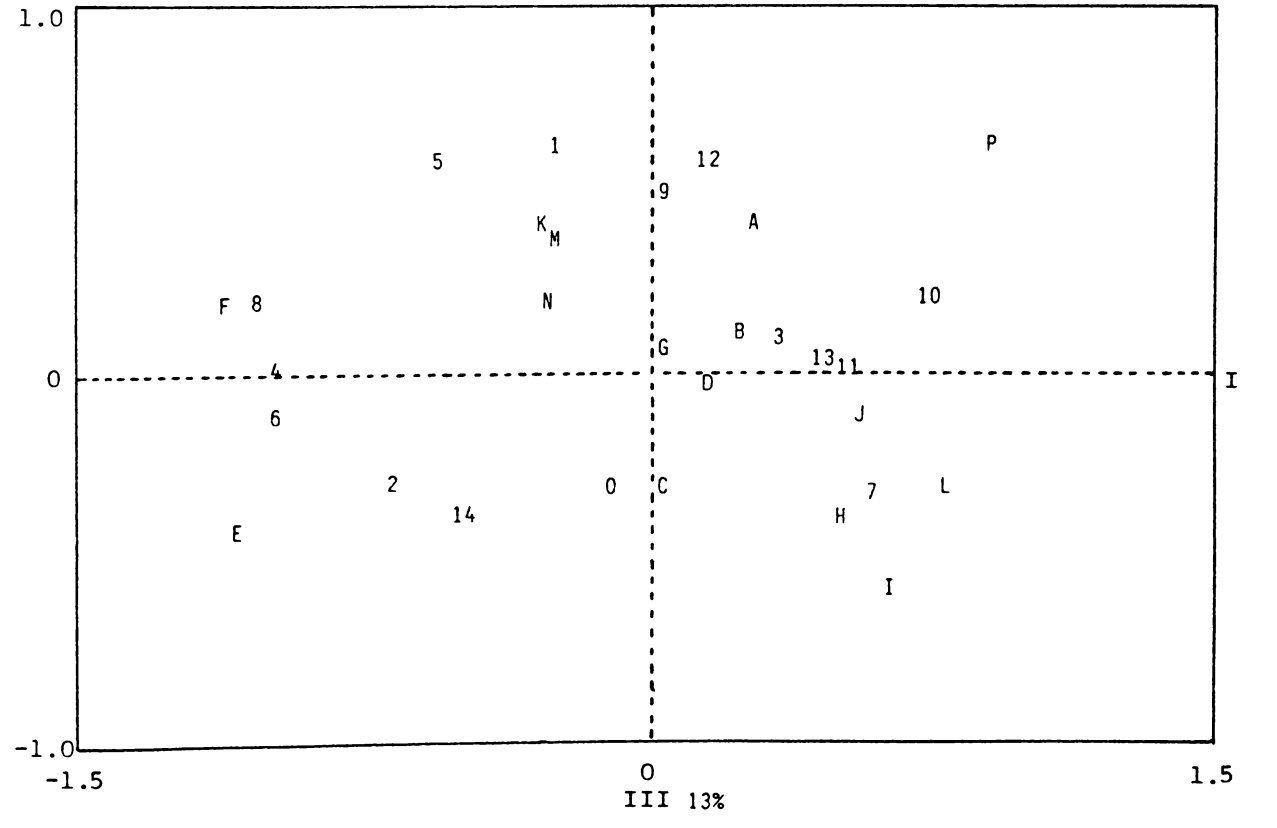


Figure 21 (Continued): **Aroha**

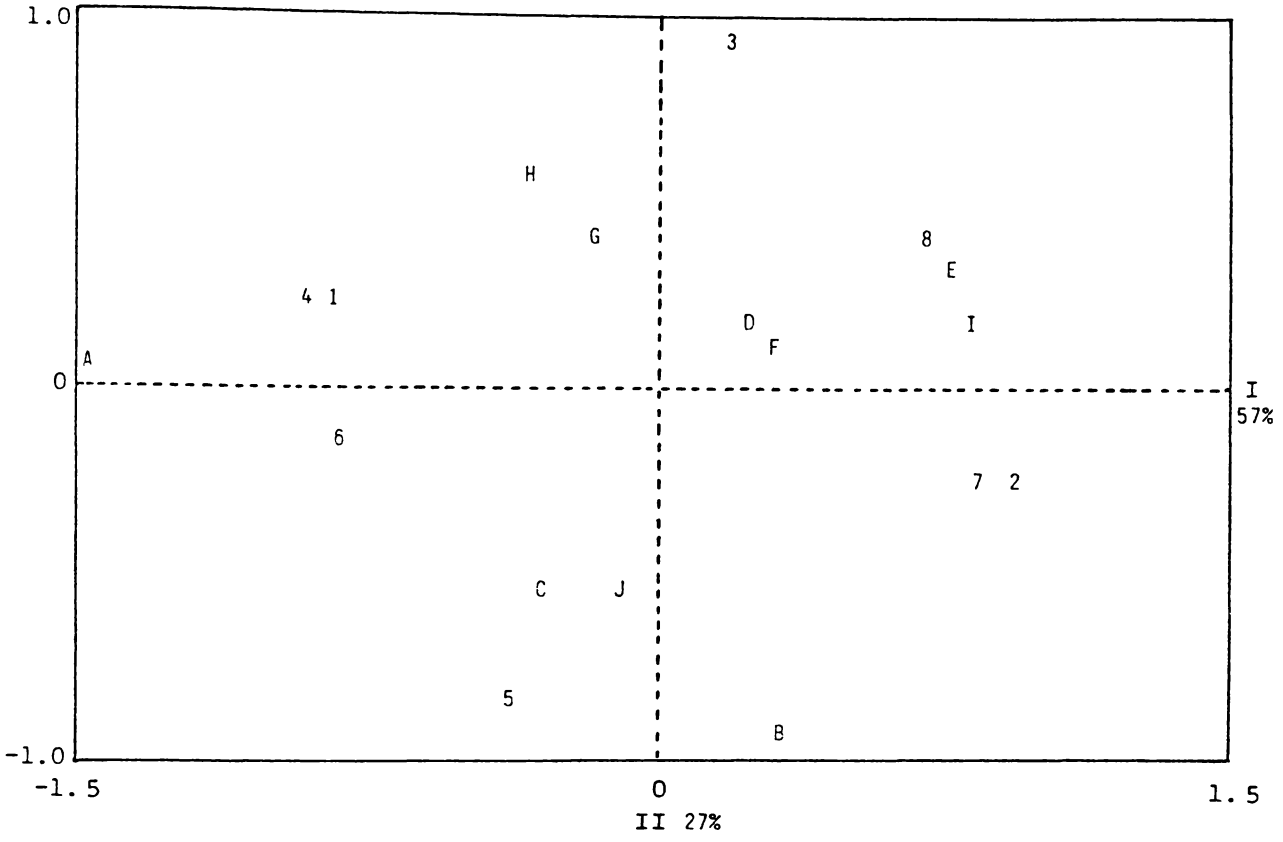
Elements

A Studying physics
B Studying chemistry
C Studying biology
D Working as an architect
E Studying engineering
F Studying woodwork
G Studying technical drawing
H The school system
I Studying English
J Studying maths
K Working as a teacher
L Studying Maori
M Studying art
N Playing sport
O Doing craftwork
P Religion

Constructs

1 Obscure - difficult
2 Things I feel I do not need to know much about
3 Things I find interesting
4 Things that do not (or will not) help me in my life
5 Things that challenge me
6 Things that are not encouraged by my parents
7 Do contribute to an understanding of my own environment
8 What I am not (or will not be) good at
9 Contributes to out (Maori) culture
10 Things that are important
11 Things that most people think are feminine
12 Important from a religious viewpoint
13 Things that I consider are feminine
14 Things that do not help when relating to others

Figure 22: Mihi



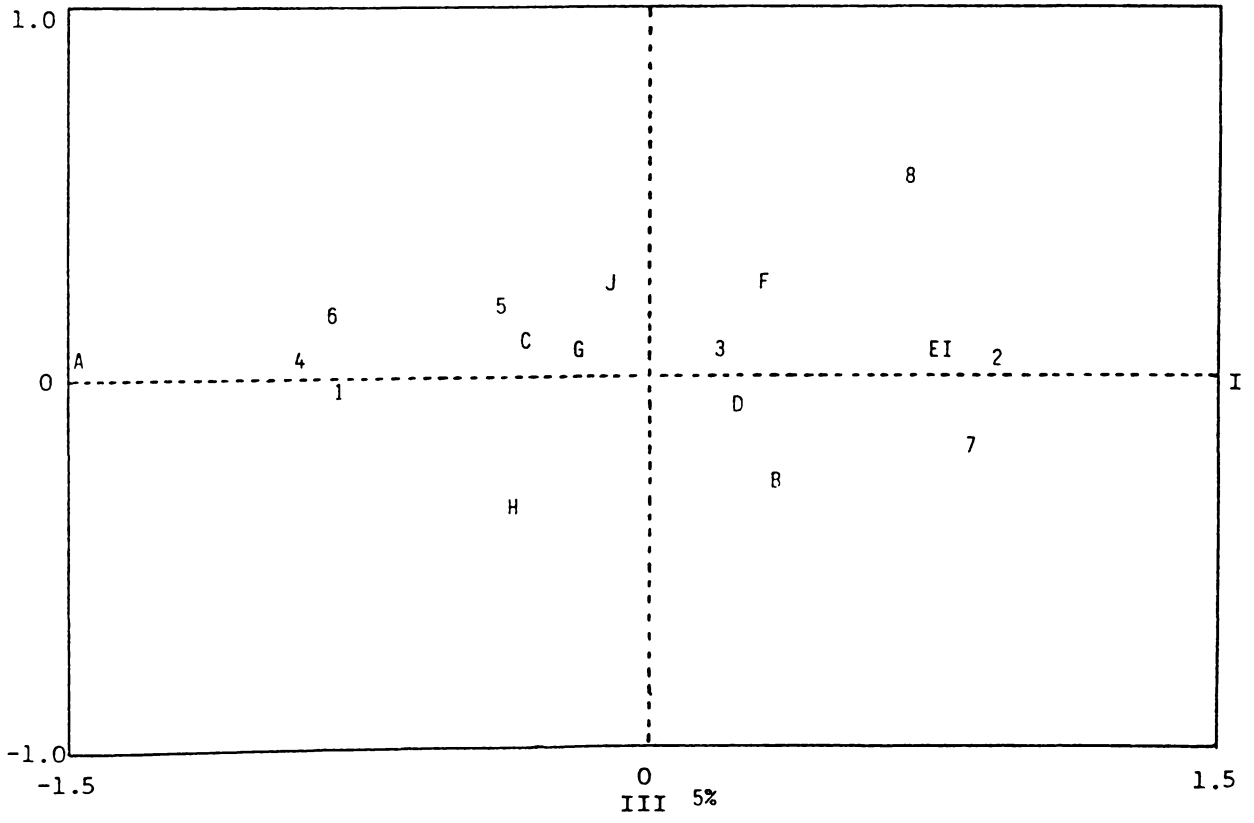


Figure 22 (Continued): **Mihi**

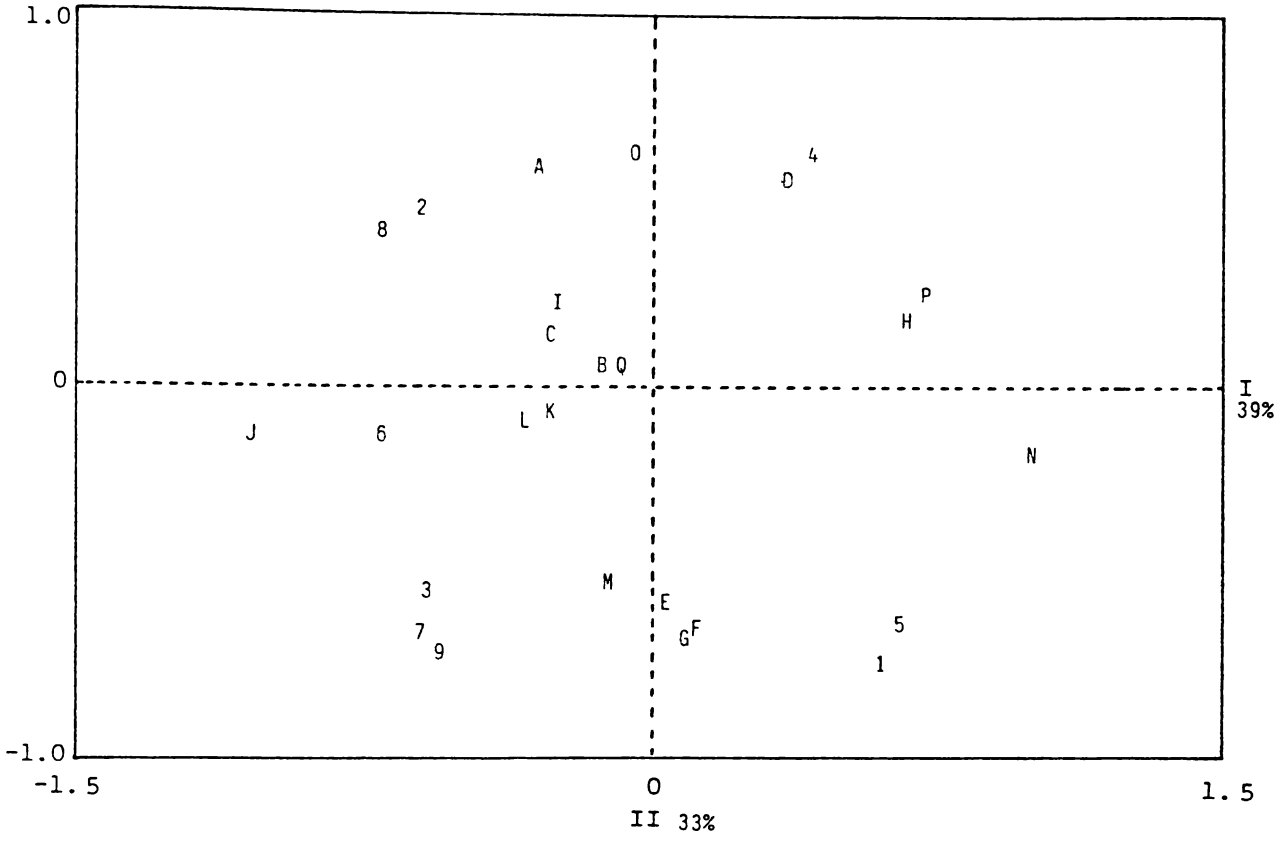
Elements

A Science writing
B Playing sport
C Doing science experiments
D Doing maths
E Lawyer job
F School
G Doing typing
H A teaching job
I Studying German
J Studying economic studies

