COGNITIVE LEVEL, AGE, AND VERBAL ABILITY AS PREDICTORS OF CHILDREN'S CONCEPTS OF HEALTH AND ILLNESS

by

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ABSTRACT

This study was designed to investigate the relative contributions of cognitive level, age, and verbal ability to the prediction of children's concepts of health and illness. The rationale for the study was based on the premise that children's cognitive developmental level would have relevance when preparing programs for child health education.

The sample consisted of 40 subjects ranging in age from 5 to 13 years who were already participants in the Preadmission Preparation Programs Study, a research project being conducted at B.C.'s Children's Hospital in Vancouver. There were 10 children selected from each of four age groups: 5-6; 7-8; 9-10; and 11-13. The subjects were administered a Health Questionnaire and a battery of Piagetian tasks representing both the concrete operational and formal operational stages of cognitive development. Verbal ability was measured by the Peabody Picture Vocabulary Test - Revised (PPVT-R).

In a stepwise multiple regression equation, with level of health concept as the criterion variable and cognitive level, age, and verbal ability as the predictor variables, it was hypothesized that, (1) cognitive level would be a stronger predictor of level of health concept than the predictors of age and verbal ability, (2) cognitive level together with age would be a stronger predictor than either index on its own, and (3) verbal ability would account for a significant portion of the variance with regard to level of health concept over and above that already accounted for by cognitive level and age. The expected entry sequence into the prediction equation was cognitive level on step 1, age on step 2, and verbal ability on step 3.

The results indicated that all three predictor variables, taken individually, were significantly correlated with the criterion variable; however, the expected entry sequence of variables into the prediction equation and the expected net effect of combined variables were not supported by the data analyses. Age was selected for entry on step 1 and verbal ability was selected for entry on step 2; cognitive level was not selected to enter the prediction equation. When forced into the equation on step 3, cognitive level contributed a negligible

additional amount of variance to the efficacy of prediction. Although cognitive level correlates highly with level of concept, when the effects of age are partialed out, the contribution of cognitive level is not significant.

Given some of the limitations of the study, small sample size and restricted range of scores for level of health concept and for the Piagetian assessment, it was suggested that in a further study with a greater representation of formal operational thinkers, there may be more support for the hypotheses.

Directions for future research were discussed in terms of conducting a similar study with a sample that has a good representation of both concrete and formal operational thinkers so that the prediction strength of cognitive level can be tested within a restricted age limit. Another suggestion was that research focus on the interaction of specific cognitive concepts with health concepts to provide a greater understanding of the developmental sequence of conceptualization of health and illness.

Implications for child health education were discussed in terms of knowledge of cognitive developmental level enabling medical personnel to communicate more effectively with children and plan appropriate intervention strategies for them.

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Chapter 1

INTRODUCTION

This study was designed to investigate children's concepts of health and illness in relation to their cognitive developmental level as determined by performance on a set of Piagetian tasks measuring both concrete and formal reasoning. The study developed out of a major research project which involved preadmission preparation of children undergoing elective surgery at B.C.'s Children's Hospital (Robinson, Conry, & Harper, 1986). The rationale for the study was suggested by the literature supporting the premise that children's cognitive developmental level would have relevance when preparing programs for children in the area of health and illness. The question then is: how well can a child's cognitive developmental level predict the level of his conceptualizations of health and illness?

1.1 BACKGROUND OF THE PROBLEM

There is a growing literature concerned with children's concepts of health and illness and the consequent implications for appropriate materials and strategies for health education and medical explanations by physicians and other professional personnel. In the past, major consideration has been given to the affective domain often interpreted from psychoanalytic theory (Beverly, 1936; Edelston, 1943; Langford, 1948, 1961; Freud, 1952). Many studies since the 1940's have commented on the emotional effect of hospitalization, surgery, and illness on children (Vernon, Foley, Sipowicz, & Shulman, 1965).

More recently, studies have been directed toward the effect of cognitive developmental level on children's concepts of health and illness with therapeutic intervention based on an interaction between the affective and cognitive domains. Bibace and Walsh (1980) in their study of the development of children's concepts of illness suggest that teaching materials and strategies be directed toward the specific cognitive developmental level of the child. Brewster (1982) in her study of the concepts of illness of chronically ill hospitalized children recommends that patient education programs be designed to fit each child's cognitive and emotional needs. In their investigation of physician communication with children and parents, Pantell, Stewart, Dias, Wells, and Ross (1981) acknowledge the importance of involvement at a cognitively appropriate level. Pantell et al. point out that effective communication can be a therapeutic lever in that experimental studies have indicated a reduction in the number of surgical complications when experimenters communicated with children prior to surgery. Their suggestion that the child be an active participant in the medical process presupposes communication at a cognitively appropriate level.

Contemporary literature strongly suggests that children's concepts of health and illness are highly correlated with developmental level. In a review of recent literature, Bibace and Walsh (1981) identified three major groups of studies: (1) the predominantly early studies which basically examine concepts in relation to age without reference to specific developmental theories (Brodie, 1974; Campbell, 1975; Mechanic, 1964); (2) the intermediate studies which relate conceptual level to age and then offer post-hoc explanations in terms of cognitive developmental level (Palmer & Lewis, 1975; Natapoff, 1978); and (3) those studies which use cognitive developmental theory to predict differences in concepts at differing ages (Carandang, Folkins, Hines, & Steward, 1979; Neuhauser, Amsterdam, Hines, & Steward, 1978; Simeonsson, Buckley, & Monson, 1979).

Bibace and Walsh (1980) attempted to show how the general stages of cognitive development are expressed in the particular content area of explanations of illness. They were able to identify six qualitatively different categories of explanations of illness that are developmentally ordered using chronological age as the gross index of developmental status. Bibace and Walsh acknowledge that all indices are embedded in content and that no index is really independent. They suggest, however, that age is probably the index least embedded in content and is, therefore, quite appropriate as a general index of developmental status.

Several studies have relied on age as the sole indicator of developmental level (Neuhauser et al., 1978; Steward & Regalbuto, 1975; Steward & Steward, 1981). Other researchers have opted for additional measures of performance such as Piagetian-type tasks of conservation and physical and social causality and other tasks such as role taking and social identity. In some studies these additional performance measures have served as the index of cognitive development with which to compare concepts of health and illness (Simeonsson et al., 1979; Carandang et al., 1979) while in other studies the focus appears to be on the intercorrelations among the tasks themselves (Perrin & Gerrity, 1981; Brewster, 1982).

