3: Children's Ideas about the Processes of Life

This chapter presents a qualitative picture of young children's thinking about the processes of life as found during the elicitation phase with individual or small groups of children. The elicitation of their thinking was carried out by teachers and researchers using a subset of the activities employed in the pilot phase. The picture presented is based on a sample of 75 children (29 infants, 23 Lower Juniors and 23 Upper Juniors). As such it does not claim to be comprehensive but simply presents a broad sketch of the typical thinking of many children in this domain. Details of the elicitation activities are provided in Appendix 2.

The elicitation consisted of a mix of activities. In some cases children were asked to provide written responses and drawings and in other cases they were interviewed. For instance, all the infant children were interviewed for all the questions because of the difficulty that many had in writing. However, with the upper and lower juniors, written responses were used wherever possible to minimise the amount of interviewing required. The elicitation of children's ideas about the living/non-living nature of a range of objects was done by interview with all children because it was thought necessary to explore their ideas on this issue as fully as possible.

The elicitation was designed to explore five areas of children's knowledge and understanding. These can be typified as

a. What choices and actions are required for healthy living?
   (Appendix 2, question 1/2/8/9/10)
b. What knowledge of the human body did children have?
   (Appendix 2, question 5/6/7/12/13)
c. What processes are performed by components of the body?
   (Appendix 2, question 4/11/13)
d. What understanding did children have of the concept of 'living thing'?
   (Appendix 2, question 15)
e. What was the child's knowledge of plants and their parts?
   (Appendix 2, question 14)

Hence the data are described under these general headings. A full analysis of the data can be found in Chapter 5.

What choices and actions are required for healthy living?

Health education is a topic undertaken to varying degrees in schools and a focus of much attention in the media. Articles and features in popular magazines, newspapers and the media often address issues of concern in this domain e.g. smoking, dietary fibre, exercise. This concern has been reflected in the curriculum with a greater emphasis placed on the development of attitudes and knowledge in schoolchildren conducive to healthy living. One simple question that arises is whether it is possible for children to understand the causal relationship underpinning their choice of actions if they do not possess a basic knowledge of their organs and bodily systems. For instance, the importance of dietary fibre has little significance if a child has no knowledge of intestines. Similarly, the effect of smoking on the alveoli of the lungs leading to emphysema and other diseases is unlikely to be understood. Despite these limitations, there is undoubtedly an element of conditioning generated by constant exposure to arguments for actions and choices for living. The question then for this research was - to what extent had such arguments been assimilated by children, and to a lesser degree - to what extent were they understood?

The first question to explore this understanding was a question which presented children with a range of foods and asked them to ring those which they considered to be healthy. The foods were categorised by the researchers into three groupings - healthy[1], indeterminate[2] and unhealthy[3] and the pupils' responses analysed. The results are displayed in Fig 3.1.

What the data show is that more than two thirds of the healthy foods were recognised by the children and that there is little variation between the age groups. Infants were slightly better at discriminating healthy foods, correctly identifying a larger percentage of those presented, but were inferior at discriminating unhealthy foods. One possible explanation is that there is a tendency on the part of infant children to indicate that *any* food is healthy and this may not reflect a greater knowledge or familiarity. The percentages for the indeterminate group of foods (bread, meat and potatoes) selected by infants as 'healthy' were also quite high. This may reflect a view that such foods are essential foods and hence healthy and a lack of knowledge of the complications attached to these e.g the eating of too much fatty meat, the lack of dietary fibre in white bread and the excessive fat in potatoes in the form of chips.

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1 Healthy foods were considered to be lettuce, orange, apples, juice, rice

2 Indeterminate foods were meat, bread and potatoes. Whilst they can form part of a healthy diet, fatty meat, white bread and chips all have particular health problems associated with their consumption.

3 Unhealthy foods were sugar, chips, coke, burgers, crisps, sweets and biscuits.

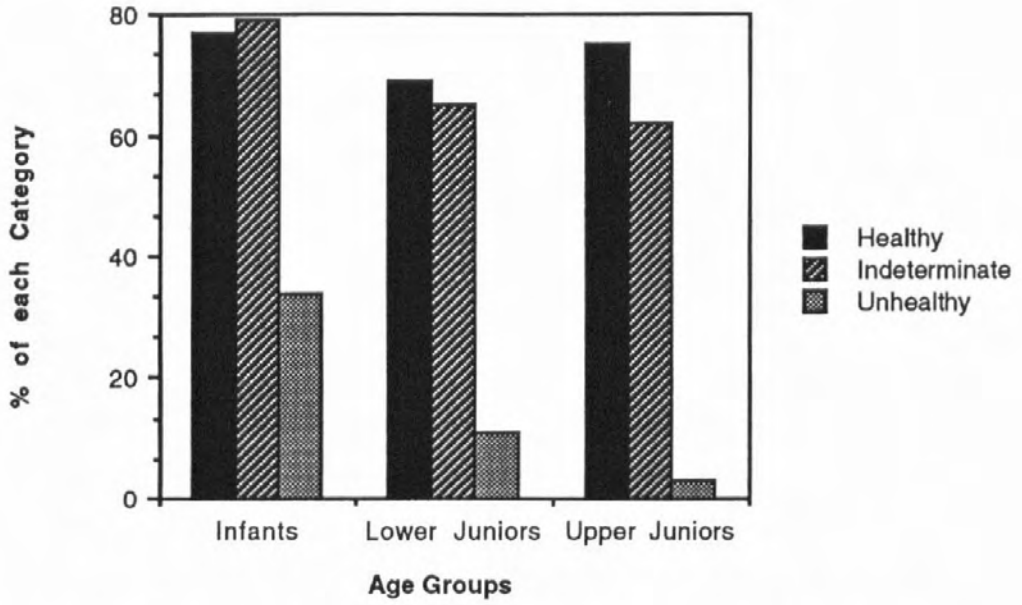

Fig 3.1: Chart showing the percentage of all the possible foods in each group identified as 'healthy' by each age group.

What this data does clearly show is that these children had little difficulty in making a judgement of what constituted a healthy food. This view was supported by another question which asked children to draw on two empty plates - a healthy meal and an unhealthy meal. Typical responses are shown in Fig 3.2 and Fig 3.3.