Constructs

1 I find boring
2 I think are important
3 I find hard
4 Is unenjoyable
5 Needs no concentration
6 Is a waste of time
7 I find neat
8 Is necessary

Figure 23: Maurice



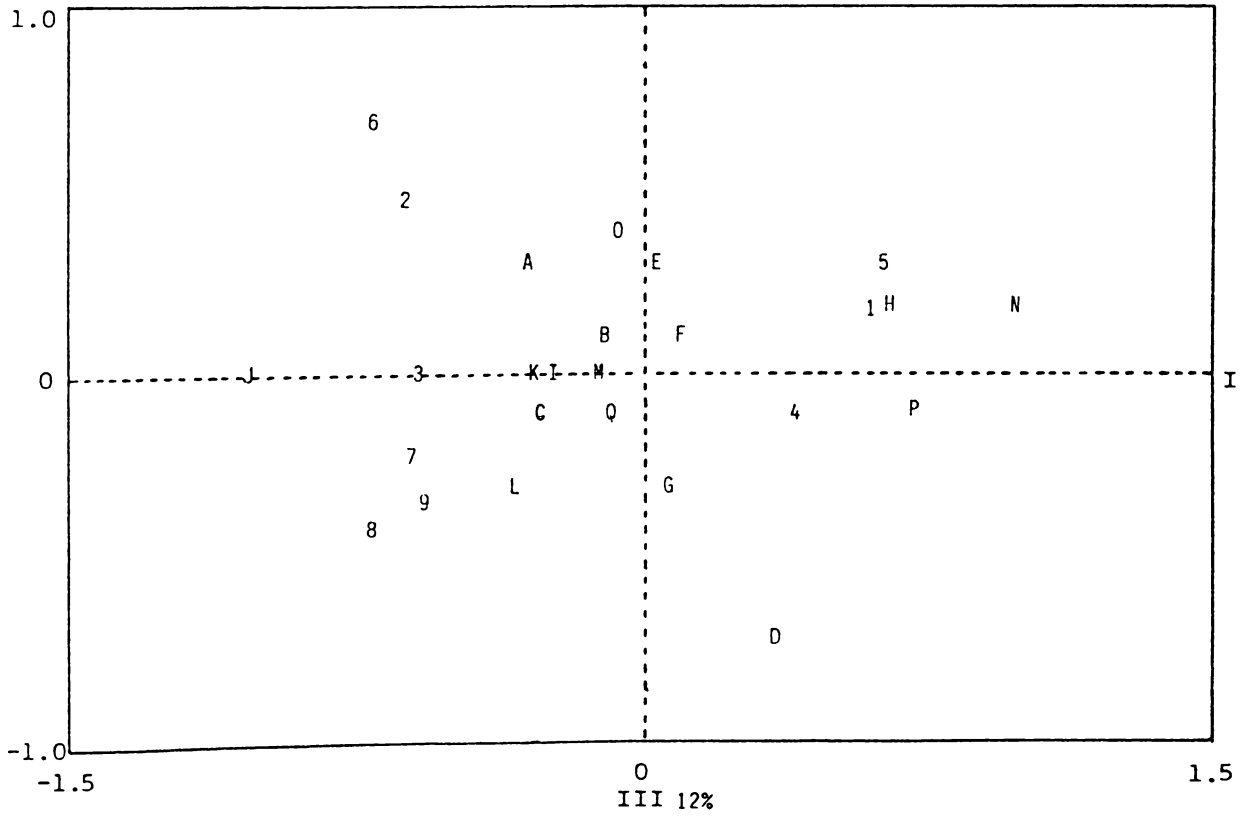


Figure 23 (Continued): **Maurice**

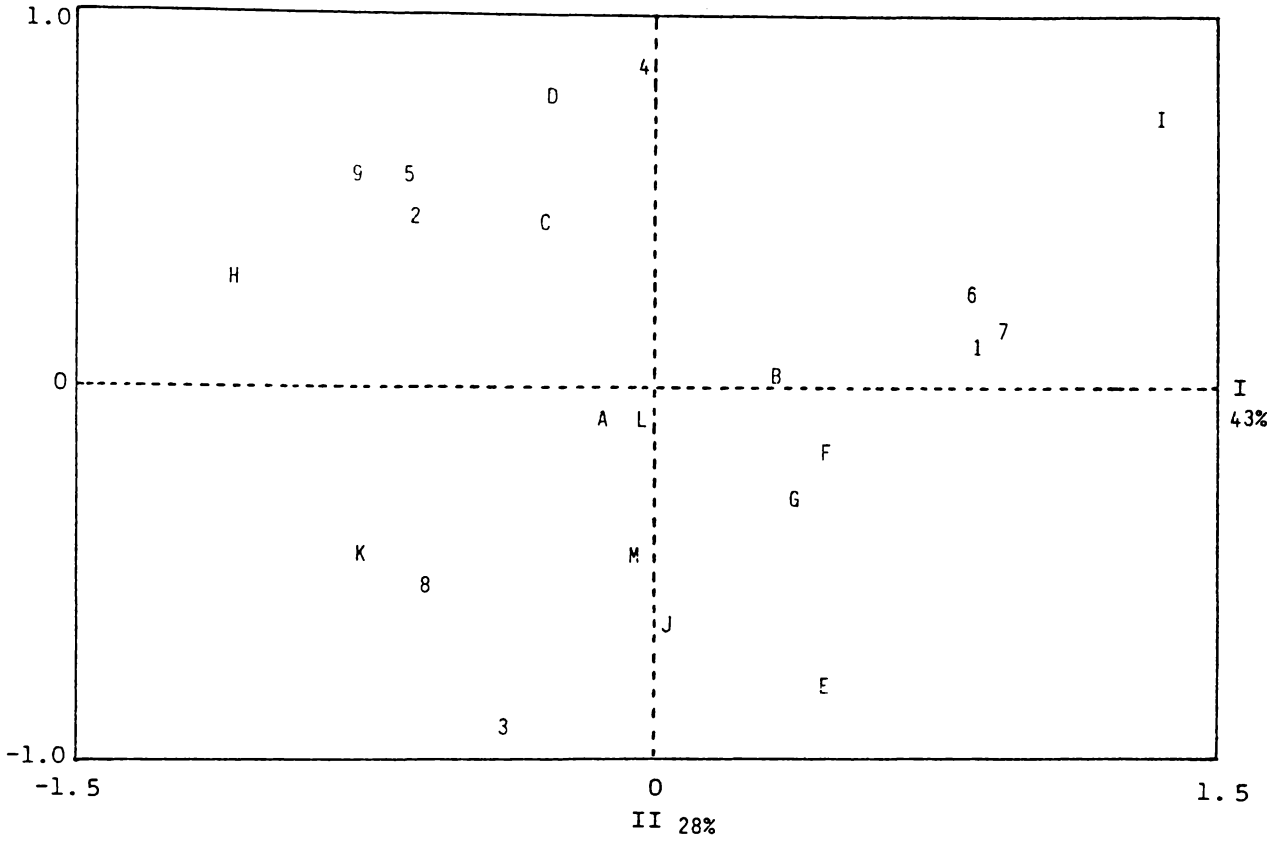
Elements

A Playing basketball or rugby
B Studying physics
C Doing science experiments
D Being a pilot
E Studying plants
F Studying animals
G Being a carpenter
H Studying English
I Studying social studies
J Watching TV
K Working with chemicals
L Drawing diagrams
M Studying art
N Doing homework
O Doing maths
P Studying German
Q Helping Dad with the car

Constructs

1 I dislike
2 What I am (or would be) good at
3 I think are unimportant
4 I find useful
5 I find boring
6 I find easy
7 I don't need to know about
8 I think are pretty good
9 What my parents wouldn't (or don't) encourage me to do