It is evident from the above studies that although the researchers recognize the importance of relating cognitive level to concepts of illness and health, there is no consistent means of establishing cognitive developmental level and little rationale is provided for the selection of particular tasks. In those studies which make reference to Piagetian tasks, researchers have focused on conservation tasks as the sole measure of cognitive level attainment (Bernstein & Cowan, 1975; Carandang et al., 1979; Perrin & Gerrity, 1981). By limiting their criterion to performance on just one measure, they have weakened the validity of their findings.

While the structure of the development of cognitive skills is very complex, it is generally acknowledged that concrete operational thought is organized over a period of years. In their four-year study of the development of concrete operational thought, Tomlinson-Keasey, Eisert, Kahle, Hardy-Brown, and Keasey (1979) concluded that the process was one of "gradually emerging skills that are related" and that "the form of the relationship is such that certain skills precede others as prerequisites." This gradual process supports the directional nature of change documented by Kuhn (1972) and Arlin (1981).

According to Arlin (1981), there are a minimum of three subsystems representing the concrete operational stage: seriation, classification, and conservation. The three subsystems represent gradual acquisitions of concepts by the application of the "logic of classes" and the "logic of relations" to new situations as they are encountered.

The majority of studies involving Piagetian-type tasks have dealt with establishing the concrete level of thought; fewer studies have included measurement of formal thought. The measurement of formal thought in these studies has been based on performance in a task of conservation of volume and sometime an additional task related to abstract thinking. Perrin and Gerrity (1981) determined whether subjects had reached the stage of formal operations by their understanding of conservation of volume and their abstract interpretation of a common proverb. Although measuring only a very limited aspect of formal operational thought, researchers, nevertheless, tend to attribute all the qualities of thought processes associated with formal thought to the subject who has performed successfully on one or two representative tasks, which may lead to type I errors. Conversely, they may be committing type II errors by eliminating large numbers of subjects who are essentially formal operational but lack the particular concept being measured. The studies under review have samples of subjects in various age groups, ranging from 3 to 16 years of age and yet the same tasks have been employed with little or no rationale provided for the selection of tasks.

The traditional assessment of formal reasoning involves performances on eight formal concepts: multiplicative compensations, probability, correlations, combinations, proportional reasoning, the coordination of two or more systems of reference, mechanical equilibrium, and forms of conservation beyond direct verification (Inhelder & Piaget, 1958; Arlin, 1982). Inhelder and Piaget (1958) define these schemata as "the concepts which the subject potentially can organize from the beginning of the formal level when faced with certain kinds of data, but which are not manifest outside these conditions." Hence, many formal operational thinkers may readily lack one or another of these schemata.

1.2 STATEMENT OF THE PROBLEM

Although there is considerable evidence to support the premise that children's conceptions of health and illness progress along a developmental sequence, there has been no consistent means of relating this developmental progression to the Piagetian stages of general cognitive development. Researchers have limited their assessment of cognitive level attainment to performance on one or a few tasks involving conservation of mass, weight, and volume rather than tapping into the framework of gradual acquisition of abilities and relating these acquisitions to the child's developing concepts of health and illness.

The actual content area of concepts of health and illness has been investigated with increasing sophistication. Bibace and Walsh (1980, 1981) have delineated well-documented sequences of development equivalent to the cognitive stages of Piagetian theory. Using their system of coding for level of concept, this study purports to examine level of concept with regard to cognitive level, age, and verbal ability. The problem then that will be investigated in this study is to what extent the variables of cognitive level, age, and verbal ability contribute to the prediction of a child's level of conceptualization of health and illness.

The expectations for the present research are:

1. That cognitive developmental level is a stronger predictor of the concomitant concepts of health and illness than developmental level based solely on the index of chronological age.
2. That cognitive level together with age will be a stronger predictor of level of concept than either index on its own.
3. That verbal ability (operating as an additional measure of cognitive competence) will also account for a significant portion of the variance with respect to these concepts.

The variables to be investigated will now be described in terms of operational definitions.

1.3 DEFINITION OF TERMS

1. Level of concept is defined as the category of explanation given by the subject with respect to questions regarding concepts of health and illness.

2. Cognitive developmental level is defined as the level of thought process associated with the attainment of a particular Piagetian stage as assessed by the administration of a battery of tasks.

3. Verbal ability is defined as the language quotient attained by performance on a standardized test i.e. Peabody Picture Vocabulary Test-Revised (PPVT-R) which is considered to be a reliable and valid measure of receptive language.

1.4 JUSTIFICATION OF THE STUDY

In terms of clinical implications, many researchers have given credence to the importance of cognitive developmental level whether determined by age or other indices. Cook (1975) contends that children's psychological reactions to illness and hospitalization cannot be understood without knowledge of their conceptions concerning these experiences. Bibace and Walsh (1981) suggest three practical uses for their research in the area: establishing empathy, using the information to design meaningful educational strategies and materials, and understanding the degree of control over health and illness that a child might feel. Brewster (1982) recommends that hospital personnel put "information gathering" before "information giving". She suggests that staff members must determine how children view the cause of their illness and the reason for treatment in order to design effective programs.

The present study proposes to offer further support for the premise that children's conceptions of health and illness are closely related to their level of cognitive development. The study was designed to provide further knowledge in the field by presenting a more clearly defined rationale for the assessment of cognitive developmental level than has been put forth in previous studies. Furthermore, through the process of cross-validation, it may be possible for medical personnel to estimate cognitive level by posing questions related to causation of illness. In addition to using the general index of age, they will have access to a further index in order to more accurately predict a child's conceptualization of health and illness and plan intervention strategies accordingly. This additional index purports to be more sensitive to the concept of gradual acquisition of level of cognitive development.

In summary, then, the present research may have relevance both in terms of clinical implications and in terms of methodological strategies.

Chapter 2

REVIEW OF THE LITERATURE

According to the literature, children's concepts of health and illness have been viewed from the perspective of two major theoretical traditions. This review will trace the shift in focus from the psychodynamic framework to the cognitive developmental framework and will critique the major studies of interest as they relate to the problem of the present study. Emphasis will be placed on research that has been carried out within the cognitive developmental model with particular reference to those studies which have contributed to the formulation of the problem statement.