These responses were typical in that children of all ages were capable of making a satisfactory distinction. Older children tended to produce better drawings, mention more foods and discriminate between healthy and unhealthy foods more effectively. For upper juniors, the foods most commonly drawn as healthy in order of popularity were carrots, vegetables, lettuce and fish. Similarly for lower juniors they were vegetables, carrots, peas and fish.

However, the order for infants was chips, bread, fish and fruit. As such, this shows a marked distinction between the infants and the other two groups in the failure to recognise that chips are generally conceived of as being a relatively unhealthy way of consuming potatoes. The numbers of infants who gave these responses were also much lower than with the lower or upper juniors. Both of these facts would suggest that the notion of what constitutes a healthy food is not so clearly established amongst this group. This is also the first of many instances where a clear difference emerged between infants and the other two groups of children.

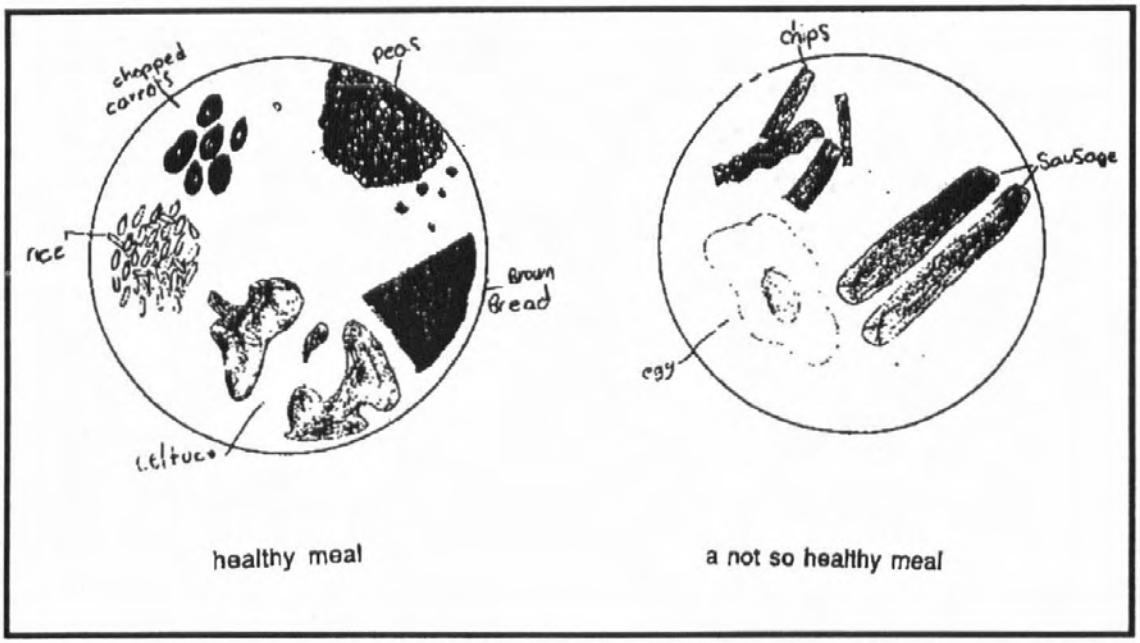

Fig 3.2: Leah-age 9

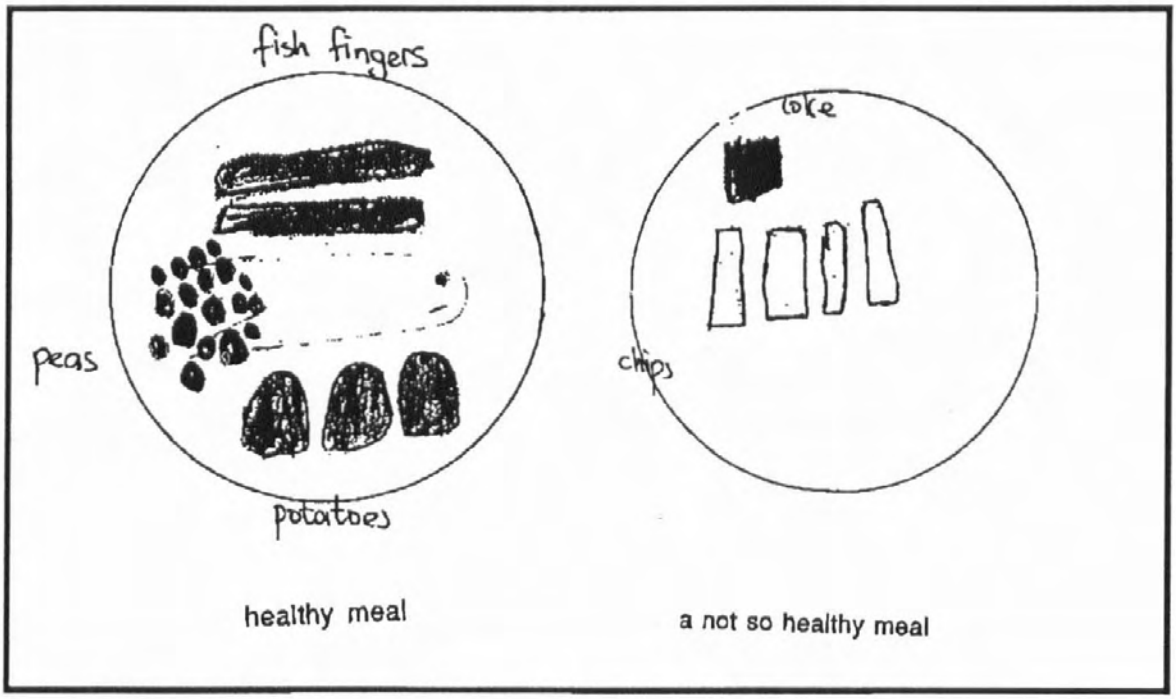

Fig 3.3: Muhammed-age 6

Children were also asked to draw four things that are to do with keeping healthy. Typical responses are shown in Fig 3.4 and Fig 3.5. Overwhelmingly, pupils of all ages drew food in response to this question. The second most popular choice was some indication of exercise or sleeping as being a healthy activity. It was notable though that

the activities tended to be 'adult' ones i.e jogging, weight-lifting which would suggest that their knowledge was a reflection of media influence. Exercise was only mentioned by a minority of the infants as opposed to a majority of the lower and upper juniors. Relatively few other activities were mentioned by children of any age group. Those that were were predominantly watching TV and drinking. The justification for the former tended to be that 'it gave you peace and quiet' and 'you learn things'.