Figure 24: Russell



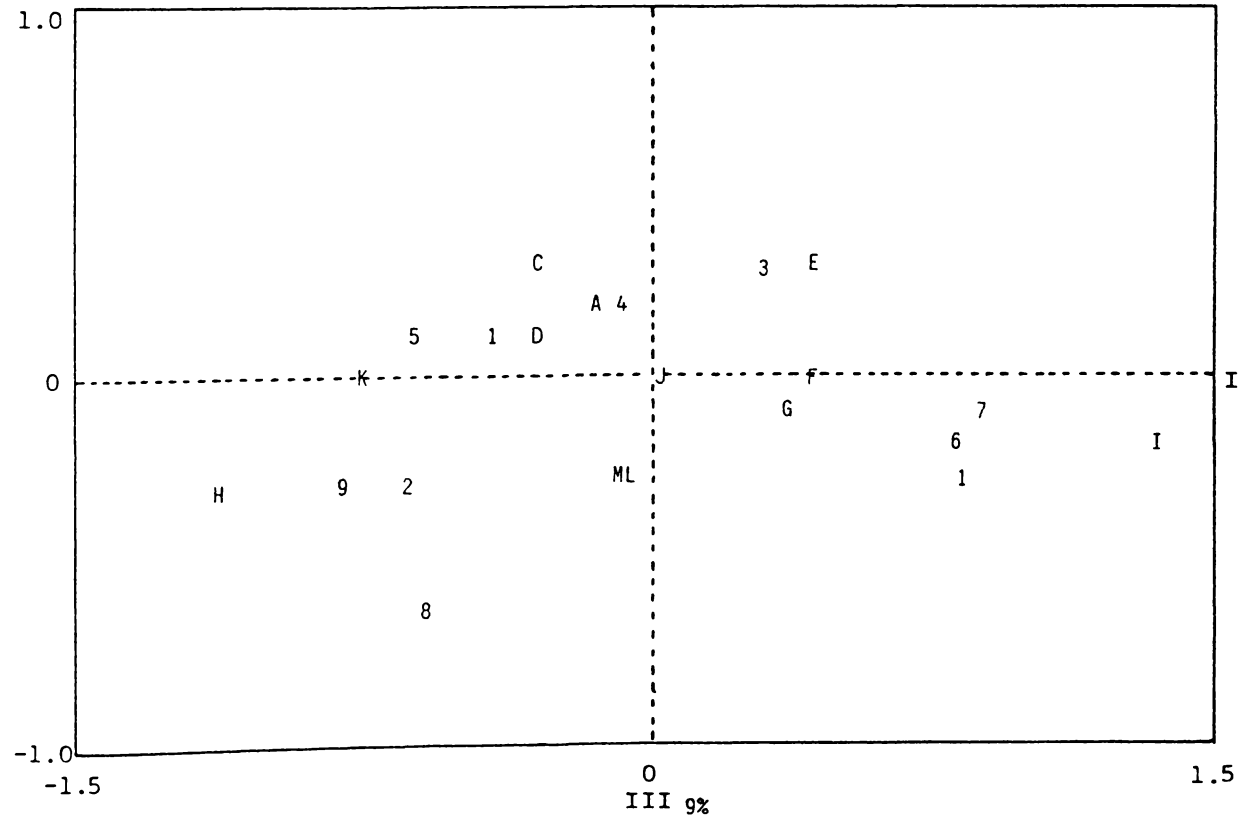


Figure 24 (Continued): **Russell**

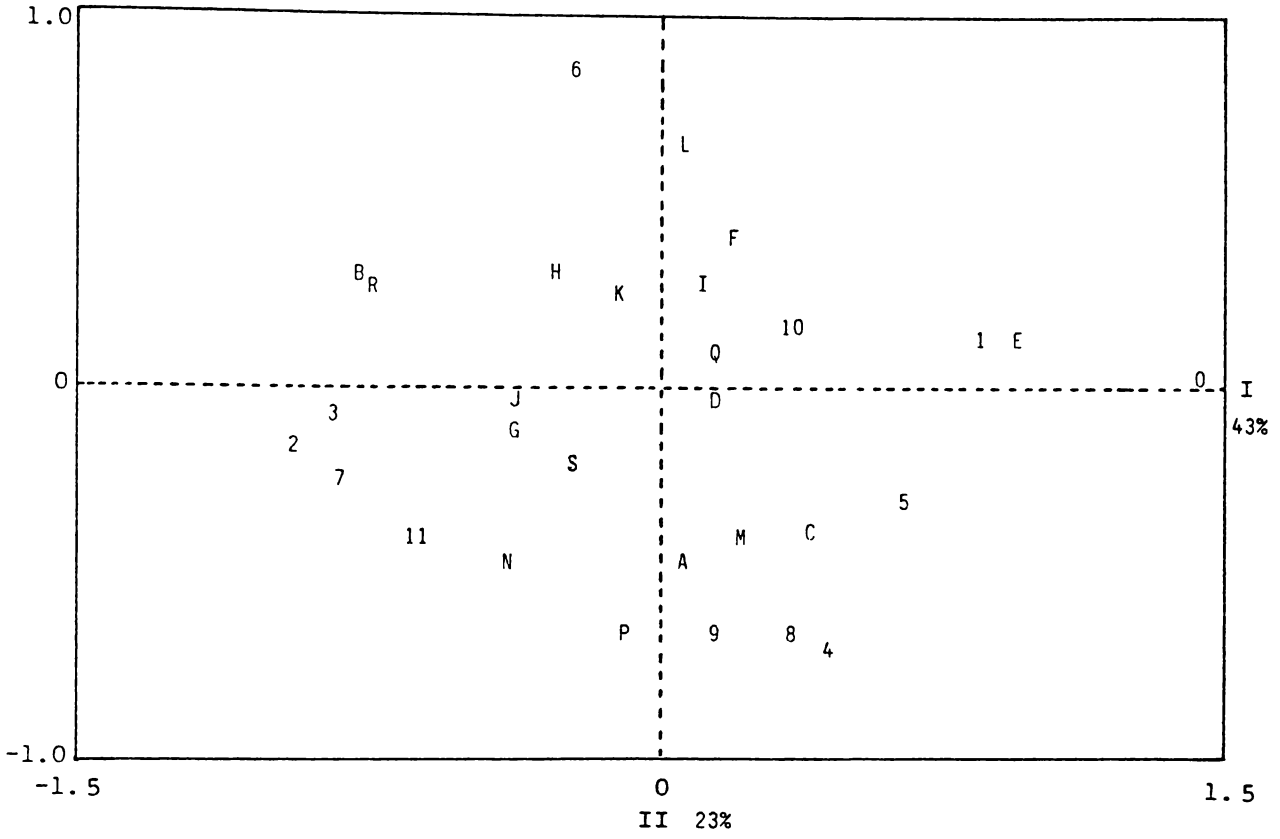
Elements

A Working with electronics
B Studying social studies
C Doing art
D Studying English
E Studying history
F Studying technical drawing
G Attending Junior Naturalists' Club
H Working in a hospital
I Doing science experiments
J Studying music
K Working with computers
L Playing chess
M Studying maths
N Reading novels
O Working in a shop
P Playing war games with model soldiers
Q Playing soccer
R Being a technician
S Studying science

Constructs

1 I find dull
2 I think are useful
3 I find hard
4 I think will be necessary for a career
5 I like
6 I think is serious
7 Are encouraged by my parents
8 Useless for making a living
9 I think is important
10 I take an interest in
11 I think I am good at
12 We talk about at home
13 Requires litte time
14 Things more for boys
15 I find boring

Figure 25: Louana



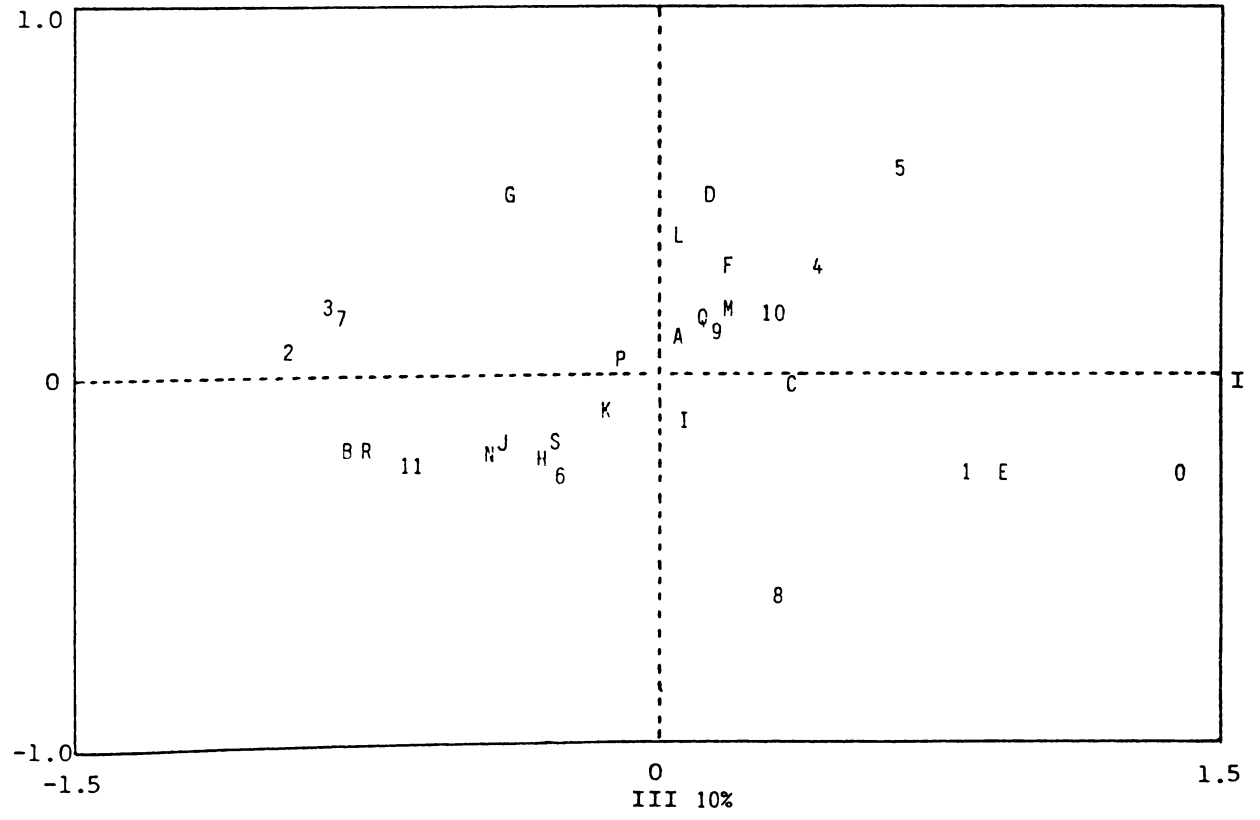


Figure 25 (Continued): **Louana**

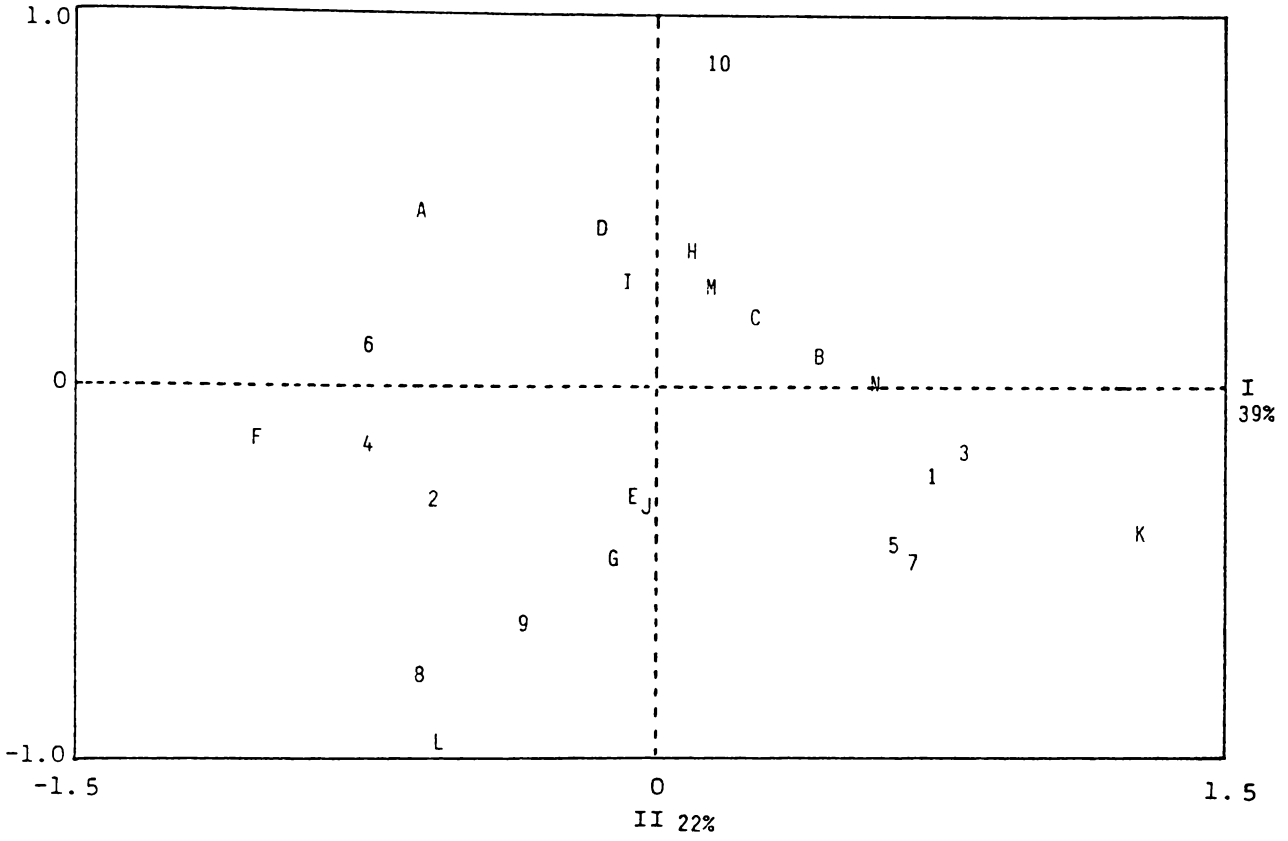
Elements

A Being a housewife
B Playing hockey
C Doing clothing
D Being at school
E Doing economic studies
F Studying social studies
G Studying French
H Doing art
I Learning about chemicals and things
J Being out of school
K Studying science
L Working in a shop
M Doing English
N Playing music
O Studying maths
P Being a policewoman
Q Learning about plants and animals
R Playing rugby
S Reading

Constructs

1 I find hard
2 I like doing
3 I find interesting
4 Useful when I leave school
5 I think are serious
6 Is not necessary in my life
7 I'm confident with
8 Things that are (or would be) useful in my life
9 Things that are important
10 What I am not (or would not be) good at
11 I find enjoyable