2.1 CONCEPTS OF HEALTH AND ILLNESS WITHIN A FRAMEWORK OF PSYCHODYNAMIC THEORY

Much of the literature concerning children's conceptions of health and illness is related to the psychodynamics of illness and hospitalization. It appears to be well documented that the experience of illness and hospitalization is a psychologically stressful situation with regard to both short term and long term implications (Vernon, Foley, Sipowicz, & Schulman, 1965). Within the framework of psychodynamics, the primary emphasis has been on the impact of illness and hospitalization on children's emotional well being. Psychoanalysis has been the major theoretical basis for understanding and intervening in the behavioral problems of ill children. It has been reported that the trauma experienced by the child could result in mood swings, loss of self-confidence, temper tantrums, and phobias (Freud, 1952). Much of the negative affect was presumed to be related to the child's belief that he was being punished for something that he has done wrong and that he was to blame for the onset of illness (Beverly, 1936; Nagy, 1951; Langford, 1948). From the literature of these researchers, it seemed apparent that the feelings of the sick child were related to his beliefs or concepts about illness. Children's concepts of health and illness were considered only in relationship to the psychological reactions accompanying the illness experience. A number of studies evolved from the awareness of the importance of children's beliefs about illness in order to better understand their fears and to help alleviate them.

Many of the earlier studies were more in the nature of observations, descriptions of case studies, or general surveys rather than in the form of methodologically controlled research. There is, however, a similarity in their findings in terms of the association of punishment and wrongdoing with illness.

One of the earliest researchers, Beverly (1936) reported the association of punishment and blame with illness. In a survey of hospitalized cardiac and diabetic children, 90% of the respondents interpreted the cause of illness as wrongdoing. When specifically questioned about their own illness, 90% of the cardiac patients reported that they became ill because "they had run too much", while 85% of the diabetic patients responded that "they ate too much sugar". Beverly stated two reasons for the association of fear with medical procedures: the possibility of death, and the "mystery and magic" related to the background of medicine with the accompanying connotations of sin and punishment. Beverly provided very limited information regarding the format of his survey. Many of the conclusions that he has drawn appear to have been based on observation from individual case studies.

Separation from parents during hospitalization was another frequently cited source of distress and thought to be connected with wrongdoing and punishment (Edelston, 1943; Langford, 1948). Edelston interpreted "separation anxiety" as being caused by a feeling of rejection due to a wrongdoing on the part of the child. According to Langford, parental admonitions directed to the child in terms of threats (i.e. that he would catch a cold if he didn't wear his boots) could lead to the conceptualization that illness was punishment.

Freud (1952) discussed the effects of nursing, medical, and surgical procedures and the effects of pain and illness on children from a psychoanalytic perspective. She commented that some surgical procedures could be interpreted as mutilation or castration. With regard to illness as an act of punishment, Freud observed that many restrictive measures used as punishment were also often in effect during the process of treatment of illness: (i.e. food restrictions, bed and room confinement). Again, it would appear that Freud's arguments were based on clinical experience from the viewpoint of psychoanalytic interpretation rather than through the use of controlled methodology.

Many other studies have noted the association of wrongdoing, punishment, and blame with illness and hospitalization (Vernon et al., 1965). Children were found to have misconceptions about the cause of illness and the necessity of hospitalization. Medical procedures were seen as being punitive making it difficult for medical personnel to carry out their treatments and to intervene in the reduction of stress. As misconceptions about illness and hospitalization came to be identified as factors contributing to psychological distress, researchers began to further explore the nature of children's beliefs about illness. The awareness of the importance of children's concepts of illness and the developmental psychologist's increasing interest in cognition and causality have generated a considerable amount of research in this area (Bibace & Walsh, 1981).

The studies which have used the framework of psychodynamic theory have generally interpreted children's views as a moral issue. Cook (1975) contends that methodology is influential in the kinds of responses that children will make. He found that children's spontaneous explanations tended to be more immature than they were actually capable of giving and that spontaneous explanations were more frequently related to moral issues.

From the brief survey of studies in this section, it seems evident that the findings are subject to at least two major criticisms. First, there is a problem of confounding theoretical implications. It would seem that the psychoanalytic approach is particularly susceptive to presupposing causality: i.e. linking "separation anxiety" with wrongdoing and punishment. Secondly, methodologies differ considerably making comparisons among findings difficult. Most early reports appear to be based on observations made from individual case studies. Questioning techniques vary considerably from eliciting notions of causality from pictorial representations to answering "yes-no" questionnaires. Lack of adequate description of methodological procedures further weakens reliability and validity.

Thus it would seem that the theoretical orientation of the researcher and the type of methodology (i.e. questioning technique used during the investigation procedures) could have an effect on the type of responses elicited from children regarding their conceptualization of health and illness. These factors become further apparent in the discussion in the following section.

2.2 CONCEPTS OF HEALTH AND ILLNESS WITHIN A FRAMEWORK OF COGNITIVE DEVELOPMENTAL THEORY

Several studies have focused on children's concepts of health and illness within the framework of cognitive levels of development. Different lines of reference have emerged from the cognitive developmental tradition. Some researchers have been concerned with understanding the physical mechanisms of health and illness (Carandang et al., 1979; Perrin & Gerrity, 1981; Bibace & Walsh, 1981) while others have examined the moral implications (Kister & Patterson, 1980) and the psychosocial implications (Millstein, Adler, & Irwin, 1981). Those concerned with the physical mechanisms have related concept level with age (Bibace & Walsh, 1981; Brodie, 1974) or other indices such as developmental level determined by Piagetian-type tasks, role taking tasks and others (Brewster, 1982; Perrin & Gerrity, 1981). Those concerned with moral implications have focused on the examining of the concept of "immanent justice" in relation to concept achievement (Medinnus, 1959; Kister & Patterson, 1980). Still others have explored a dual model involving cognitive development as well as psychosocial and/or moral development (Millstein et al., 1981; Simeonsson, Buckley, & Monson, 1979).

The survey of the literature in this section will focus on the studies concerned with understanding the physical mechanisms of health and illness. Some studies are of particular interest because they have served as models for generating further research (Bernstein &

Cowan, 1975; Perrin & Gerrity, 1981; Bibace & Walsh, 1981). These and other studies will be critiqued in terms of their strengths and limitations and their relevance to the present study.

As with the early studies discussed in the previous section, the earliest studies operating within the cognitive developmental framework also have methodological weaknesses and limited information is provided regarding samples and procedures. It is, however, interesting to note the increasing sophistication in research design over the past four decades.

One of the earliest researchers to report on developmental trends in the responses of her subjects was Nagy (1951, 1952, 1953). She investigated children's ideas about health and illness and about "germs" and found that children between the ages of 3 and 5 could not understand the causes of illness; children of 6 or 7 years of age believed that illness was due to infection but could not specify any further; children of 8 to 10 years of age were able to associate infection with "germs"; children of 11 to 12 years of age were able to acknowledge that illnesses were caused by different "germs". Nagy provides very limited information about her samples and methodology which makes her work difficult to interpret. Her interpretation of the data did not seem to take into account the moral aspect of causality.