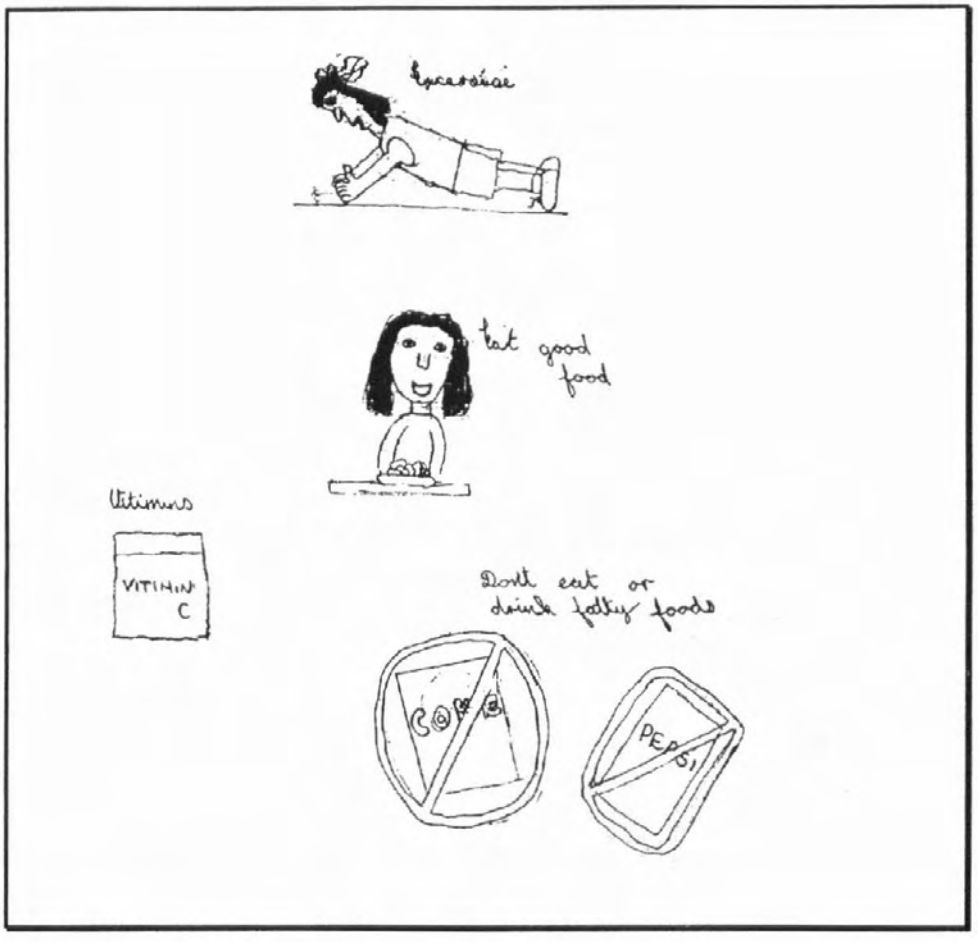

Fig 3.4 Alexis: Age 10

Taken in conjunction with the responses to the other question, the picture that emerges is that these children had already developed from their everyday experience an association of healthy living with certain types of food and were able to identify what constitutes such a food. Consequently it was unlikely that any intervention would have done anything to improve children's ability to discriminate in this domain until it provided children with a more refined knowledge of the variety of types of food and their associated functions.

The final question in this area of children's understanding of health explored whether children had an understanding of the more psychological aspect of keeping healthy associated with feelings and actions. Children were shown a list of examples (Running, feeling happy, swimming, playing with friends, sleeping, eating, laughing, reading, arguing, watching television, smoking and fighting) and asked which of these they associated with keeping healthy.

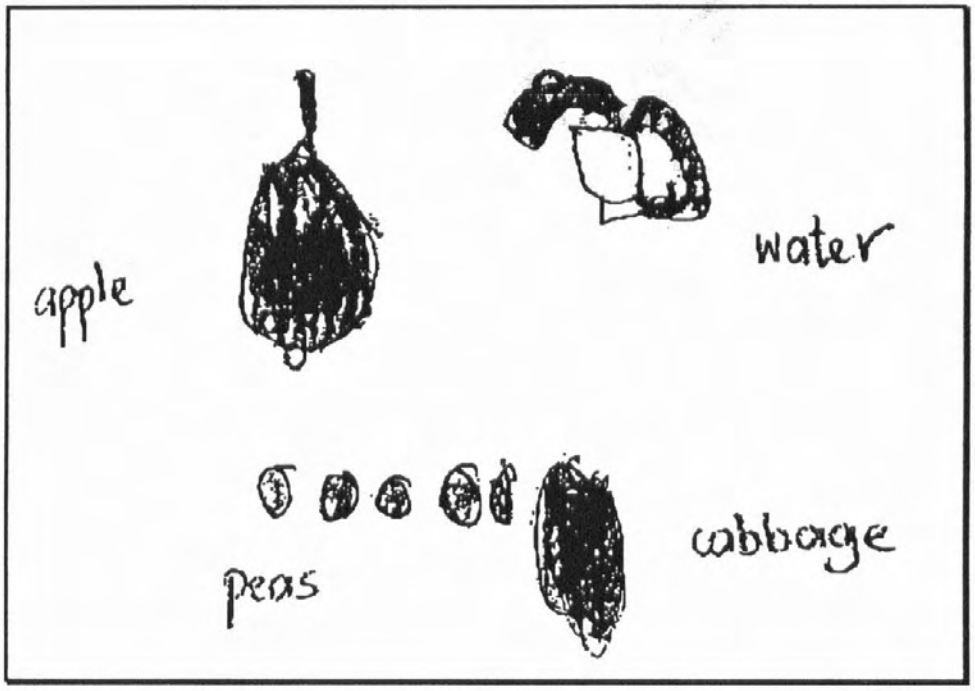

Fig 3.5 Sarah: Age 6

The activities were grouped into three groups by the researchers. These were 'healthy' (running, feeling happy, swimming, playing with friends), 'indeterminate' (reading, laughing, arguing and eating) and 'unhealthy' (smoking, watching television and fighting). Fig 3.6 summarises the data showing the extent to which children were capable of making the same choices as the researchers.