Figure 26: Angela



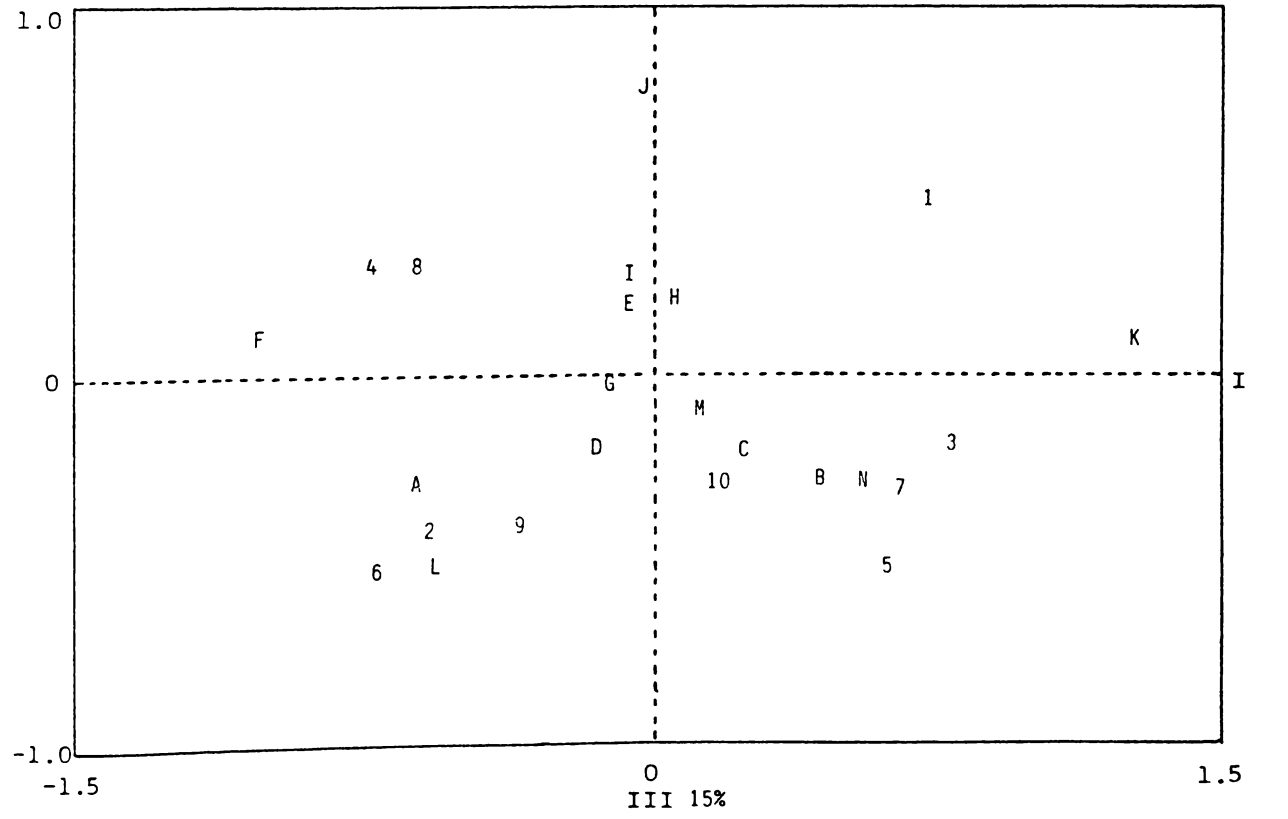


Figure 26 (Continued): **Angela**

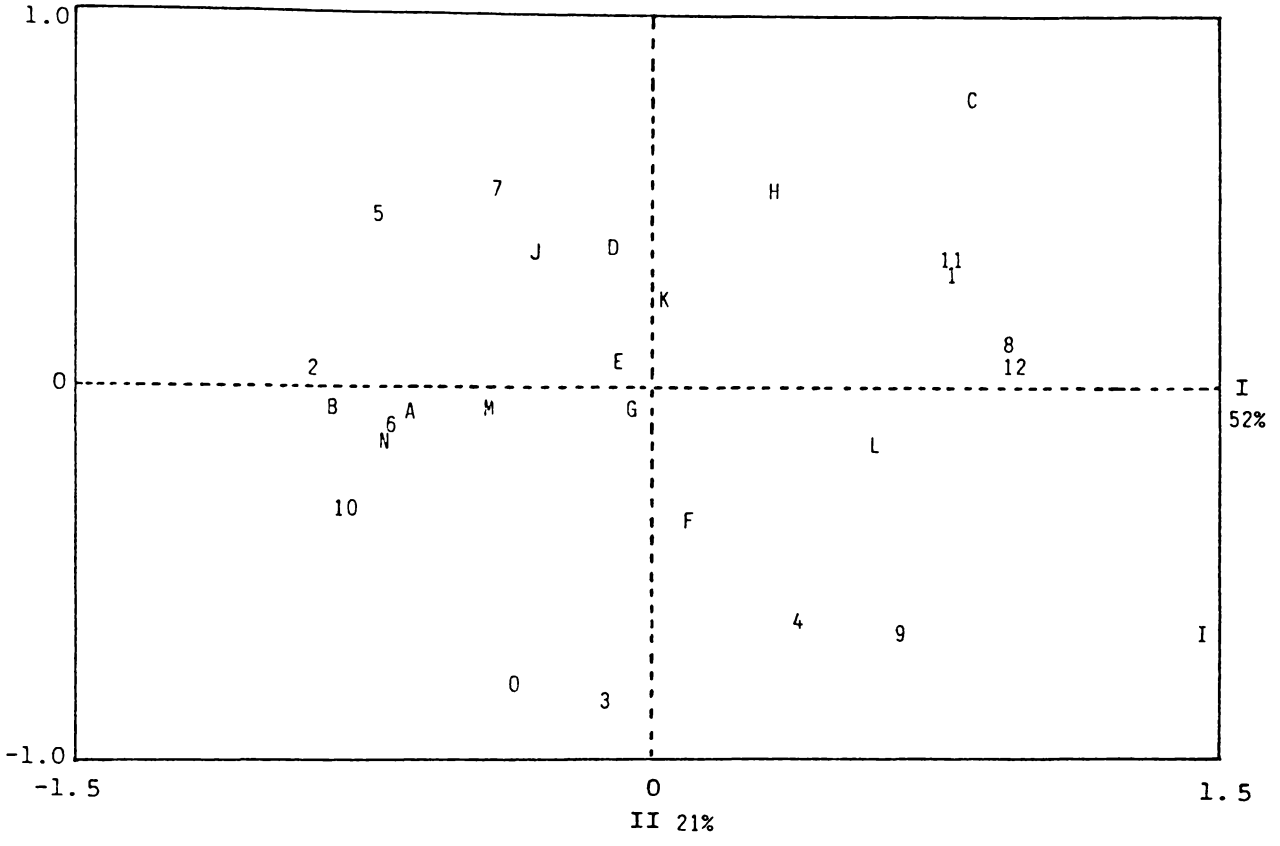
Elements

A Hairdressing
B Doing science
C Doing English
D Reading books
E Watching TV
F Netball
G Playing softball
H Doing homework
I Housewife's job
J Doing chores
K Doing Dad's jobs
L Air hostessing
M Doing maths
N Doing a science job

Constructs

1 I dislike
2 Lots of funs
3 Hard to understand
4 I think is a girl's thing
5 Not encouraged by my parents
6 I find good
7 I think I am not (or will never be) good at
8 Waste of time
9 I think are Pakeha things
10 I finds useful

Figure 27: Janis



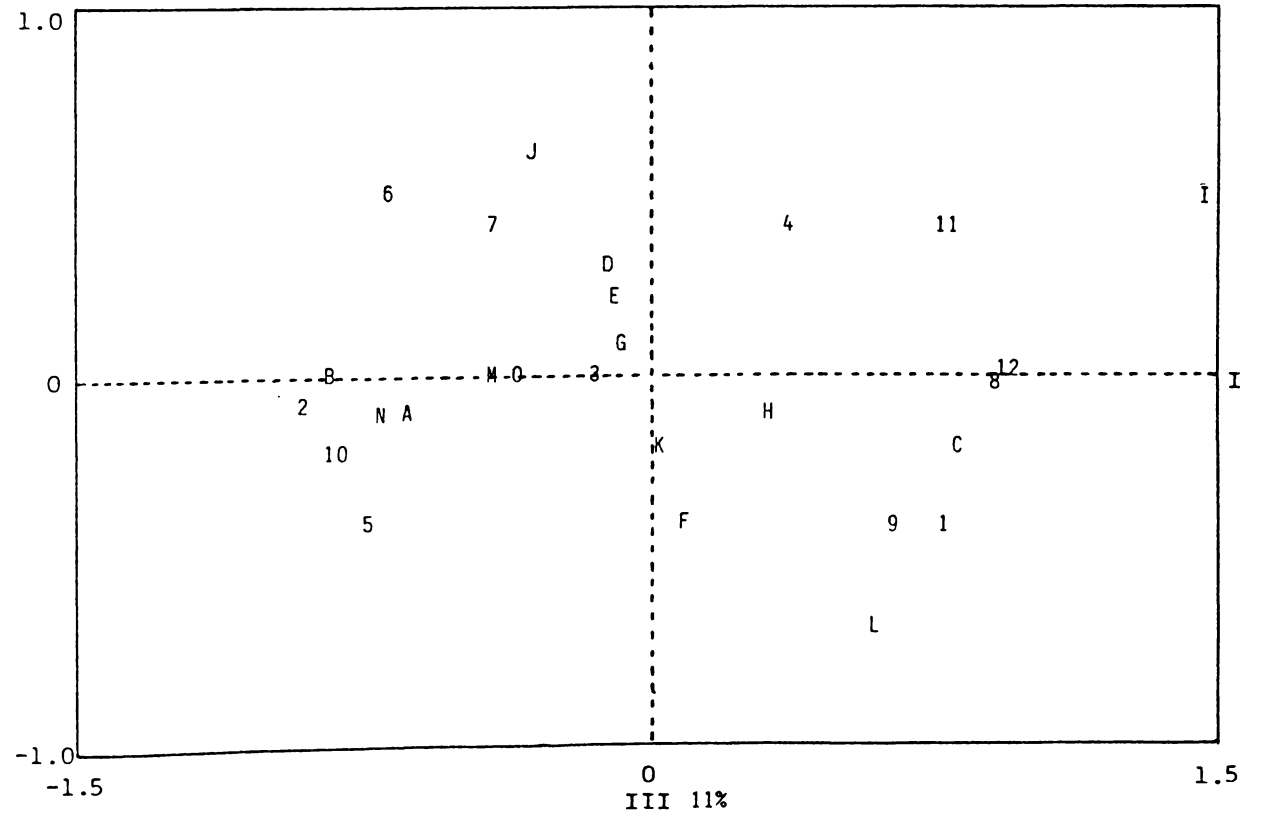


Figure 27 (Continued): **Janis**

Elements

A Teaching art
B Studying art
C Studying physics
D Studying maths
E Studying biology
F Doing science experiments
G Studying the human body
H Studying chemistry
I Practising typing
J Sitting School Certificate
K Being a doctor
L Being a lab technician
M Studying English
N Studying German
O Making music

Constructs

1 I find boring
2 I think are worthwhile
3 I find easy
4 I think are non-academic
5 I think is a boy's thing
6 What we talk about at home
7 I think are important
8 Things I consider to be unfavourable to me
9 What I am (or could be) good at
10 I find unenjoyable
11 I am not keen on

APPENDIX 5.2

Chi-squared contingency tables

Chi-squared contingency table (A)

	Male		Female		Total
	Actual	Expected	Actual	Expected	
School associated elements: science related	33	37	59	55	92
non-science related	59	56.3	81	83.7	140
career-associated elements: science-related	16	12.9	16	19.1	32
non-science related	22	23.7	37	35.3	59
	130		193		323
x^2 = 0.3 (dF = 3) n.s.					

Appendix 5.2 (Continued)

Chi-square contingency table (B)

	Non-Polynesian		Polynesian		
	Actual	Expected	Actual	Expected	Total
School associated elements:					
science	37	38.5	55	53.6	92
non-science	48	58.5	92	81.5	140
career linked elements:					
science	19	13.4	13	18.6	32
non-science	31	24.7	28	34.3	59
	135		188		323

x^2 = 0.06 + 0.04 + 1.9 + 1.4 + 2.3 + 1.7 + 1.6 + 1.2

= 10.2 (dF = 3) $p < 0.02$

APPENDIX 5.3

t-test analysis of 'composite saliency' scores taken from the sample students' final grids - grouped according to sex

t-test analysis of 'composite saliency' scores taken from the sample students' final grids - grouped according to sex

Boys			Girls		
Name	Score	N of elements included in score calculation	Name	Score	N of elements included in score calculation
Lei	.60	5	Louana	.30	3
Robert	.75	5	Amanda	.43	3
Peter	.81	6	Jackie B	.76	5
Sean	.58	5	Lynda	.44	4
Wayne	1.40	1	Susan	.60	5
Murphy	.48	4	Jocelyn	.37	5
Russell	.53	5	Aroha	.55	3
Andrew	.63	5	Jackie L	.60	3
Maurice	.37	5	Mihi	1.14	2
John	1.00	3	Sharon	.51	5
			Sandra	.69	7
			Angela	.57	2
			Leanne	.42	4
			Ruth	.50	5
			Janis	.56	5
$\Sigma = 7.15$ $\Sigma = 44$			$\Sigma = 8.44$ $\Sigma = 66$		
$\bar{x}_1 = 0.715$ $\bar{x} = 4.4$			$\bar{x}_2 = 0.563$ $\bar{x} = 4.4$		
$s.d_1 = 0.3$			$s.d_2 = 0.2$		

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s.d_1^2}{n_1} + \frac{s.d_2^2}{n_2}}}$$

$$= 1.14$$

With a criterion of $p < 0.05$ (two tailed) and the separate variance t-test model, a statistically significant result requires $t > 2.2$ (Popham, 1967), therefore the above t value is not significant.

APPENDIX 5.4

t-test analysis of 'composite saliency' scores taken from the sample students' final grids - grouped according to ethnicity

t-test analysis of 'composite saliency' scores taken from the sample students' final grids - groupted according to ethnicity

Non-Polynesians			Polynesians		
Name	Score	N of elements included in score calculation	Name	Score	N of elements included in score calculation
Robert	.75	5	Lei	.60	5
Peter	.81	6	Wayne	1.40	1
Sean	.58	5	Murphy	.48	4
Andrew	.63	5	Russell	.53	5
Amanda	.43	3	Maurice	.37	5
Lynda	.44	4	John	1.00	3
Jocelyn	.37	5	Louana	.30	3
Jackie L	.60	3	Jackie B	.76	5
Sharon	.51	5	Susan	.60	5
Leanne	.42	4	Aroha	.55	3
			Mihi	1.14	2
			Sandra	.69	7
			Angela	.57	2
			Ruth	.50	5
			Janis	.56	5
$\Sigma = 5.54$ $\Sigma = 45$			$\Sigma = 10.05$ $\Sigma = 60$		
$\bar{x}_1 = 0.554$ $\bar{x} = 4.5$			$\bar{x}_2 = 0.67$ $\bar{x} = 4$		
$s.d_1 = 0.1$			$s.d_2 = 0.3$		

$$t = \frac{-0.116}{\sqrt{0.002164 + 0.005853}}$$

$$= -1.296$$

With a criterion of $p < 0.05$ (two tailed) and the separate variance t-test model, a statistically significant result requires $t > 2.2$ (Popham, 1967), therefore the above t value is not significant.

APPENDIX 6.1

Separate Pearson product-moment correlation tables for sex and ethnic groupings

Table A: The Pearson product-moment zero-order correlations between all measures used in the initial surveys, with both sexes treated separately. Male (N = 236 - 262) correlations are above the diagonal; female (N = 263 - 295) correlations are below the diagonal.