Blos (1956) appears to be the first researcher to organize results within a Piagetian framework. His study (cited in Cook, 1975) involved 42 healthy children comprised of three age groups: 5 to 6 year olds, 7 to 8 year olds, and 9 to 10 year olds. Responses were elicited to questions related to a series of illustrations depicting situations related to illness. The data were interpreted in terms of three stages of development: (1) the descriptive stage, (2) the explanatory stage, and (3) the causative stage. Blos pointed out that these stages were similar to Piaget's categories of conceptual thinking.

At about the same time period, Gips (1956) investigated ill children's interpretations of the cause of illness and their concepts of diagnosis, therapy, and hospital setting. According to Gips (cited in Cook, 1975), most children tended to view causation of illness in terms of blame and the index of age determined whether the blame was attached to self or others. Gips questioned 100 hospitalized subjects about the blame for illness by using a projective picture. Blame attributed to outside forces decreased with chronological age. Cook (1975) points out a pertinent limitation of the study in that the investigator's categorization system of causality of illness indicated that the basis for categorization was primarily on the nature of the causal agents that the child used with no consideration given to the additional qualifying statements.

Gellert's (1961) investigation included both sick and healthy subjects. Her sample was composed of 72 hospitalized children and 30 healthy children ranging from 4 to 16 years of age. The subjects were presented with a picture of a sick child lying in bed and were asked questions related to the cause of illness. In support of Gips' results, Gellert also found that attribution of blame decreased with age which suggests a trend toward increasing objectivity. Cook levels the same criticism towards Gellert's study as he did at Gips in that her assumptions may have presupposed the number of blaming statements to the detriment of objective ones. Thus it would appear that different kinds of questioning techniques elicit different kinds of responses in the data making comparisons among studies difficult to carry out.

Brodie (1974) found that the views of healthy children toward illness differed from those of ill children and from those of children with a high level of anxiety . In her study, 408 students comprised of 114 first graders, 135 third graders, and 159 fifth graders were tested with group "true-false" questionnaires, the Sarason General Anxiety Scale for Children (GASC) and the Children's Illness Anxiety Scale (CIAS). In making her final evaluations, Brodie used findings from other studies conducted on ill children as a comparative framework. In view of the fact that different methodologies were used, the validity of her study was weakened (Cook, 1971).

In reviewing the literature prior to the time of his study, Cook summarizes three important factors influencing children's concepts of health and illness: (1) the state of health of the subjects, (2) the age of the subjects, and (3) the methods of investigation. Cook points out that state of health being a significant variable is congruent with Piaget's theory about the interaction of the affective and cognitive domains. Age as a significant variable is clearly an integral aspect of Piagetian theory. As for the third factor, Cook contends that divergence in results is at least partly due to the fact that "different methods of investigation tap different kinds of thinking."

It would appear that the early studies focused on concepts of health and illness in terms of general developmental progression with age and on discerning whether there were differences in concepts from healthy children as opposed to ill children. It is clear that efforts to compare results among various studies meet with difficulty because of differing methodologies and differing assumptions made by researchers depending upon their theoretical viewpoint. Experimental constructs and operational definitions are often ambiguous. Direct comparisons then have been obscured by basic theoretical and methodological differences.

Cook (1975) investigated the comparative development of causality with regard to illness and with regard to another non-medical phenomena (i.e. rain) within a single methodological framework involving both healthy and ill children. It was hypothesized that the level of maturity of children's causal thinking would be influenced by age, state of health, and the nature of the phenomena explained. Cook found that children's explanations of the causes of illness and rain became increasingly mature as they grew older. Explanations of rain were generally more mature than explanations of illness. Sick children tended to give more immature explanations of both rain and illness than healthy children. It was Cook's contention that the immaturity of children's explanations of illness was not of a purely cognitive nature; they represented an attempt to maintain cognitive and emotional control over an otherwise frightening situation. While acknowledging some methodological weaknesses in his study, Cook contends that his research demonstrated two important factors related to the maturity of children's explanations: degree of structure within the questioning technique, and the semantic form of questioning. His research is an important advance because of his use of a strict methodology and his attempt to use a controlled methodology to investigate a problem which had previously resulted in conflicting data: that of the comparison of level of concept of healthy and ill children.

Researchers continued to explore children's concepts of health and illness in relation to a variety of variables. Mechanic (1964) investigated the influence of mothers' attitudes on their children's health attitudes and behaviour. Gochman (1971) undertook a study regarding the relationship of perceived vulnerability to children's health beliefs. Campbell (1975) sought to provide information as to how views of illness evolved and changed. He obtained data from 264 children and their mothers regarding the meaning of illness and found age-linked differences and cross-generational differences.

Natapoff (1978) investigated a number of variables: age, sex, intelligence, and socioeconomic status. She found that there were both qualitative and quanititative changes with age consistent with theories of concept develpment. Age proved to be the one significant variable; intelligence, socioeconomic status, and sex differences were not significant.

The group of studies just reviewed basically examined concepts in relation to age without reference to specific developmental theories or related conceptual level to age and then offered post-hoc explanations in terms of cognitive developmental level. The following studies to be reviewed are those which used cognitive developmental theory to predict differences in concepts at differing ages.

While not specifically investigating concepts of health and illness, a study by Bernstein and Cowan (1975) has relevance in terms of methodology as it seems to have provided a model followed by many researchers. Bernstein and Cowan used a Piagetian framework in their investigation of children's concepts of how people get babies. Their sample was composed of 60 children, 20 in each of three age groups: 3-4 year olds, 7-8 year olds, and 11-12 year olds. They found that children's concepts of how people get babies followed a Piagetian developmental sequence. Their methodology provided a framework of reference for further investigations including research on children's concepts of health and illness (Carandang et al., 1979; Brewster, 1982; Redpath & Rogers, 1984; Feldman & Varni, 1985; and others).

In the Bernstein and Cowan study, the children were assessed by using a battery of tests including the Piagetian-type tasks of conservation of matter and volume. Another important feature of their study is in the use of Piaget's clinical method of interviewing. Each answer was probed until the child's thinking became as explicit and as detailed as he was able to make it. Their study represents a new attempt to gather systematic normative data directly from children. Bernstein and Cowan predicted that their study would promote a common research strategy in the area of cognitive development, whereby a known task anchor would be used as an index to locate previously unexplored areas of children's thought. The limitation of their strategy was in using only one indicator of concrete reasoning as their index. As previously discussed, the acquisition of cognitive stages is a gradual process and the discriminatory power of one or two tasks is limited in terms of providing a clear indication as to how far the child has advanced within this process.