The data would again suggest that the infants were better than lower or upper juniors at discriminating 'healthy' activities. However, the fact that they selected a significant percentage of each of the 'unhealthy' activities as being 'healthy' would imply that there is a tendency by infants to select *any* activity as being 'healthy'. This would explain why they apparently seem to be more successful at discriminating healthy activities and why they state that a large number of the indeterminate activities are 'healthy'.

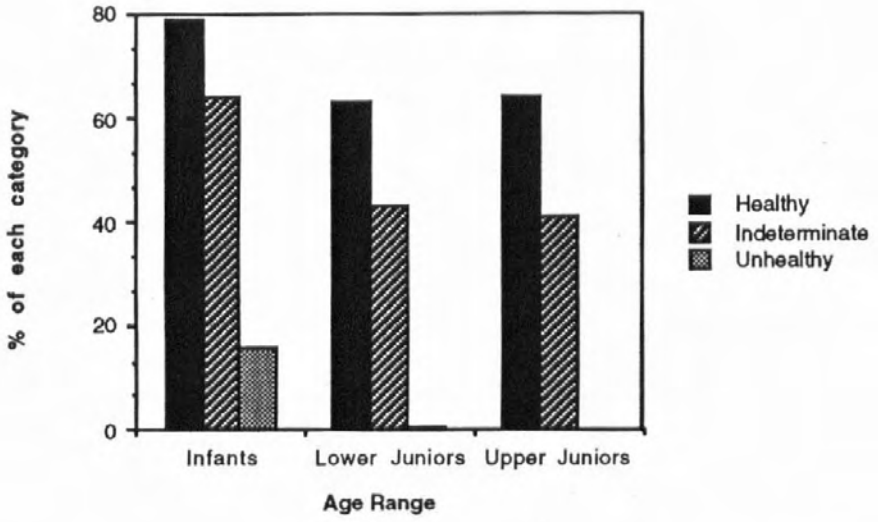

Fig 3.6: Table showing the % of all possible activities in each category selected as 'healthy' by each age range.

The limited evidence presented here suggests that children have already internalised an everyday understanding of what constitutes a healthy food and what are healthy actions/feelings by the time they have entered school. Hence the intervention was not expected to show significant changes in their responses. Whilst further work and reinforcement may be valuable for some children, progress from this baseline requires a knowledge of the body and its parts to understand the effect of common illnesses/diseases and chemicals on them. In addition, the different functions of food and their effect on the body have to be understood in order to address the concept of a balanced diet.

What knowledge of the body did children have?

This proved to be a truly fascinating area of the research. Although substantive work has been undertaken by other researchers[4], it has been done by those working in the domain of nursing and psychology and not in education. Hence the research provided an opportunity to explore the area and add to the knowledge of children's understanding of their bodies.

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4 See Gellert, E. Children's Conception of the content and functions of the human body. *Genetic Psychology Monographs*, 1962, 65, 291-411 and
Carey, S. *Conceptual Development in Childhood*. Cambridge.MIT Press. 1985

Children were asked to draw on an outline of the body what they thought was in their own bodies. Two responses are shown in the Fig 3.7 & 3.8.

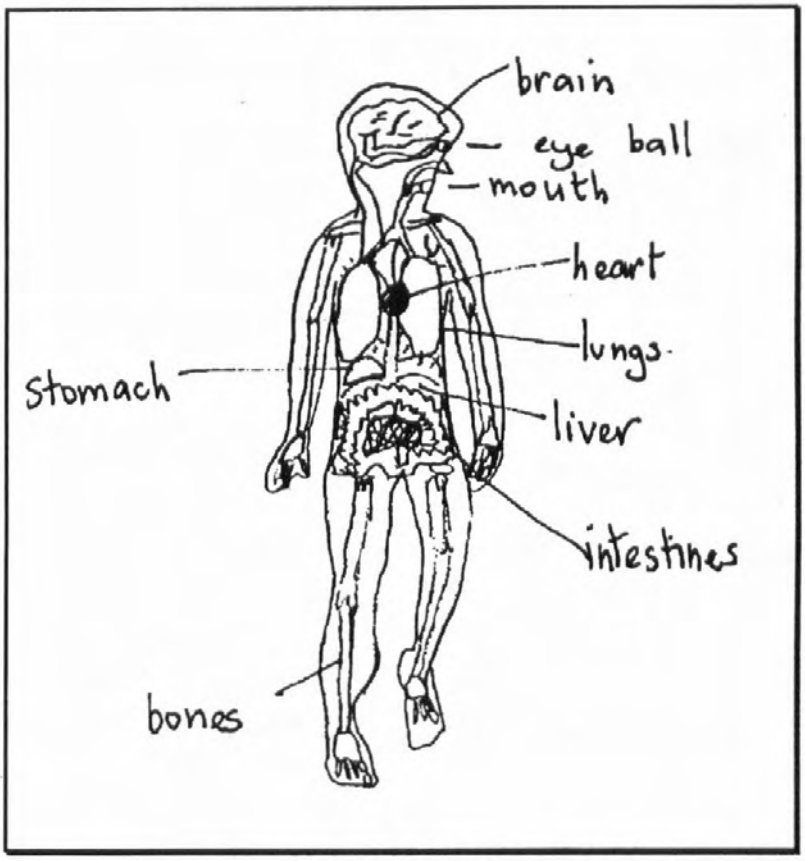


Fig 3.7: Richard[5]-age 10

The interesting aspect of this type of question is that it does not suffer from the weakness of interviews where the child may attempt to articulate a verbal response to an intuitive or incomplete view which may be taken too literally by the interviewer. The majority of children enjoy drawing and will attempt some representation of what they know. Where the nature of the representation was not clear, the children were asked to say what they thought it represented.