Measure	1	2	3	4	5	6	7	8	9
1. TOSCA		.24**	.27**	.13	.23**	.09	-0.23**	.43**	.65**
2. Total IAR	.19*		.81**	.83**	.04	-0.02	-0.03	.07	.10
3. + IAR	.11	.79**		.34**	.04	-0.07	.03	.09	.10
4. - IAR	.20**	.85**	.35**		.03	.02	-0.07	.03	.07
5. Cat-CS	.21**	-.04	-0.07	0.0		-0.32**	-.54	.19*	.31**
6. Des-CS	.10	.01	.07	-0.05	-0.27**		-0.58**	.09	.01
7. Rel-CS	-0.24**	.04	.02	.05	-0.63**	-.56**		-.20*	-0.21**
8. Hid. Fig.	.36**	.05	0.0	.08	.09	.10	-0.15		.34**
9. Sci. Quest.	.38**	-.03	-0.02	-0.03	.15	.12	-0.23**	.39**	

* = $p < 0.01$ ** = $p < 0.001$

Table B: The Pearson-product moment zero-order correlations between all measures used in the initial survey:

European students: (N = 331 - 355)

Measure	1	2	3	4	5	6	7	8	9
1. TOSCA		.19**	.14*	.17*	.16	.05	-0.17*	.34**	.51**
2. Total IAR			.81**	.83**	-.05	.06	0.0	.06	.04
3. - IAR				.35**	-.07	.06	.03	.03	.03
4. + IAR					-.02	.04	-0.02	.07	.03
5. Cat-CS						-0.38**	-.55**	.19*	.20**
6. Des-CS							-.53**	.06	.05
7. Rel-CS								-0.22**	-.20**
8. Hidden Figures									.35**
9. Science Questionnaire									

* = $p < 0.01$ ** = $p < 0.001$

Table C: The Pearson-product moment zero-order correlations between all measures used in the initial survey:

Maori students (N = 129 - 149)

Measure	1	2	3	4	5	6	7	8	9
1. TOSCA		.18	.19	.10	.32**	.15	.33**	.46**	.35**
2. Total IAR			.77**	.84**	.06	-0.09	.03	.07	-0.08
3. + IAR				.30	.03	-0.06	.02	.06	-0.06
4. - IAR					.06	-0.09	.02	.05	-0.07
5. Cat-CS						-0.12	-0.65**	.04	.19
6. Des-CS							.65**	.20	.03
7. Rel-CS								-0.14	-0.18
8. Hidden Figures									.35**

* = $p < 0.01$ ** = $p < 0.001$

Table D: The Pearson product-moment zero-order correlations between all measures used in the initial survey:

Pacific Island students (N = 25 - 29)

Measure	1	2	3	4	5	6	7	8	9
1. TOSCA		.16	.15	.12	.34	-0.27	.02	.27	.45
2. Total IAR			.77**	.87**	.01	-0.20	.21	0.0	.14
3. + IAR				.36	.03	-0.29	.30	.19	-0.03
4. - IAR					0.0	-0.07	.07	-0.15	.24
5. Cat-CS						-0.49*	-0.47*	-0.16	.23
6. Des-CS							-0.52*	-0.03	-0.01
7. Rel-CS								.23	-0.13
8. Hidden Figures									.31
9. Science Questionnaire									

* = $p < 0.01$ ** = $p < 0.001$

APPENDIX 6.2

An item analysis of the Science Questionnaire according to sex

An item analysis of the Science Questionnaire according to sex

Question	Means		Standard Deviation		t-value
	Girls (N=286)	Boys (N=265)	Girls	Boys	
1	3.2	3.5	1.0	0.9	3.6**
2	3.1	3.6	1.7	1.7	2.9*
3	2.7	3.1	1.1	1.3	4.6**
4	1.6	2.4	2.0	2.0	4.4**
5	1.8	2.2	1.2	1.4	4.1**
6	1.2	1.5	1.3	1.4	2.7*
7	1.9	2.3	1.3	1.1	3.4**
8	1.6	1.9	1.3	1.3	2.3
9	1.2	1.5	1.0	0.9	3.9**
10	1.2	1.4	0.8	0.8	3.0*
11	1.1	1.3	0.6	0.7	2.2
12	1.7	2.1	1.8	1.8	2.8*
13	2.0	2.0	1.5	1.5	-0.2
14	1.3	1.4	0.8	0.7	1.7
15	0.9	0.9	1.4	1.4	-0.1
16	0.4	0.5	1.0	1.1	1.5

** = $p < 0.001$ * = $p < 0.05$

APPENDIX 6.3

One-way ANOVAs with respect to ethnic differences on the initial measures, and the Scheffe procedure applied

Notes: 1. In the following tables, * denotes pairs of groups significantly different at the 0.05 level.
2. The number of students in each group varied across each measure within the ranges:
European 354-363
Maori 142-152
Pacific Island 26-30

Table 1: TOSCA by Ethnicity

ANOVA: Source	D.F.	Sum of Squares	Mean Squares	F ratio	F prob.
between groups	2	17984	8992	65.8	0.0000
within groups	538	73541	137		
Total	540	91525			

Scheffe procedure:	Mean	Groups		1	2	3
	34.1	European	1		*	*
	21.5	Maori	2			
	23.8	Pacific Island	3			

Table 2: Science Questionnaire by Ethnicity

ANOVA: Source	D.F.	Sum of Squares	Mean Squares	F ratio	F prob.
between groups	2	14741	7370	28.6	0.0000
within groups	532	137125	258		
Total	534	151866			

Scheffe procedure:	Mean	Groups		1	2	3
	1.8	European	1		*	
	-9.9	Maori	2			
	-4.6	Pacific Island	3			

Table 3: Hidden Figures Test (Field Independency) by Ethnicity

ANOVA: Source	D.F.	Sum of Squares	Mean Squares	F ratio	F prob.
between groups	2	213	106	4.7	0.009
within groups	528	11851	22		
Total	530	12063			

Scheffe procedure:	Mean	Groups		1	2	3
	7.8	European	1		*	
	6.4	Maori	2			
	7.2	Pacific Island	3			

Table 4: +IAR by Ethnicity

ANOVA: Source	D.F.	Sum of Squares	Mean Squares	F ratio	F prob.
between groups	2	47	23	4.6	0.01
within groups	524	2673	5		
Total	526	2720			

Scheffe procedure:	Mean	Groups		1	2	3
	13.0	European	1		*	
	12.4	Maori	2			
	12.9	Pacific Island	3			

Table 5: -IAR by Ethnicity

ANOVA: Source	D.F.	Sum of Squares	Mean Squares	F ratio	F prob.
between groups	2	14	7	1.1	0.3
within groups	524	3227	6		
Total	526	3241			

Scheffe procedure:	Mean	Groups		1	2	3
	12.1	European	1			
	11.7	Maori	2			
	12.2	Pacific Island	3			

Table 6: Total IAR by Ethnicity

ANOVA: Source	D.F.	Sum of Squares	Mean Squares	F ratio	F prob.
between groups	2	112	56	3.7	0.025
within groups	524	7879	15		
Total	526	7990			

Scheffe procedure:	Mean	Groups		1	2	3
	25.1	European	1		*	
	24.1	Maori	2			
	25.0	Pacific Island	3			

Table 7: Cat-CS by Ethnicity

ANOVA: Source	D.F.	Sum of Squares	Mean Squares	F ratio	F prob.
between groups	2	129	64	3.9	0.02
within groups	523	8673	17		
Total	525	8802			

Scheffe procedure:	Mean	Groups		1	2	3
	9.6	European	1		*	
	8.5	Maori	2			
	9.8	Pacific Island	3			

Table 8: Des-CS by Ethnicity

ANOVA: Source	D.F.	Sum of Squares	Mean Squares	F ratio	F prob.
between groups	2	93	47	3.0	0.05
within groups	523	8212	16		
Total	525	8306			

Scheffe procedure:	Mean	Groups		1	2	3
	8.7	European	1			
	7.7	Maori	2			
	9.7	Pacific Island	3			

Table 9: Rel-CS by Ethnicity

ANOVA: Source	D.F.	Sum of Squares	Mean Squares	F ratio	F prob.
between groups	2	351	176	8.3	0.0003
within groups	524	11079	21		
Total	526	11430			

Scheffe procedure:	Mean	Groups		1	2	3
	6.6	European	1			
	8.3	Maori	2	*		*
	5.5	Pacific Island	3			

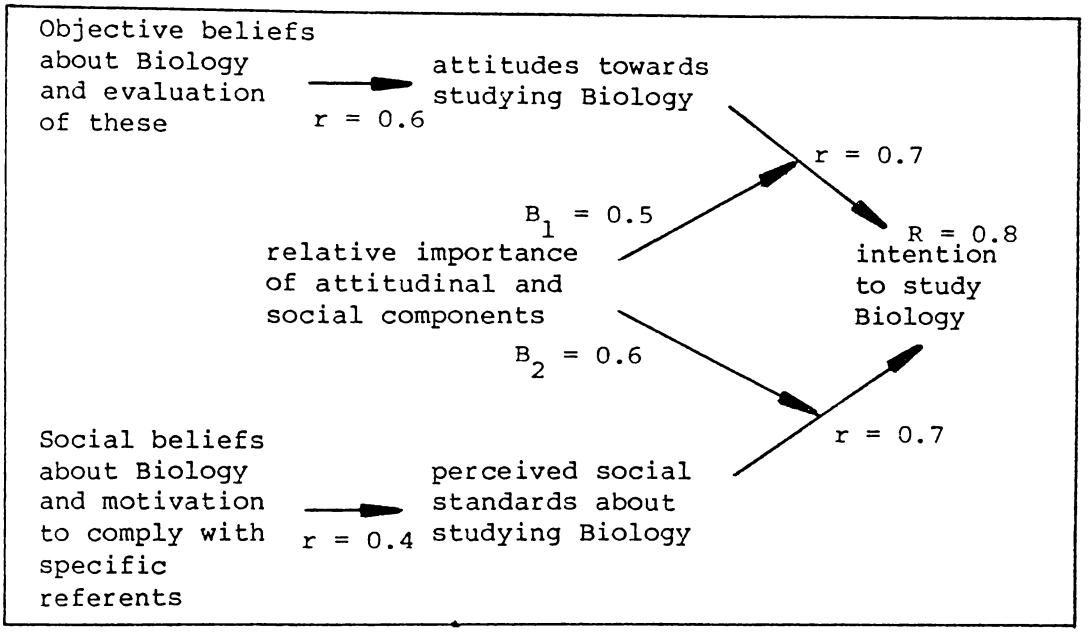
APPENDIX 6.4

The TRA analyses of the F5 students' responses

The TRA analyses of the F5 students' responses

Figure 1: Students' intentions to study Biology

Girls



Boys

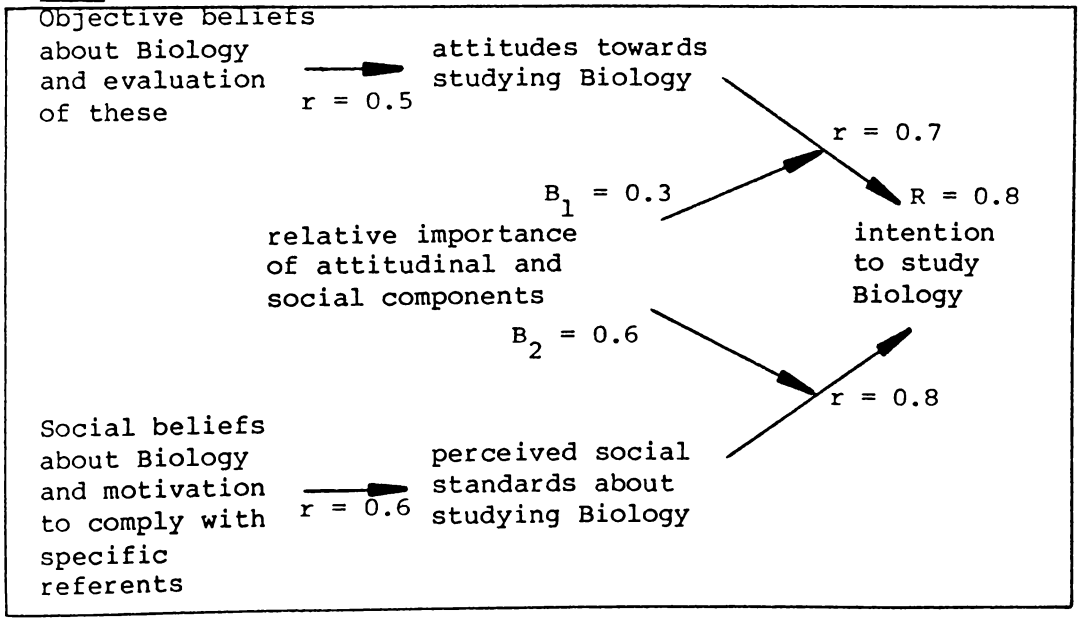
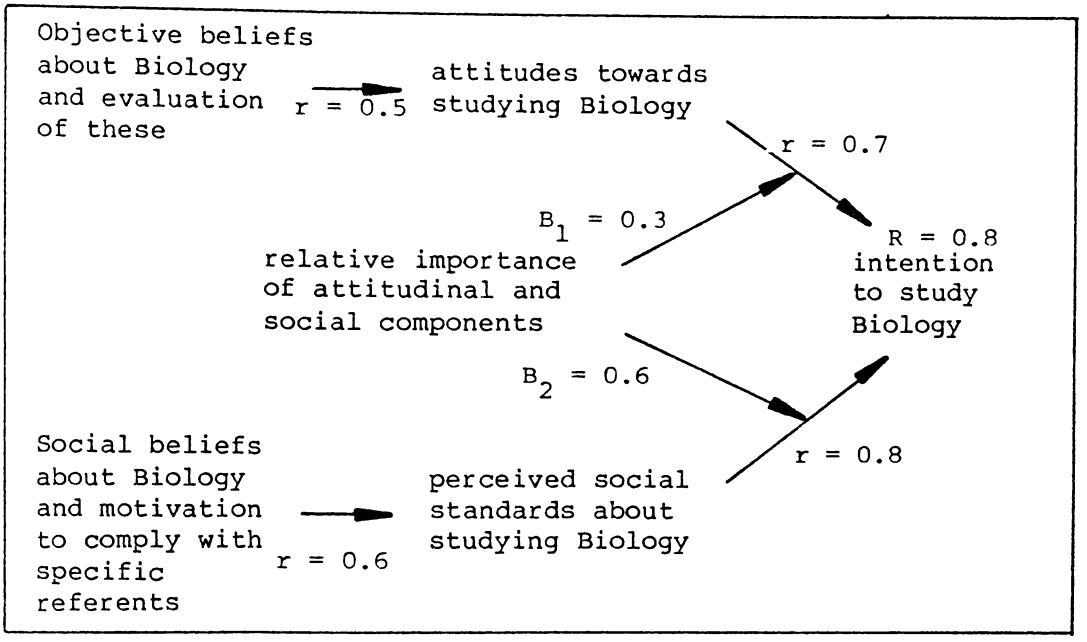