Along with Bernstein and Cowan (1975), other researchers were supporting the use of Piagetian-type tasks as the index of cognitive developmental level with which to compare concepts of health and illness. Simeonsson et al. (1979) used tasks of conservation as well as role taking skills and physical causality tasks to compare with conceptions of illness. Their subjects consisted of 60 hospitalized children in three age groups (5, 7, 9 year olds). They found that scores for conservation tasks and role taking skills reflected developmental differences while scores relating to physical causality did not. Simeonson et al. do not provide any discussion as to why this was so. Their question for assessment of physical causality was: What makes clouds move? But they did not specify whether or not they used Piaget's clinical methods of eliciting answers. Their method of questioning may have affected their results. In general, their findings suggested developmental differences in children's illness causality concepts; they also noted that some questions were more developmentally sensitive than others.

Following in the same tradition, Perrin and Gerrity (1981) tested children at five different grade levels (Kindergarten, second, fourth, sixth, and eighth grades) in the areas of cause, prevention, and treatment of illness in addition to assessing their general cognitive development. Cognitive development was assessed through tasks involving conservation of mass, weight, and volume, transformations, interrelationships among parts, physical causality, and abstract thinking. There was no clearly defined rationale for the selection of these particular tasks. Although the results displayed a wide range of scores at each level, overall mean scores indicated a developmental sequence and parallel trend in each of these areas, increasing with each higher grade level. It is interesting to note that there was a wide range of scores at each level. Perrin and Gerrity observed that only one third of the eighth graders had reached the stage of formal operations as determined by their performance on tasks of conservation of volume and by their abstract interpretation of common proverbs.

Six other studies have been located using Piagetian tasks in assessing cognitive level in order to make a comparison with conceptualizations of health and illness. All of these studies cite Bernstein and Cowan and/or Perrin and Gerrity as providing a model for particular aspects of their methodology. Each of these studies will be briefly reviewed in terms of what they have contributed to the problem.

Myers-Vando, Steward, Folkins, and Hines (1979) tested 12 chronically ill children diagnosed as having congenital heart disease and 12 healthy children. Although the results indicated deficits in the chronically ill group with regard to general cognitive tasks, illness causality measures did not indicate differences between the two groups. Considering their age range (8 to 16 year olds), and given no indication as to how many children were in each age group regarding stages, their claim that cardiac disease affects the rate at which a child will attain conservation reasoning is questionable. Many studies refer to Piaget's "décalage factor" when their hypotheses do not work out. The "décalage factor" refers to the developmental discrepancies between tasks based on differential experience. Myers-Vando et al. use the "décalage factor" to support low cognitive functioning and to explain high conceptual level for their cardiac patients.

Carandang et al. (1979) studied levels of illness concepts among children with diabetic siblings. Their results revealed a significant association between pretested Piagetian level of cognitive development and illness conceptualization. Children with ill siblings demonstrated lower conceptualization levels than did children with healthy siblings. The sample for this study involved 36 children who had siblings ill with diabetes and 36 matched control children who had healthy siblings. There were three age levels within each group corresponding to the three cognitive levels. They discuss the possible influence of the "décalage factor" with stress as intrusion but also attribute the lower level of illness conceptualization by children with ill siblings to the coping style of their mothers. Their study appears to have been well conducted. Their study supports that of Bernstein and Cowan in the contention that Piagetian theory can be applied to understanding children's beliefs about new events.

Brewster (1982) investigated the relationship between cognitive development and the understanding of illness causation in 50 chronically ill hospitalized children aged 5 to 12. Piagetian theory was used to explain and predict understanding. Her results indicated a three-stage sequence in the development of the understanding of illness causation following Piagetian stages: Stage 1, disease is caused by human action; Stage 2, a belief in univariate physical causality; Stage 3, acknowledgement of multiple causation. Neither specific illnesses, sex of child, nor length of hospitalization were found to affect level of response. Although Brewster found no relationship between length of hospitalization or type of illness and levels of cognitive understanding of illness, her sample included children with varying degrees of experience with hospitalization and varied types of illness. Further, these factors were distributed across four age groups and the sample size may have been insufficient to obtain significant correlations. The sample of children was divided into four age groups with approximately equal numbers in each age group: ages 5-6 (N=13), ages 7-8 (N=11), ages 9-10 (N=12), ages 11-12 (N=11).

Three other very recent studies have followed the Piagetian task model: Redpath and Rogers (1984) using healthy children; Potter and Roberts (1984) exploring children's perceptions of chronic illness (i.e. epilepsy and diabetes) and Feldman and Varni (1985) investigating conceptualizations of children with spina bifida.

The study by Potter and Roberts is of particular interest because it represents the first attempt to devise and then evaluate a method of communicating with children about illness. Using Piagetian tasks to determine the cognitive level of the child, the authors then attempted to find out whether explanations of illness increased understanding and acceptance of illness in peers. Potter and Roberts used the Piagetian water and clay conservation tasks adapted from Perrin and Gerrity (1981) to divide their subjects into two distinct groups: subjects performing at the preoperational level (unable to conserve on either task) or the concrete operational level (conserving on both tasks). Those that did pass one task but not the other did not participate further to ensure clearer distinctions in cognitive development. Furthermore, all preoperational subjects were drawn from the first grade while all concrete operational subjects were in the third or fourth grades. The authors have devised controlled groupings although based on limited assessment. Age, alone, may have been the most powerful predictor of level of concept. Their methodology, however, does not allow for the gradual acquisition of skills which is an integral characteristic of the theory of Piagetian stages.

The study by Redpath and Rogers (1984) serves to exemplify the difficulty with using only one or two tasks to determine cognitive level particularly if those tasks are not suitable for the particular age range involved in the study. Redpath and Rogers, working with a sample of 30 children at each of two grade levels (preschool and second grade), attempted to relate children's concepts of illness as well as concepts of hospitals, medical personnel, and operations to their cognitive development as measured by performance on a conservation task and a causality task. They found that children's understanding of medical concepts including illness was significantly related to their levels of cognitive development as measured by a causality task but not when measured by a conservation task. Redpath and Rogers attribute the failure to find more significance in their correlations to the low number of subjects per cell and/or to vertical "décalage". However, another possible cause is that the particular tasks chosen were inappropriate for the ages represented in the study. The tasks would likely have been too difficult for the preschoolers (mean age = 3.75 years) and too easy for the second graders (mean age = 7.5). According to research by Arlin (1981), 69% of children in grade one had achieved conservation of mass; it is predicted that by second grade the percentage would be substantially higher. Tomlinson-Keasey et al. (1978) found that by the age of 7.9, 92% were considered to be concrete operational as determined by understanding of conservation of mass and a further 5 % were considered to be transitional. It would seem apparent that the tasks chosen for this study would have little discriminatory power for the age levels being investigated.