Fig 3.7 & 3.8 show two contrasting answers from children of the same age. The former shows a detailed biological knowledge with the organs drawn approximately to size and placed in the correct position of the body. Very few children were capable of providing such an answer. In contrast, Fig 3.8 shows a very limited understanding with only two parts drawn, neither of which is the correct shape or correctly placed. These drawings are shown to exemplify the range of answers which can be produced by upper junior children.

5 The annotations to this diagram are those of the interviewer.

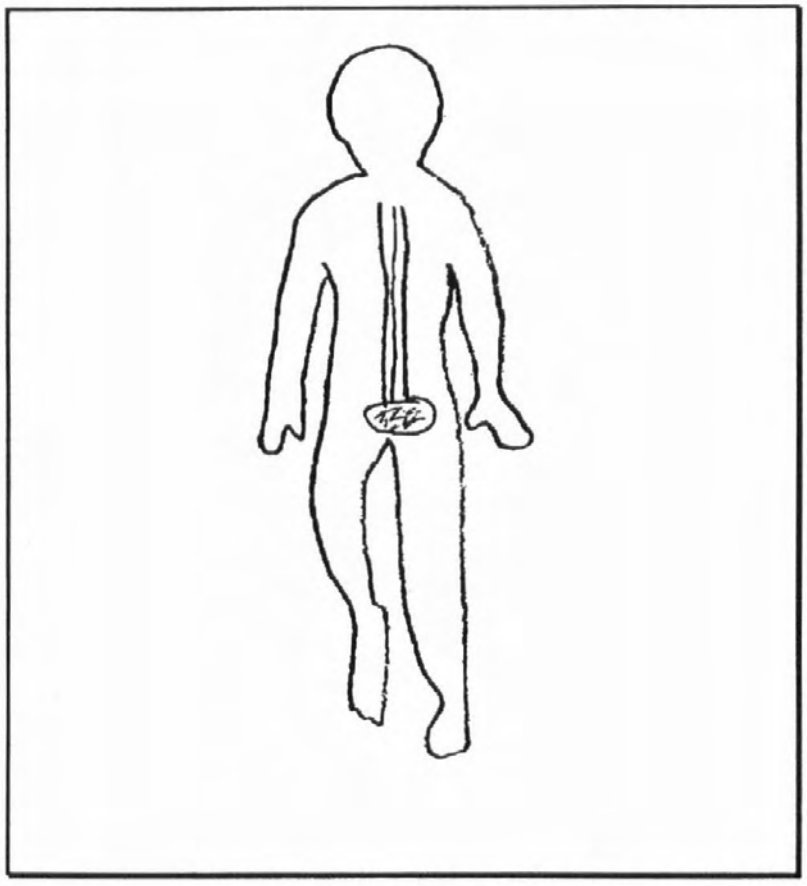


Fig 3.8: Claudia - age 10

Predominantly, children provided answers which incorporated the heart, bones, stomach and brain. Fig 3.9 shows that significant percentages of each age group mentionied these organs/parts of the body. The number mentioning the brain grew rapidly across the age range, and for infants the most commonly mentioned parts were bones. The decline in the frequency with which bones were mentioned by lower and upper juniors is inexplicable. When children are asked to *name* the parts of the body, other studies have found that blood is mentioned a large number of times as well.

On average, infants drew 3.4 organs or parts of the body which had increased to 5.0 for upper juniors. A fairly typical answer from a younger child is shown in Fig. 3.10. The increase in the number of parts drawn or mentioned supports the idea that children's biological knowledge naturally develops over this period of growth.

Fig 3.8 also reveals one of the other problems for children which is that many are not aware of the correct size and/or location of the organs. Fig 3.11 shows an example of a child's conception of their lungs.

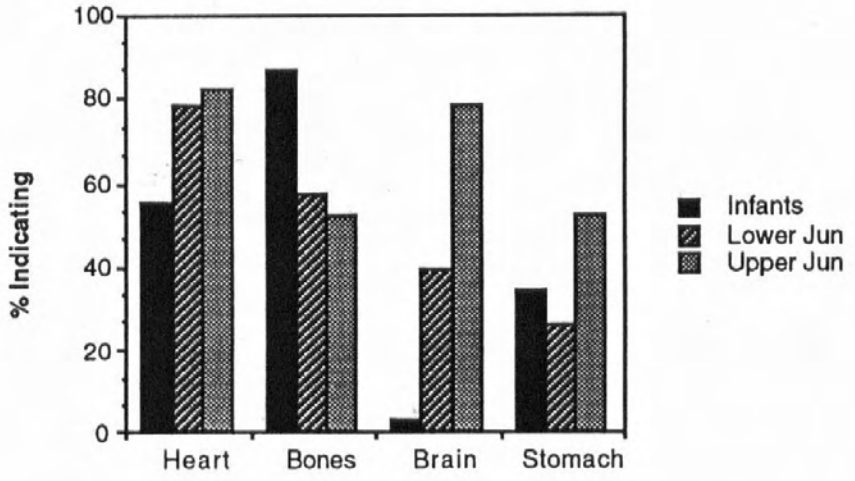


Fig 3.9: Most often mentioned organs of the body and % indicating

Such errors are not surprising since internal organs by their very nature are not visible or available for touch. Therefore it is difficult for the child to develop a knowledge of an object which can only be partially sensed. This research shows that children draw those organs or parts which are more easily sensed - the heart which beats, bones which can be felt and the brain because the capacity for self-conscious reflection and awareness has developed in children by this age. In general, organs such as kidneys, lungs, intestines are not sensed and not part of everyday language i.e. ' use you brain', 'my stomach aches', 'he's got no heart', which may provide one explanation for their lack of awareness of these organs.

Further evidence of a similar problem came from another question which asked children to add to an outline of the body to show where their heart was. Over two thirds of all the children drew the heart as a valentine shaped object (Fig 3.12). Similarly over two thirds of lower and upper juniors placed the heart on the left of the body rather than in a central location.