Figure 1 (Continued)

Non-Polynesian students



Polynesian students

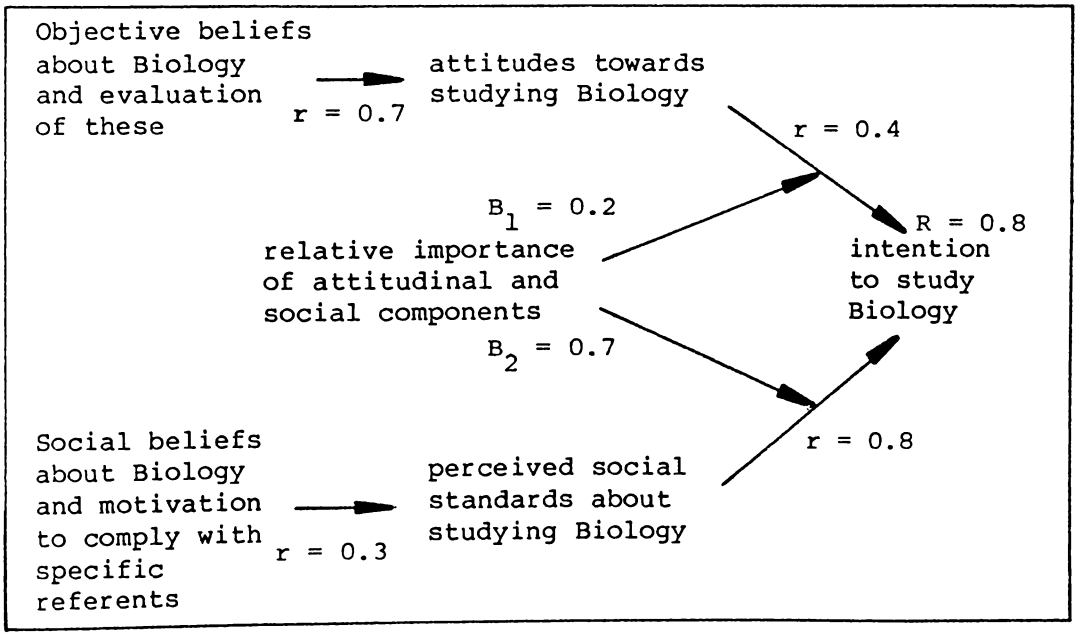
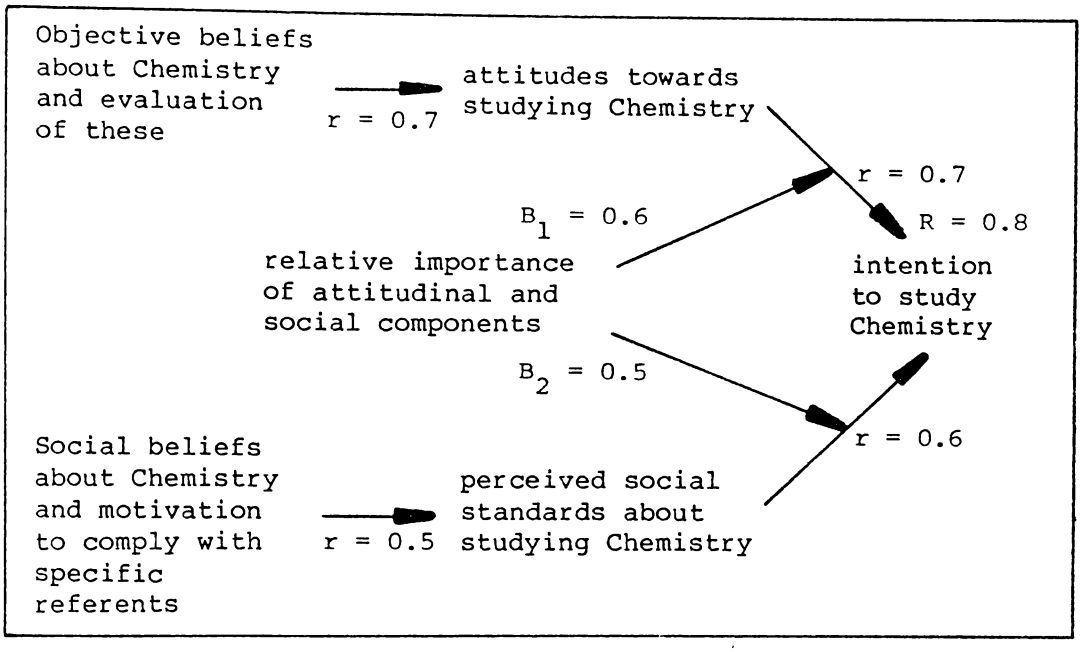


Figure 2: Students' intention to study Chemistry

Girls



Boys

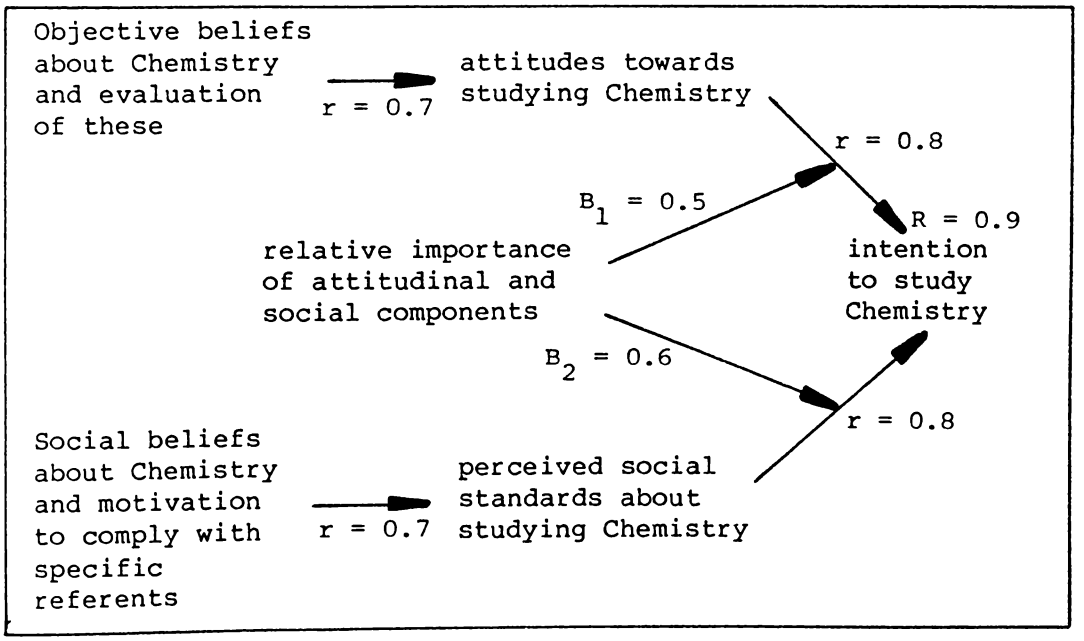
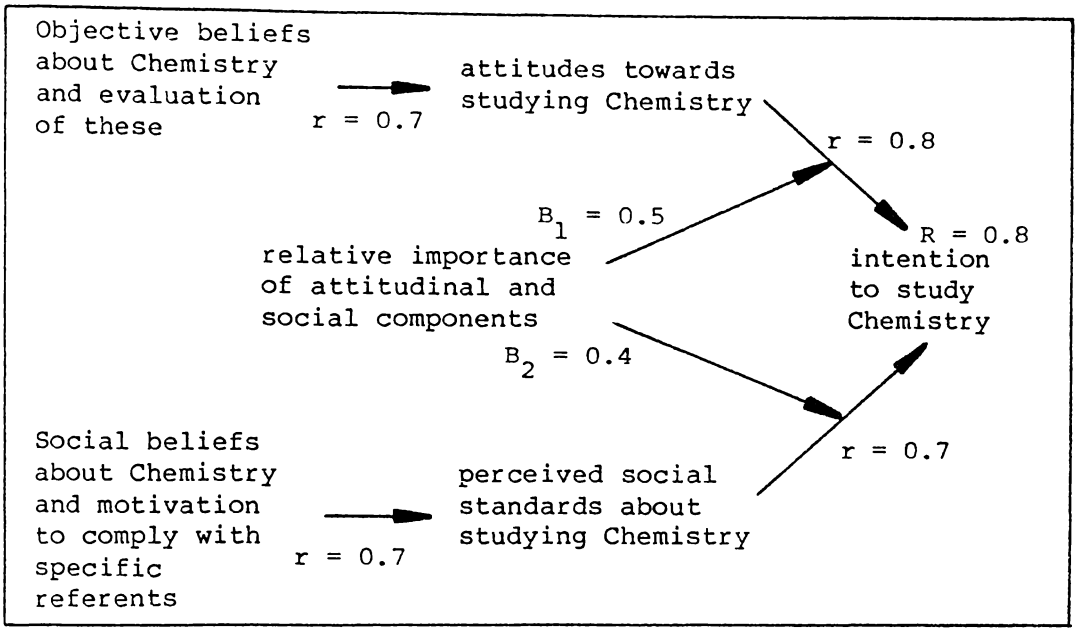


Figure 2 (Continued)

Non-Polynesian students



Polynesian students

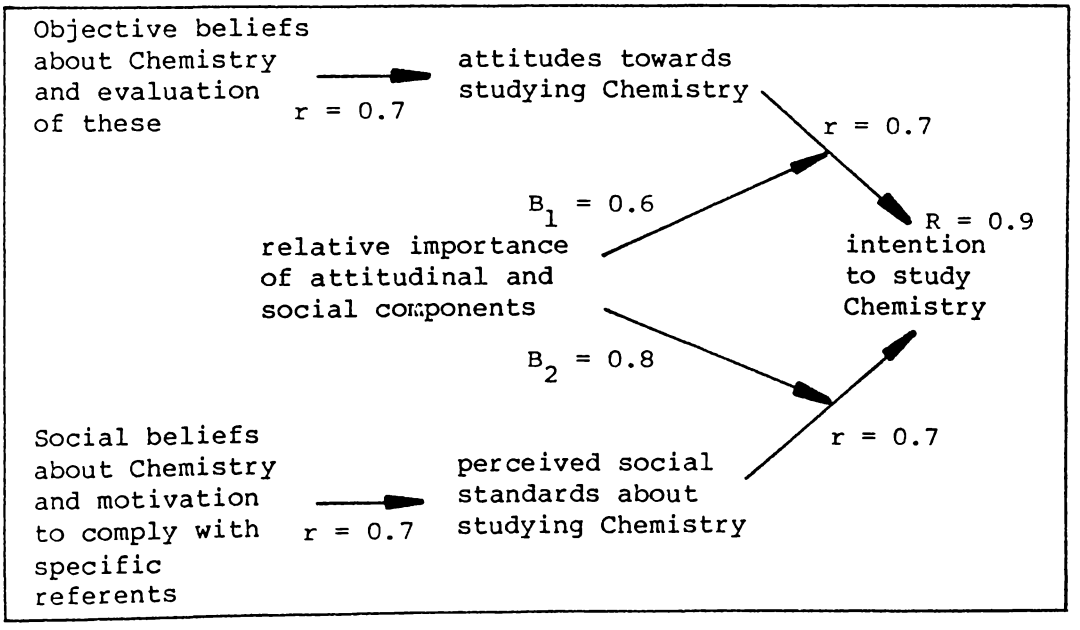
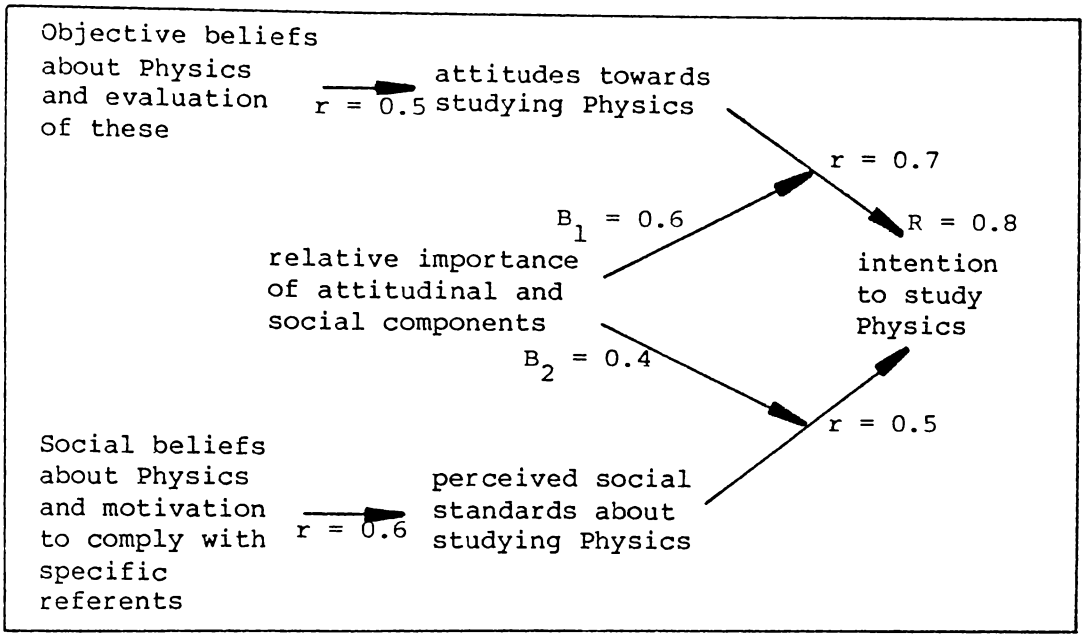