The remaining study to be discussed within that group choosing Piagetian tasks as the index for cognitive development is that of Feldman and Varni (1985). Their study was designed to assess children with spina bifida in terms of their general cognitive development, conceptualizations of health and illness, and their understanding of their own specific illness. Feldman and Varni found that children received higher scores in health and illness conceptualizations than general cognitive development with ratings highest in their explanations of spina bifida. Their statistical analysis appears to be based solely on mean scores and standard deviations with no correlational studies being conducted. A particularly noteworthy feature of their discussion was their acknowledgement that they had not used a battery of tests and that a battery of tests would be necessary to warrant any general conclusions regarding cognitive developmental levels. They also acknowledged that chronological age alone was not a sufficient predictor of cognitive level.

From the analysis of the above group of studies, it seems apparent that findings are often contradictory and that researchers often resort to the notion of "décalage" to explain contradictions rather than examining their methodology for potential weaknesses. Bibace and Walsh (1981) have described five variables that may have an effect on responses: (1) the perceptual characteristics of the illness i.e. whether the illness is visable or not, (2) the degree of familiarity of the stimulus i.e. a common illness such as a cold compared with one that is not so familiar such as epilepsy, (3) the mode of presenting the task (i.e. verbal or pictorial), (4) the mode of questioning i.e. clinical method of inquiry versus "true-false" questions, and (5) the affective or emotional states of the subject. Many researchers have discussed whether affective states accelerate or delay cognitive development but their conclusions remain ambiguous because of contradictory findings.

Other factors also may influence findings leading to conflicting results. In some studies sample size has been insufficient for the problems being investigated i.e. number of variables (Brewster, 1982). The choice of tasks is sometimes inappropriate and/or incomplete for determining cognitive levels. In addition, statistical analyses involve different measures of evaluation making comparisons among studies difficult. Jackson (1980) indicates that variation in findings is "substantially due to statistical artifacts rather than to situation-specific validity".

Other studies have not employed Piagetian tasks for assessing several cognitive levels but rather have relied on the index of age. Bibace and Walsh (1980, 1981) were instrumental in examining the concepts of health and illness to further delineate how stages progress within this area. Although they used the index of age as their criterion for establishing developmental level, they have a well conducted study in terms of methodology. Their study contributed to the formulation of the problem of the present study.

Bibace and Walsh developed a framework with which to describe children's concepts of illness by studying three groups of healthy children who were assumed to represent preoperational, concrete operational, and formal operational periods of cognitive development based on chronological age. Using a protocol to elicit responses to questions of illness concepts, the authors classified the answers into six types of explanations that were developmentally linked according to age. From this developmental perspective, Bibace and Walsh found that the type of illness explanation varied with the chrononlogical age of the child, with children giving more sophisticated explanations as they became older, indicating increasing cognitive development. Using the Piagetian stages of cognitive development as a theoretical framework, they derived three major types of explanations that were basically consonant with the prelogical, concrete logical, and formal logical stages of thought processes. Within each of the three major categories, two additional subtypes of explanations were delineated. Table 1 illustrates the three major categories and their corresponding subtypes of concepts of illness.

Table 1: Developmental Conceptions of Illness

I.	<u>Prelogical Explanations</u>
	Category 1: Phenomenism
	Category 2: Contagion
II.	<u>Concrete-Logical</u>
	Category 3: Contamination
	Category 4: Internalization
III.	<u>Formal-Logical Explanations</u>
	Category 5: Physiological
	Category 6: Psychophysiological

(Bibace & Walsh, 1981)

Bibace and Walsh derived these categories from a study involving an initial sample of 180 children aged 4 to 14 years and then validated them in two subsequent studies. The strategy for evolving these categories was similar to that used by Kohlberg, Loevinger, and Laurendeau and Pinard (Bibace & Walsh, 1981). The theories of Piaget and Werner served initially as a general guideline for collecting observations. These observations were then used to set up provisional categories which specified the manner in which the abstract theoretical concepts became concrete. The categories delineated by Bibace and Walsh will be briefly described.

Within the category of prelogical explanations, there were two subcategories: phenomenism and contagion. Phenomenism represented the most developmentally immature explanation in that the cause of illness was "an external concrete phenomenon that may co-occur with the illness but that is spatially and/or temporally remote". Children were essentially unable to explain how these phenomena caused illness. Contagion was found to be the most common explanation given by the more mature children within the prelogical stage. The cause of illness was found in "objects or people that were proximate to, but not touching the child". The relation between cause and illness was explained only in terms of magic or proximity.

Within the category of concrete-logical explanations, the two subcategories were contamination and internalization. Contamination characterized the explanations of the younger children in the concrete-logical stage. In this category, the cause of illness was viewed as a person, object, or action that was external to the child and that had an aspect that was harmful to the body. Contamination occurred through the child's body coming into physical contact with the person or object or by the child participating in the harmful action. Internalization was the type of explanation offered by older children in the concrete logical stage. In this category, illness was located within the body but its cause might be external, usually a person or object connected to the internal effect of illness through the process of internalization, a process such as swallowing or inhaling.

Finally, within the stage of formal-logical explanations, the two subcategories were physiological and psychophysiological explanations. In physiological explanations, offered by younger children in the formal-logical stage, the cause may be initiated by external events, but the source and nature of the illness were with specific internal physiological structures and functions. The physiological explanation usually involved a nonfunctioning or malfunctioning internal organ or process. Psychophysiological explanations represented the most mature responses. The illness was also described in terms of internal physiological processes but with an additional and/or alternative psychological cause.

Bibace and Walsh concluded that their findings were clearly congruent with theoretical expectations regarding qualitative differences in cognitive developmental processes. They claimed that the frequency distributions of normal children were congruent with Piagetian theory and therefore constituted empirical grounds for the validity of their categories.

Bibace and Walsh have been cited in several studies which were modelled on the category system which they formulated (Feldman & Varni, 1985; Steward & Steward, 1981; Meltzer, Bibace, & Walsh, 1984). Steward and Steward investigated children's conceptions of medical procedures. Meltzer et al. investigated children's conceptions of smoking. Both studies used independent means to gain access to stages and found categories that were congruent with those delineated by Bibace and Walsh.