Infant drawings showed a wider variety of placements for its location which may indicate some uncertainty in their knowledge. Developing a knowledge of the heart and its position poses a particular problem for science educators because of the overwhelming number of everyday images which erroneously represent the heart as a valentine shaped object on the left of the body. One explanation for the data may be that infant children had not fully internalised this everyday image but this had certainly occurred for lower and upper junior children.

Fig 3.10:
Susan - age 8

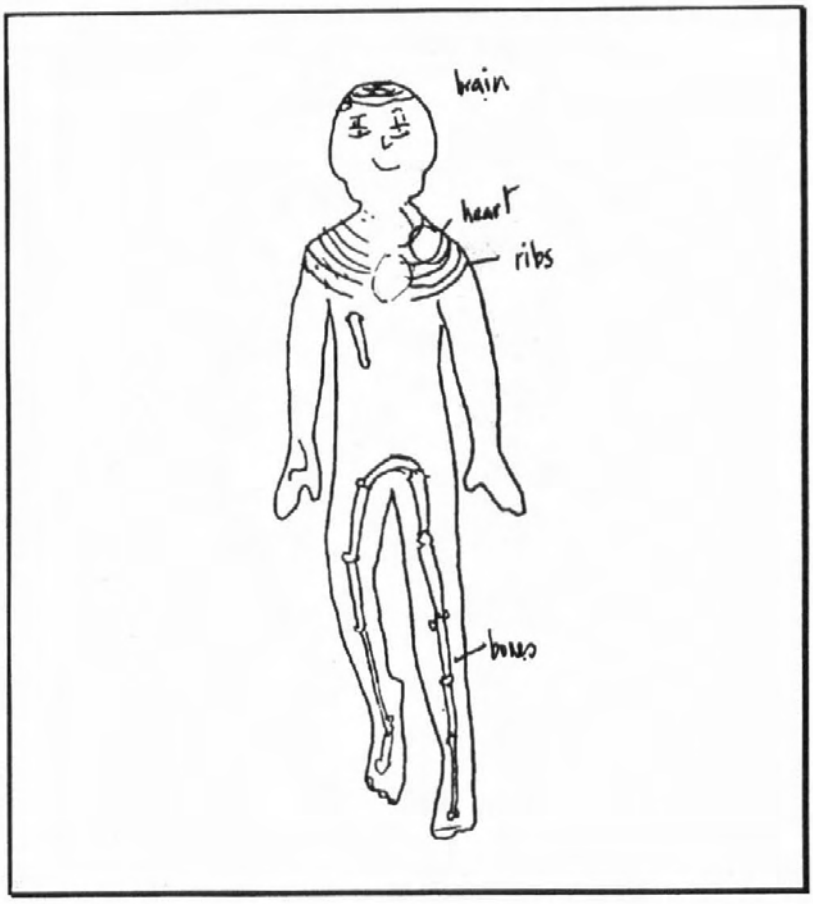
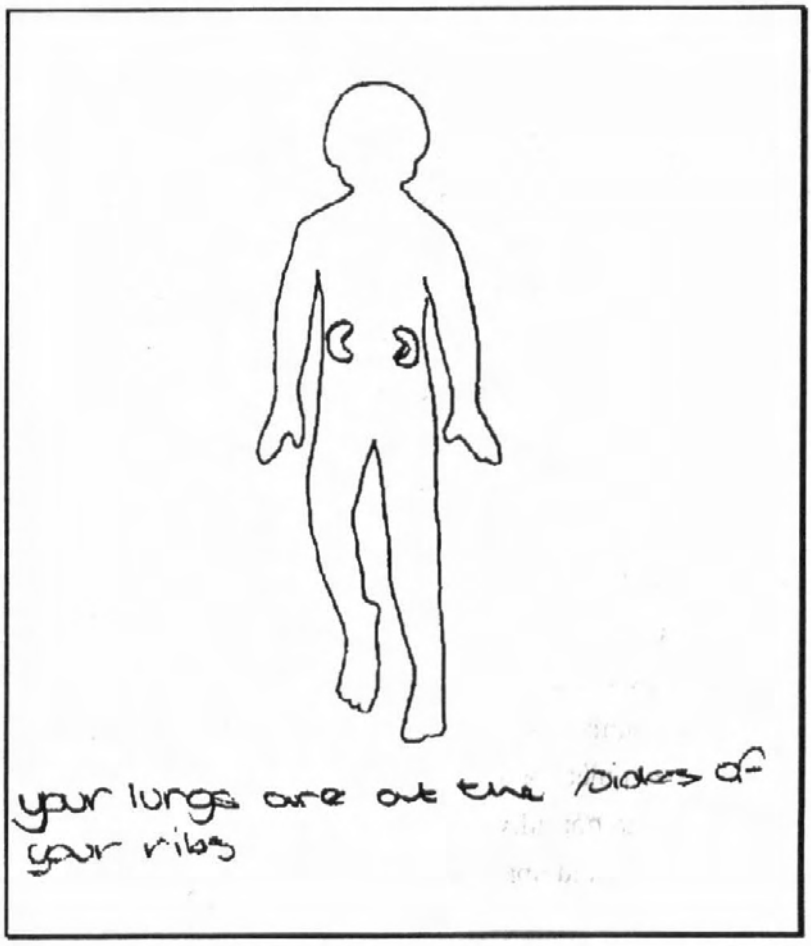


Fig 3.11:
Natalie - age 10.