Figure 3: Students' intention to study Physics

Girls



Boys

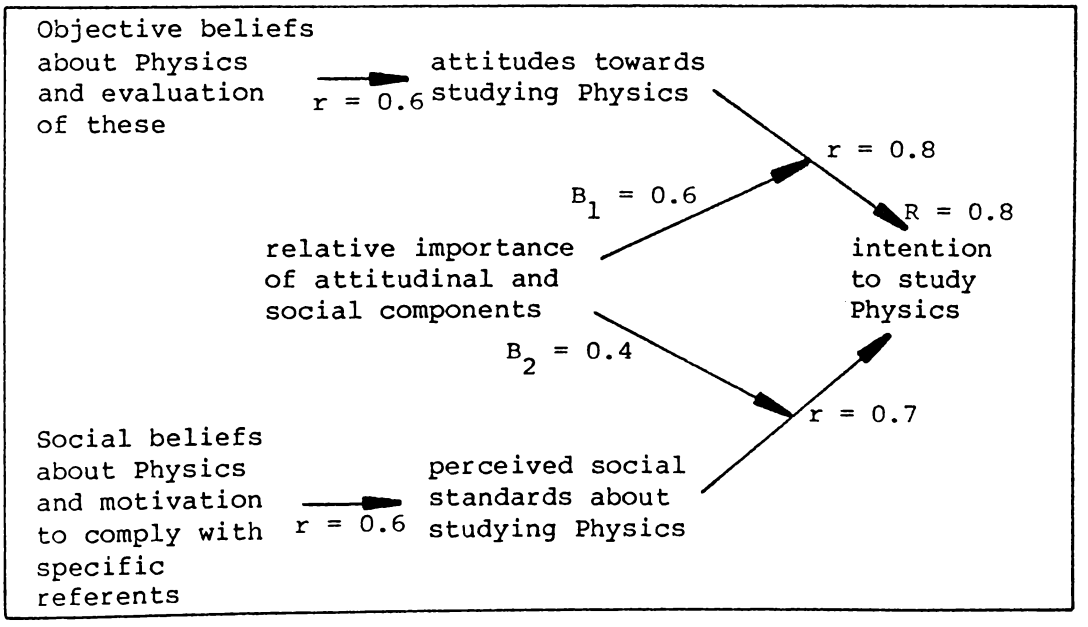
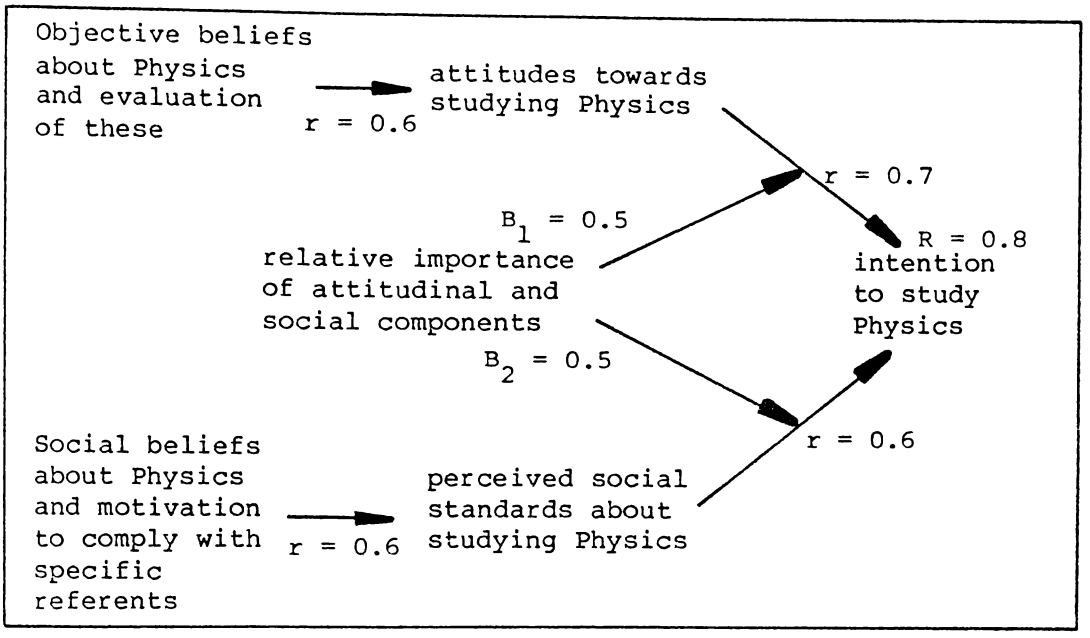
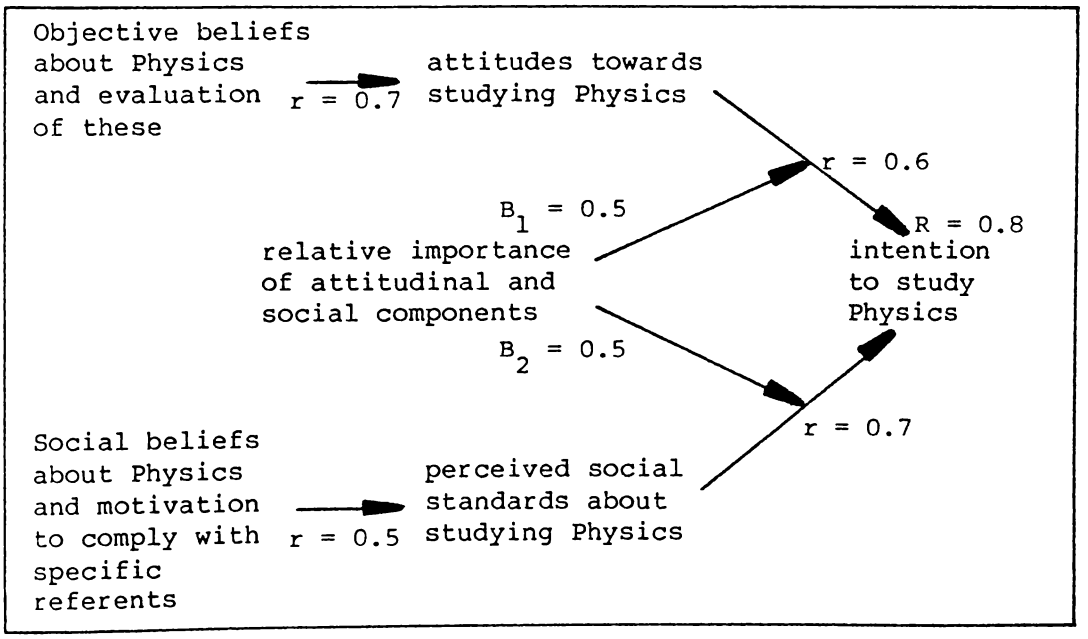


Figure 3 (Continued)

Non-Polynesian students



Polynesian students



APPENDIX 6.5

The results of the preliminary, open-ended, TRA questionnaire.

Note: 1. As more than one response was possible for each question cumulative percentages may exceed 100.
2. The sample of students (N=111) comprised fourth and fifth form students (refer Section 3.3.4).

1. What are the advantages, for you personally, in studying science in the Fifth form?

Response Category	Percentage
Career (job) prospects	66.6
Personal enjoyment	38.7
Knowledge about world	33.3
Prepares for subsequent study	22.5
Provides practical activities	17.1

2. What are the disadvantages, for you, in studying science in the Fifth form?

Response Category	Percentage
Difficult	27.0
Not interesting	18.9
Requires a lot of study	14.4
Not necessary for career	11.7
Requires considerable memorisation	7.2

3. What are the reasons why you might want to study Biology in the Sixth form?

Response Category	Percentage
Career	35.1
Interesting	23.4
Enjoy working/learning about plants & animals	18.0
Teaches about environment	17.1
Learn about our bodies	12.6

4. What are the reasons why you might not want to study Biology in the Sixth form?

Response Category	Percentage
Not necessary for a job	26.1
Uninteresting	24.3
Difficult	12.6
Lot of work required	5.4
Already have sufficient knowledge	3.6

5. What are the reasons why you might want to study Chemistry in the Sixth form?

Response Category	Percentage
Necessary for a job	33.3
Interesting	21.6
Knowledge about the world	12.6
Practical work enjoyable	15.3

6. What are the reasons why you might not want to study Chemistry in the Sixth form?

Response Category	Percentage
Difficult	34.2
Boring/uninteresting	26.1
Not necessary for a job	18.9
Complex formulae, equations	14.4

7. What are the reasons why you might want to study Physics in the Sixth form?

Response Category	Percentage
Job requirements	33.3
Interesting	15.3
Important for everyday life	11.7
Help with maths	8.1

8. What are the reasons why you might not want to study Physics in the Sixth form?

Response Category	Percentage
Uninteresting/unenjoyable	44.1
Difficult	25.2
Requires maths	10.8
Not necessary for a job	3.6

9. List those who you believe would think science is an important subject for you to study. Indicate who they are after their name. eg. Brian (best friend)

Response Category	Percentage
Father	56.8
Mother	51.4
Friends	27.0
Teachers	21.6
Employer	18.0
Relations	17.1
Self	13.5
Brothers	13.5
Sisters	12.6

10. List those who you believe would think science is not an important subject for you to study. Indicate who they are beside their name.

Response Category	Percentage
Friends	18.9
Mother	12.6
Father	9.9
Brothers	6.3
Sisters	2.7
Relations	4.5
Self	3.6

APPENDIX 6.6

The SAQ (F4) Section B results

Notes: 1. Boys (B) N=71, Girls (G) , European (E) N=115, Maori (M) N=26, Pacific Island (P) N=9

2. Data in these tables have been rounded to whole numbers and then expressed in percentages

Question 8: How likely is it that you will study:

(i) Response by sex:

	Extremely Likely		Quite Likely		Neither		Quite Unlikely		Extremely Unlikely	
	B	G	B	G	B	G	B	G	B	G
(a) Biology	20	30	25	37	17	14	18	7	20	12
(b) Chemistry	13	12	27	24	32	12	16	22	13	30
(c) Physics	31	5	28	16	20	17	9	26	13	36

(i) Response by ethnicity:

	Extremely Likely			Quite Likely			Neither			Quite Unlikely			Extremely Unlikely		
	E	M	P	E	M	P	E	M	P	E	M	P	E	M	P
(a) Biology	26	23	22	31	27	44	16	15	11	10	23	11	17	12	11
(b) Chemistry	10	23	11	24	23	44	21	27	11	21	19	0	28	8	33
(c) Physics	17	23	0	14	54	22	19	12	33	21	8	11	30	4	33

Question 9: Briefly explain why you ticked where you did for each science subject.

Response Categories		B	G	E	M	P
(a) Biology -	Don't know	10	6	10	4	0
	Dislike	27	15	20	31	13
	Interesting	21	30	27	27	0
	Career	16	19	20	12	13
	Knowledge	3	15	7	8	50
	Easy/hard	6	3	4	0	25
	Not necessary	17	11	13	19	0
(b) Chemistry-	Don't know	12	9	12	8	0
	Dislike	25	33	31	24	33
	Interesting	20	19	18	24	22
	Career	17	12	14	16	0
	Knowledge	6	6	4	8	33
	Easy/hard	6	8	6	8	11
	Not necessary	15	13	12	2	0
(c) Physics -	Don't know	6	15	11	12	13
	Dislike	22	42	37	16	38
	Interesting	21	9	13	28	0
	Career	38	6	20	28	0
	Knowledge	2	4	1	8	13
	Easy/hard	6	9	7	0	38
	Not necessary	3	8	10	1	0

Question 10(a): What job, do you hope to have when you leave school?

Response Categories	B	G	E	M	P
Don't know	16	25	18	28	44
Apprenticeship	22	9	15	20	0
Academic/Professional	20	21	22	16	22
Farming	9	3	7	0	0
Labourer	5	0	1	8	11
Semi-professional	25	22	25	16	11
Shop assistance	3	21	10	2	1

Question 10(b): What job, or career, do you think you will have when you leave school?

Response Categories	B	G	E	M	P
Don't know	37	44	34	69	56
Apprenticeship	13	9	12	8	11
Academic/Professional	13	13	16	4	0
Farming	10	1	6	0	11
Labourer	3	1	2	0	11
Semi-professional	21	15	19	12	11
Shop assistance	3	17	12	8	0

Question 11(a): How much thought have you given to your future courses at school?

Response Categories	B	G	E	M	P
a very considerable amount	31	38	37	27	33
quite a lot	59	46	54	46	44
very little	10	15	10	23	22
none	0	1	0	4	0

Question 11(b): Who, or what, helped you to decide what courses you should take?

Response Categories	B	G	E	M	P
Don't know	0	1	0	4	0
Myself	14	11	7	44	0
Parents	56	58	63	32	56
Employer	9	11	10	8	0
Teachers	4	13	10	4	11
Siblings	4	5	4	4	33
Friends	1	0	1	0	0
Exam requirements	10	1	6	4	0

Question 12(a): What will be the three most important subjects you will be studying next year?

Note: In order to present these data succinctly, only the three most common subjects offered are listed and the rank ordering of each subject choice is ignored. The figures are percentages of the totals for each student group.

Subject Choice	B	G	E	M	P
English	71	74	67	94	89
Mathematics	84	74	80	72	67
Science	50	41	51	29	22

Question 12(b): Why do you think these subjects are important for you?

Note: The responses to each choice are combined in this table to reveal the most common reasons for offering the subjects selected for part (a) of this question. The figures are mean percentage responses by each student group to each response category.