Bernstein and Cowan (1975), Perrin and Gerrity (1981), Brewster (1982), and Bibace and Walsh (1981) have been frequently cited as providing models for establishing scoring and coding categories. Of these studies, Bibace and Walsh represent the most sophisticated methodology. Their index of developmental level was based on age but they cautioned that age should be assumed to be correlated with stage not equivalent to stage. They emphasize that "it is crucial to note that age could not in any way be rigidly adhered to as the sole developmental marker", but could be used as a general index of development. Bibace and Walsh failed, however, to gain access independently of the effects of operational level on the development of concepts. Hence, it is the intent of the present study to investigate the relationship of operational level and age to the development of concepts of health and illness. Furthermore, it is hypothesized that cognitive level will be a stronger predictor of level of concept than the index of age and, secondly, that cognitive level together with age will be a stronger predictor of level of concept than either index on its own.

One additional variable will be investigated, that of verbal ability. Although some studies have concluded that intellectual functioning is not a significant factor (Natapoff, 1978), Peters (1978) suggests that linguistic facility is a factor when communicating to children about health and illness. Linguistic ability may mediate or be mediated by cognitive competence. The third hypothesis then is that verbal ability will also account for a significant portion of the variance with respect to level of concept. As a standardized test of receptive language (PPVT-R) had been included in the battery of tests administered in the Preadmission Preparation Program, it was decided to use the results in the present study.

Three variables then will be investigated within the present study: cognitive developmental level, chronological age, and verbal ability. The relative strength of each variable as a predictor of level of concept will be tested in a multiple regression analysis.

2.3 STATEMENT OF THE THREE HYPOTHESES

In a stepwise multiple regression equation with level of concept as the criterion variable and cognitive level, age, and verbal ability as the predictor variables, the following hypotheses will be tested:

1. Cognitive level will be a stronger predictor of level of concept than the predictors of age and verbal ability. "Stronger" means that cognitive levels will enter the prediction equation on step 1 and will account for a greater portion of the variance than that accounted for by age or verbal ability.
2. Cognitive level together with age will be a stronger predictor than either index on its own. The amount of variance accounted for on the second step by the composite of

cognitive level and age will be greater than that accounted for by either index on the first step.

3. Verbal ability will account for a significant portion of the variance with regard to level of concept over and above that already accounted for by cognitive level and age and will enter the prediction equation on step 3.

The problem restated then is to determine the contribution made by each of the independent variables of cognitive level, age, and verbal ability to the prediction of the criterion variable, level of concept. The methodology for testing the hypotheses will be described in the following chapter.

Chapter 3

METHODOLOGY

Subjects were selected from the population of a study in progress investigating pre-admission preparation of children entering B.C.'s Children's Hospital for elective surgery. Six categories of surgery were included in this major study: Orthopedic, E.N.T. (Ears, Nose, and Throat), Genital-Urinary, Plastic, Dental, and General Surgery. None of the surgical procedures was considered to be life-threatening. There were three types of admission procedures involved: Day Care, Inpatient, and Admit-day-of-surgery. During the Preadmission Preparation Programs Study, a series of six interviews was conducted with each of 200 children and their parents. These children were living in the Lower Mainland of British Columbia, in and around Vancouver. The children ranged in age from 5 to 12 years; age was determined as of date of surgery.

This researcher, as one of the research assistants for the Preadmission Preparation Program, received permission from the Project Head and the Project Coordinator to conduct the present study as an additional investigation that might contribute to the purpose of the major study, that of investigating the preparation of children for surgery. The data for the present study was gathered during the sixth and final interview following surgery. It was decided that 20 of the first cases would be assessed as part of a pilot study and the following 40 cases would be assessed as participants in the main study.

3.1 PILOT STUDY

In a preliminary investigation, 20 cases were assessed as part of a pilot study during which time this researcher had the opportunity to become familiar with the assessment instruments and procedures and the clinical technique for interviewing. The children, ranging in age from 5 to 12 years (Mean age = 9.4), were administered the Children's Health Questionnaire and a set of Piagetian tasks.

In order to test the first two hypotheses, a stepwise multiple regression analysis was conducted on the data from the 20 cases. Level of concept was the dependent variable (criterion variable) with cognitive level and age entering the prediction equation at the first and second steps respectively. Both of the independent variables were found to be significantly correlated with the criterion variable beyond the .05 level of significance. The results of the multiple regression analysis indicated that a multiple R of .65 was obtained which accounted for 42% of the variance. Age accounted for 15% of the variance while cognitive level accounted for an additional 27% of the variance. The results of the analysis on the data from the pilot study support the proposed hypotheses that cognitive level is a stronger predictor of level of concept than age and that cognitive level together with age is a stronger predictor than either index on its own. Because of the limited number of subjects in the pilot study, the results must be interpreted with caution; the findings, however, are congruent with theoretical expectations and are encouraging for the present study.

Following the pilot study, a few alterations were made in the assessment procedures. It was decided that two questions from the Children's Health Questionnaire would not be scored as they were not well suited to eliciting causality explanations from the children. (Table 2 contains the revised questionnaire.) The questions would be retained, nevertheless, so that children's ideas about the meaning of the terms "health" and "sick" could be explored as "warm-up" questions. It should be noted here that Simeonsson et al. (1979) found that some questions were more developmentally sensitive than others. Further modifications were introduced within the Piagetian assessment battery in order to improve the suitability of the tasks and procedures.

The pilot study served to permit the researcher to gain some experience with Piagetian assessment techniques, to modify the task structures where necessary, and to test the hypotheses in a trial run.

Training sessions in Piagetian assessment techniques were provided by the researcher's supervisor and included practice sessions with children of various ages.

3.2 SUBJECTS

For the present study, the 40 cases following those used in the pilot study were assessed as participants in the main study. There were 10 children assigned to each of four age groups: 5-6 (Mean age = 5.98 years), 7-8 (Mean age = 7.78 years), 9-10 (Mean age = 9.53 years), and 11-13 (Mean age = 12.21 years). The 2 children who were 13 years of age had been 12 on the date of their surgery. The age span of 5 to 13 years of age covers the period of the acquisition of concrete operational thought and the beginning of the formal operational stage.

Children were assigned to each of the four cells in the order that they were assigned to this researcher until each cell had the required number of subjects. As some surgical procedures tend to be age specific, some cells were filled earlier than others. In order to complete the cells of the groups of older children, this researcher conducted the final interview for 6 children who had originally been assigned to another research assistant working with the Preadmission Preparation Program. All of the data for the present study was gathered by this researcher.

3.3 PROCEDURES

The children were interviewed and assessed individually in their home environment. Rapport was established and a suitable place, free from distraction, was found for conducting the interview. The children were first interviewed with the Children's Health Questionnaire. Table 2 represents the format of the Children's Health Questionnaire.