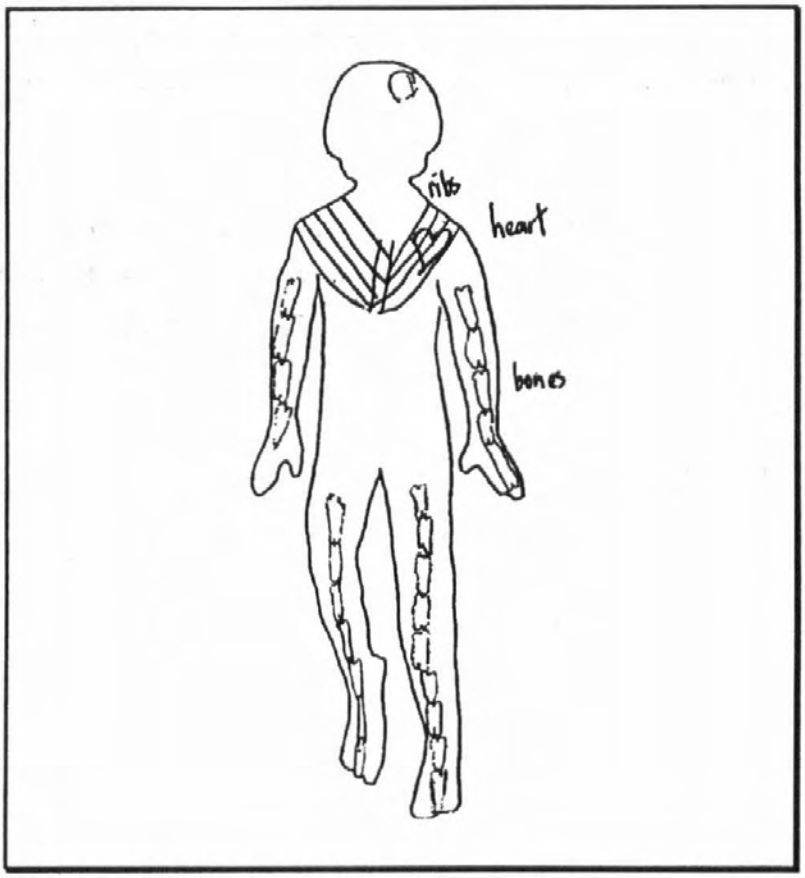


Fig 3.12: Clare - age 8

Further questions explored what these children thought the heart did and what blood was for. Typically infant children responded by indicating that the heart beats.

Beats and beats and beats and beats	Vandna-age 6
The heart beats	Tarana-age 5
Keeps you breathing and its flicking	Hamera-age 6

A greater depth of biological knowledge is shown in the understanding of older children, the majority of whom explained that the heart pumps blood.

> *Your heart beats every day and night and pumps blood into your veins. If it stops you will die.*
>
> Kelly - age 9

A few children associated its function with respiration.

It helps you to breathe	Lan - age 9

It was not possible to discover whether this was a genuine confusion or because they perceived the bodies processes on a holistic basis where organs and their function are interlinked.

Responses to questions about the purpose of blood and how it is carried around the body were more mixed and complex. At a basic level, blood was described as necessary to keep you alive by both infants and upper juniors, but surprisingly not by lower juniors. A greater level of understanding was possibly shown by those children who indicated some knowledge of a circulatory process by stating that blood moved or ran through the body.

Keeps you alive	Winston - age 10
It goes through your veins	Kevin - age 8
Go round all your body	Dean - age 5

The latter idea was held by a reasonable minority of children of all ages. However, for approximately a third of all pupils, the question proved too difficult and no response was obtained. Some of the other responses obtained to this question give a glimpse of some of the ideas, some of which are quite logical, that children can hold about the purpose of blood.

It makes you stand up	Anthony - age 8
Keeps your skin clean	Susan - age 8
It lubricates the joints	Andrew - age 10
It runs good food around the body after it has been digested.	Edwin- age 9

The final response approximates most closely to the scientific view but was expressed rarely by children. Children's ideas about how blood is carried around the body, showed a range of thinking. There were a number of younger children who tended to think that blood moved itself or that body movement helped it to move.

When you walk and do things	Dean - age 5
It moves itself	Tumseela - age 5
It moves around when you wiggle	Kathy - age 6

The latter notion carries with it the view of the body as an empty vessel around which blood sloshes. Many lower and upper junior children mentioned the veins in such responses and this shows a greater biological knowledge.

It goes through your veins Dustin - age 6

Interestingly, the term 'arteries' was never mentioned by children and this would seem to be reflection of the lack of everyday use of this term.

The final question in this series simply asked children where in the body they thought they had muscles. The result of the elicitation are shown in Fig 3.13 which shows the two locations mentioned by more than 50% of all children, their arms and their legs. The next most-mentioned location chosen was fingers (Infants 21%, Lower and Upper Juniors 0%).

The trend of the intervention was to improve children's awareness of the numbers of parts in their body with muscles. However, this evidence again supports the notion that these children were only aware of those parts of their body which can be directly sensed or perceived i.e. muscles in the arms and legs.

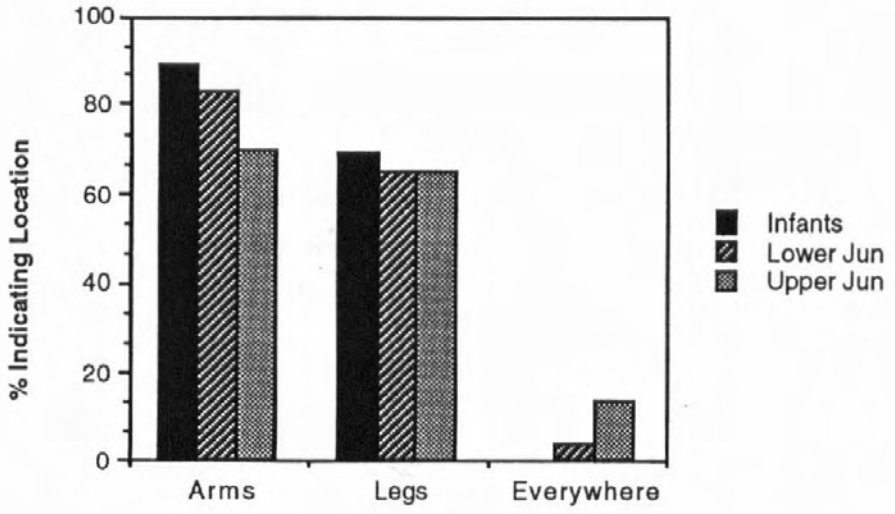


Fig 3.13: Percentage of children mentioning that muscles could be found in the arms, legs and everywhere in their body.