Response Category	B	G	E	M	P
Don't know	3	3	3	5	7
Career	64	54	64	34	57
Interest	3	10	7	15	0
For knowledge	7	16	11	11	11
To help others	4	2	3	4	0
Easy	4	3	2	7	7
Compulsory	6	5	5	7	8
Of personal value	4	6	4	13	7
All other reasons	1	2	1	4	0

APPENDIX 6.7

An item analysis of the Science Questionnaire
according to ethnicity

An item analysis of the Science Questionnaire according to ethnicity

Question	Means			Standard deviation			t values		
	E	M	PI	E	M	PI	E/M	E/PI	M/PI
1	3.4	3.2	2.9	0.9	1.0	1.2	2.2	3.1*	1.8
2	3.5	2.9	3.3	1.7	1.6	1.3	3.6**	0.7	-1.1
3	3.1	2.5	2.7	1.2	1.1	1.2	5.0**	1.5	-0.9
4	2.2	1.5	1.8	2.0	1.9	2.0	3.6**	1.0	-0.7
5.	2.2	1.5	2.0	1.3	1.2	1.0	5.2**	0.7	-2.0
6	1.5	1.0	1.6	1.4	1.3	1.4	3.7**	-0.3	-2.1
7	2.3	1.6	2.3	1.1	1.3	1.0	6.0**	-0.1	-2.7*
8	1.9	1.5	2.1	1.3	1.3	1.1	3.1*	-1.0	-2.4*
9	1.4	1.2	1.2	1.0	1.0	0.7	3.0*	1.0	-0.4
10	1.3	1.2	1.3	0.8	0.8	0.8	1.3	-0.1	-0.8
11	1.2	1.1	1.6	0.7	0.5	0.8	1.7	-2.6*	-3.9**
12	2.2	1.2	1.3	1.8	1.6	1.7	5.4**	2.3	-0.3
13	2.1	1.9	1.7	1.5	1.5	1.5	1.9	1.3	0.4
14	1.5	1.2	1.4	0.7	0.7	0.8	3.8**	0.4	-1.4
15	0.8	1.2	0.8	1.3	1.5	1.3	-2.6*	0.2	1.3
16	0.4	0.5	0.3	1.0	1.2	1.0	-1.7	0.2	0.9

Notes:
1. * = $p < 0.01$ ** = $p < 0.001$
2. E = European (N=358)
   M = Maori (N=152)
   PI = Pacific Island (N=27)

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ADDENDUM

This addendum provides additional material which

(a) considers aspects of the TOSCA correlations not previously discussed in the text of the thesis (Part 1) and,

(b) brings together the various questions, hitherto dispersed throughout the thesis, which could stimulate further research (Part 2).

PART 1: ADDITIONAL COMMENTS ON THE TOSCA CORRELATIONS

As the TOSCA data were derived from combining the raw scores from two forms, the Intermediate B and the Secondary B, the possibility arose that alternative interpretations of the correlations with the other empirical measures would be necessary should the individual TOSCA forms show distinctly different correlations with these other measures. For example, an age-related variable could exist, or perhaps the two forms of TOSCA measured slightly different constructs?

The first possibility was explored by recomputing the separate correlations for both TOSCA forms with the empirical measures. These analyses are shown in Table A1.1 below.

Table A1.1: The Pearson product-moment zero-order correlations between the combined TOSCA/Intermediate B/Secondary B forms and the measures used in the initial class surveys.

	N	X	s.d.	Total IAR	+ve IAR	-ve IAR	Cat CS	Des CS	Rel CS	Hid Fig.	Science Quest.
Combined TOSCA	557	30.2	13.15	.21**	.19**	.16**	.22**	.10*	-0.23**	.41**	.54**
Intermediate B (F1/2)	231	25.6	11.67	.16**	.12**	.14*	.20**	.18	-0.29**	.22**	.34**
Secondary B (F3/4)	326	33.4	13.19	.24	.22	.17	.18	.07	-0.19	.42	.54

* = $p < 0.01$ ** = $p < 0.001$

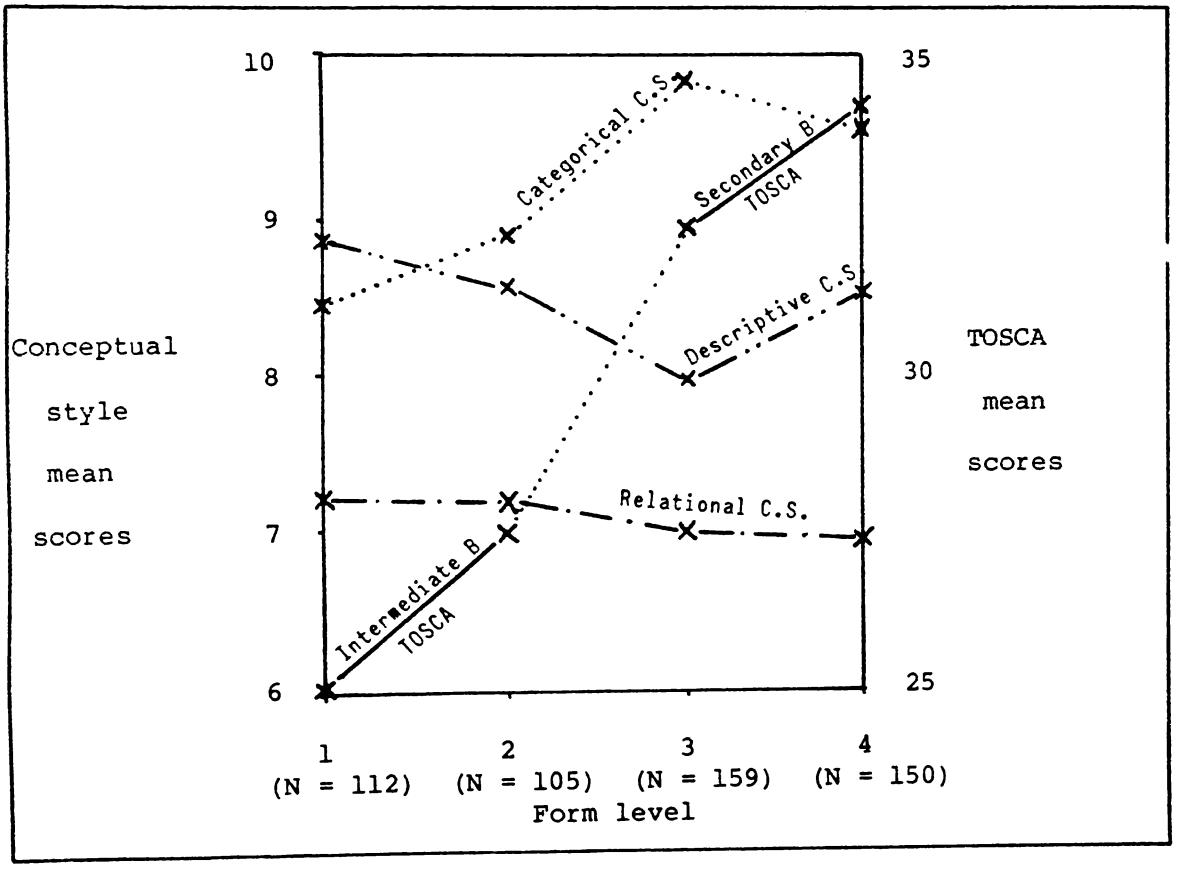
The data indicate that the interpretation of the Secondary B TOSCA correlations would be essentially the same as that offered in the body of the thesis for the combined TOSCA correlations (refer Section 6.1.1) and, as such, need no further elaboration. However, some minor variation is observed in the Intermediate B correlations.

(i) There were no statistically significant correlations found between the Intermediate B TOSCA and any of the IAR subscales. One interpretation could be that the F1 and F2 students found the Intermediate B TOSCA form relatively more difficult than did the F3 and F4 students (refer to the lower mean and reduced standard deviation) and this could have produced a positively skewed distribution of the TOSCA raw scores. This would have reduced the common variance in the correlations with all the other variables. In the main, lower correlations did occur. Therefore, whilst it is noted that the correlations between the Intermediate B TOSCA and the IAR subscales are all of the same order as those found between the combined TOSCA and the Secondary B forms and the IAR subscales, the lack of statistical significance could be due simply to the proximity of all these correlations to the critical cut-off points for statistical significance. That is, any slight movement around these tabulated values may alter the statistical significance levels considerably. Thus, those for the Intermediate B TOSCA form fell just below the cut-off points and were rejected as being statistically significant whilst those for the Secondary B and the combined TOSCA forms fell just above and were accepted as being statistically significant.

(ii) The emergence of the statistically significant correlation between the Intermediate B TOSCA and the 'Descriptive' subscale of the Conceptual Style Test is interesting in that it could support Harker's (n.d.)

suggestion that the child who generates 'descriptive' concepts has an advantage in the classroom context over a child who develops 'relational' ones. However, it is not clear from these data why similar correlations were not found for the older F3 and F4 students. Figure A1.1 shows the trends in the conceptual style and TOSCA means across the four form levels examined in this study. Age-related factors could be implicated but these data are insufficient by themselves to explain the statistical correlation found between the Intermediate B TOSCA and the descriptive subscale.

Figure A1.1: Mean conceptual style and TOSCA raw scores graphed across the four form levels used in the study.



Research which monitored the preferred conceptual styles of those pupils who scored high, and those who scored low, on TOSCA, over time could provide the data necessary to explain such findings. Such research could

well be conducted within a PCP framework in which the preferred personal constructs could be elicited from the pupils at regular intervals and any alteration in the selection and/or articulation between them noted. By using a 'conversational' (Thomas, 1979) paradigm the qualitative data so generated would provide for a detailed examination of this research problem.

The second possibility raised in the introductory paragraph to this addendum, that any differences between the separate TOSCA forms and the other measures could be due to intrinsic differences between the TOSCA forms has been undermined by the lack of major differences in the correlations shown on Table Al.1. Also, it is noted that the test constructers drew the items for each form from a common pool with a clearly established profile (or 'blue-print').

> "Those items which best met the technical criteria of appropriate indices of difficulty and discrimination were selected for the item pool from which final forms were assembled."
> (Reid et al, 1980:20)

Thus, the commonality of 'scholastic ability' between the forms has been assumed. Indirect evidence of such commonality is to be found in the relationships between the scores on the separate TOSCA forms and those obtained on specific external-criterion measures generally associated with the construct of scholastic ability. That is, the magnitude of the positive correlations demonstrated between the individual TOSCA forms and other standardized achievement tests and measures of scholastic aptitude/general mental ability/intelligence is high. The TOSCA manual (Reid et al, 1980) gives detail of these correlations.

Therefore, this researcher considers the combining of the two TOSCA forms' raw scores in this study for the purposes of computing the correlations between the various empirical measures does not affect the original interpretations offered in the body of the thesis.

PART 2: QUESTIONS FOR FURTHER RESEARCH

For convenience, these questions are grouped into two broad overlapping areas and the page numbers given in parentheses (where appropriate) refer to the location in the thesis the context for the question may be found. The 'theoretical' issues arise from a consideration of aspects of some of the underlying theoretical models and empirical measures used in the study, whilst the 'pedagogical' issues arise from a consideration of aspects of possible applications of the research to the classroom context.

(a) Theoretical issues

1. The development of personal construct systems has not been thoroughly researched and this current study has indicated something of the importance of parents, peers and the media, but much specific data still require to be collected. Do different child-rearing practices affect the development of particular kinds of personal construct systems (p245)? Do these practices influence the development of different cognitive preferences (p265)? Are there critical periods for the development of particular core constructs?

2. With respect to understanding students' outlooks on science in terms of their personal constructs, what do students do and say in the context of doing science which may reveal something of their personal constructs (p289)? Are there differences, in this regard, between members of the various Polynesian groups (Fijian, Cook Islander, Samoan, Nuiean) (p185)?

3. The notions of 'fear' and 'anxiety' from a PCP perspective may relate to self perceptions of academic self-esteem. Are the core constructs, which relate to self, stable across different academic contexts (e.g. between that within an English subject classroom and that within a science laboratory) (p317)? If there are variations, why do these occur? Are there sex and/or ethnic differences? Are notions of locus of control implicated in any possible variation (p203)? Can these possible variations be controlled?

4. With respect to the conceptual style measures, are there unequivocal interpretations of the educational implications of Polynesian students' apparent preference for using a relational, rather than a categorical, style (p203)? What is the significance of such correlations as found between the field independence dimension and the TOSCA/Science Questionnaire scores, in educational terms (p244)? Are there links with the kinds of personal constructs used (p251)?

(b) Pedagogical issues

5. Reference has been made to the paucity of research on ethnic differences in Science Education in New Zealand (p35) - what needs to be done? What science curriculum would be considered of personal value to Polynesians (p282)? Is there such a 'field' as Polynesian science? How should science be taught to Polynesian students if their preferred conceptual style is other than that preferred by science teachers, curriculum developers and text-book writers (p283)? At a more general level, the question of what 'knowledge' is considered to be of value by various minority groups in New Zealand needs to be examined (p263).

6. Are girls and Polynesian students being disadvantaged in science classrooms because of the way science is taught and evaluated (pps273, 283)? Why are single sex girls' schools and some Maori schools able to positively influence their students to study science (p289)? Can scientific 'habits' be successfully taught to students (pps40, 245)? If so, how? Further work needs to be done on the parents' and pupils' perceptions of the role and functions of schools and the effects of possible teacher/pupil conflict of such perceptions investigated.

7. What specific strategies could be used to affect individuals' outlooks on science? Answers to this question could involve an action-research approach which could explore the effects of particular school/media influences on beliefs and attitudes (pps45, 256, 273).

8. A detailed analysis of individual outlooks on science could be gained by applying a series of repertory grids (such as within a longitudinal study) to children. This approach could reveal the effects particular personal experiences (within the home/school and with parents/peers/siblings and the media) have on their outlooks on science. Such an approach may heighten the individual's awareness of his/her own personal construing and allow him/her to develop 'learning-to-learn' strategies. In this regard, the use of a device to provide immediate feedback and commentary on analysed grids would be very useful (p182). Much research could be profitably conducted within this area of metacognition.