What processes are performed by components of the body?

The research chose to examine children's understanding of the process of digestion and respiration. The process of sexual reproduction was avoided because of the difficulties of conducting research in this area with young children, and the concepts of growth and excretion were explored through asking children whether they thought a range of objects were alive, not alive or once living.

To examine what children understood about the process of digestion, children were asked to add to an outline of the body to show what happened to food in their body. This question produced a wide range of responses which illustrated the range of children's understanding and the development of their biological knowledge. At the simplest level, children would simply draw a body cavity (Fig 3.14) containing untransformed food with no tube. Alternatively, food would be shown distributed through the human body (Fig 3.15).

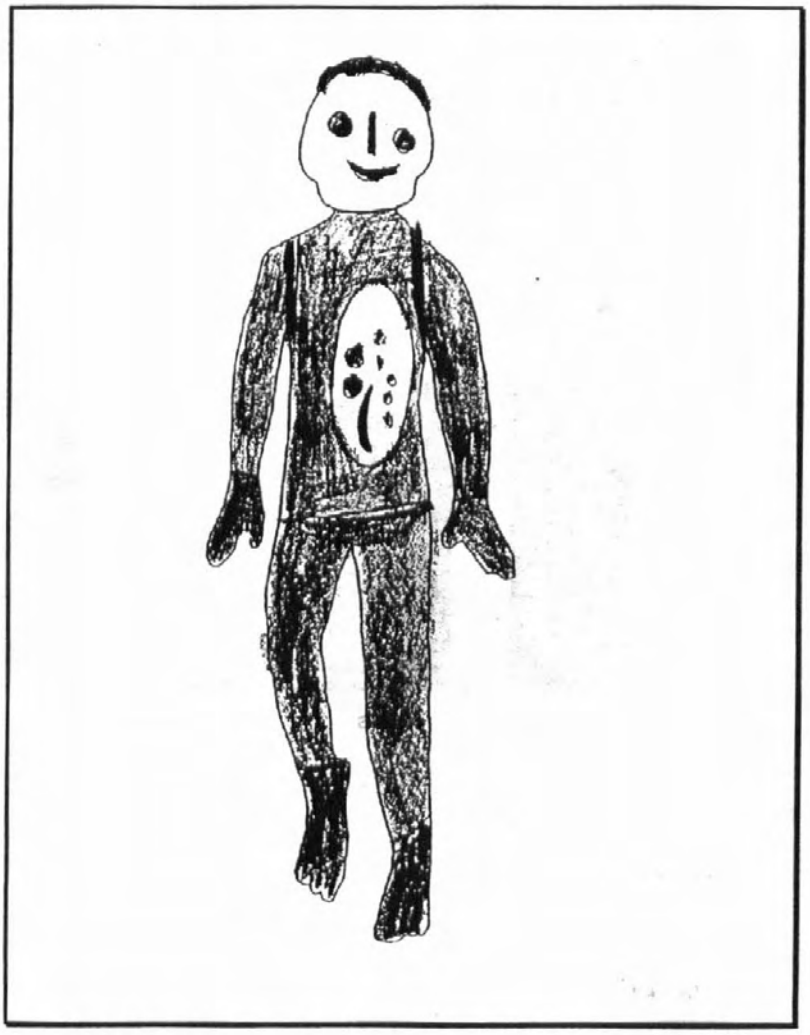


Fig 3.14: Sashidaren - age 6

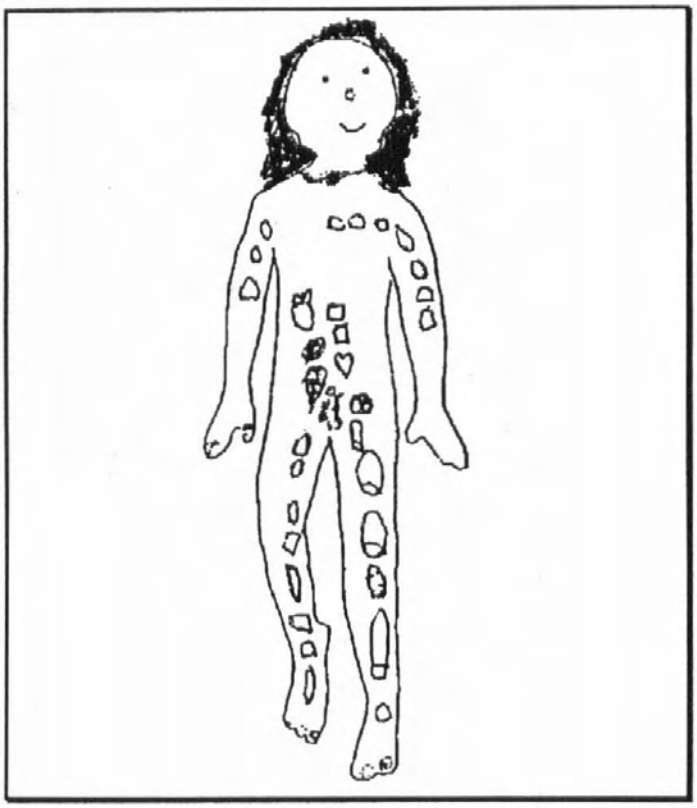


Fig 3.15 Tumseela-Age 5

As with all children's drawings, these and those that follow raise the question whether such drawings represent the limits of children's knowledge or alternatively, the limits of their representational capabilities. Firstly, it should be noted that only younger children produced drawings of this type and that the drawings show a lack of recognition of any physical connection between the mouth and the stomach or inside of the body. Secondly, some children who provided such drawings would qualify them with statements such as 'It (the food) goes into the blood. The blood goes everywhere.', which would suggest that they recognise that there was a process of at least partial transformation and that the drawings may not represent the limits of their understanding but the limits of their ability to represent food.

What these drawings lend support to is the view that an understanding of the process of digestion requires a comprehension that food can be transformed and broken down into its constituents. Till children understand this idea, the process of digestion will remain a mystery to them.

The next feature to emerge in children's responses was the tendency to draw two tubes from the mouth to the stomach. Fig 3.16 and Fig 3.17 show two good examples of such a drawings.