Table 2: Children's Health Questionnaire

1.	What does it mean to be healthy?
2.	What should children do to stay healthy?
3.	What does it mean to be sick?
4.	Why do children get sick?
5.	Why is it that some children get sick and other children don't?
6.	What makes you get sick?
7.	What makes you get better?

(Robinson, Conry, & Harper, 1986)

Questions were probed according to the clinical method initiated by Piaget and Inhelder (1958) and modified by many others (Laurendeau & Pinard, 1962; Bernstein & Cowan, 1975; Bibace & Walsh, 1981).

Following the completion of the Children's Health Questionnaire, the children were assessed by administering a representative sampling of Piagetian tasks chosen to give a reasonable estimate of their cognitive developmental level. These tasks were chosen to measure the gradual acquisition of concrete operational thought and formal operational thought. The tasks were selected from those protocols described by Arlin (1978, 1981, 1982). The protocols were modifications of those used by Piaget and Inhelder (1958, 1964).

Although there are 3 subsystems representing the concrete operational stage - seriation, classification, and conservation - seriation tasks were omitted from the format as it has been found that most children of the age range included in the study would have mastered these tasks as they represent the earliest stage of concrete operations (Arlin, 1981; Tomlinson-Keasey et al., 1979). Nine tasks representing the subsystems of classification and conservation were included in this study.

Four formal tasks were selected representing the early and middle developmental phases of formal reasoning: probability, correlations, combinations, and proportions (Arlin, 1982). Success in these tasks would give some indication that the process of formal reasoning had begun.

The instruments thus were chosen to be concordant with a structural perspective adhering to the gradual acquisition of cognitive stages.

Two other considerations that had to be dealt with were ease of administration and time required for administration. Although commonly used as a measure of formal reasoning, the task of conservation of volume was not included in the battery as the assessments took place in the home environment and this task would have been inconvenient to set up there. Time was also a further limitation as the administration of tasks had to fit within the guidelines set up by the Preadmission Preparation Program. Considering the age range under study and adhering to the process of gradual acquisition, it was felt that the tasks selected were appropriately representative of the total battery.

Tasks were commenced at age appropriate levels and continued in ascending/descending order until two consecutive failures/successes were achieved. Table 3 summarizes the common test battery sequence with suggested starting points according to the age of the subject being tested. See Appendix A for a list of required materials and Appendices B, C, and D for samples of test protocols.

Table 3: Common Test Battery Sequence

Suggested Starting Point According to Age	Task
5 - 6 years	Simple Classification
7 - 9 years	Two-way Classification
	Class Inclusion
	Three-way Classification
5 - 6 years	Number Conservation
	Quantity Conservation
7 - 9 years	Length Conservation
10 - 13 years	Area Conservation
	Weight Conservation
	Correlations
	Probability
	Combinations
	Proportions

(ERIBC: Arlin, 1978)

The tasks used in the Piagetian assessment battery were as follows:

1. Simple Classification: The subject was presented with 12 plastic attribute blocks and asked to place them in 2 or 3 groups. He was then asked to make new groups.
2. Two-way Classification: The subject was presented with a matrix (See Appendix E) and asked to select the picture that would best complete the pattern. He was then asked to give the reason for his choice. Finally, he was asked if any other picture would be suitable for completing the pattern.
3. Class Inclusion: The subject was presented with 7 green wooden blocks and 3 black wooden blocks and asked whether there were more green blocks or more wooden blocks and then was asked to give a reason for his choice.
4. Three-way Classification: The subject was presented with the three-way matrix (See Appendix F) and asked to select the picture that would best complete the pattern. He was asked to give a reason for his choice and then asked if any other picture would be equally suitable for completing the pattern.
5. Conservation of number: The subject was presented with two rows of blocks, one row of green blocks and one row of black blocks, with equal spaces between blocks and asked if there were more black blocks or more green blocks or the same number of blocks. The green blocks were then pushed together and the subject was again asked if there were more, less, or the same number of blocks. The subject was then asked to give a reason for his answer.
6. Conservation of Quantity:
   a. Continuous: The subject was presented with two plasticine balls, approximately 5 cm. in diameter, and was asked if they were the same. (If subject said they were not the same, he was asked to make them the same.) When the subject was satisfied that the two balls were the same, the examiner flattened one of the balls and asked the subject whether the balls had the same amount of plasticine or if one had more or less than the other. The subject was then asked to give a reason

for his choice.

b. Discontinuous: The two balls were again presented to establish equality. This time the examiner broke up one of the balls into several pieces and the subject was aked whether the intact ball and the group containing the pieces had the same amount of plasticine or if one or the other had more or less plasticine. The subject was asked to give a reason for his choice.

7. Conservation of Length:

a. The subject was presented with two shoelaces of equal length and was asked if the shoelaces were the same length. (If subject said they were unequal, he was asked to make them equal.) The examiner then said, "Let's pretend that these two laces are two garden snakes. It is a sunny day and they are crawling along." Moving one of the laces ahead of the other, the examiner asked, "Are they still the same length or is one longer or shorter than the other?" The subject was asked to give the reason for his answer.

b. The two shoe laces were again presented to establish equality. Curling up one of the shoe laces, the examiner said, "Now this snake decides it is time for a nap and so he curls up. Is he still just as long as the other snake or is he longer or shorter? What do you think?" The subject was asked to give the reason for his response.

8. Conservation of Area: The subject was presented with 2 sheets of "8 1/2 x 11" paper and was asked to confirm that they were the same. The subject was then presented with 2 sets of small, green self-adhesive circles (each set contained 10 circles) and was asked if they were the same. The examiner gave one of the papers to the subject along with one set of circles and kept the same for herself and then said, "This is your garden and this is my garden. These are your cabbages and these are my cabbages. You plant your cabbages in your garden and I'll plant my cabbages in my garden. Go ahead now." The examiner observed whether the subject planted his cabbages close together or spread apart and then planted hers in the opposite way. The subject was then

asked, "Do the cabbages in your garden cover more ground, less ground, or just as much ground as the cabbages in my garden?" The subject was asked the reason for his response.

9. Conservation of Weight: The subject was presented with the two balls of plasticine and was asked if they weighed the same. (If subject said they didn't, he was asked to make them the same.) The examiner flattened one of the balls and asked if it was just as heavy as the other, or heavier, or lighter. The subject was asked to give a reason for his response.

10. Probability: The subject was presented with an envelope containing 3 yellow, 3 green, and 3 purple beads and was asked what his chances would be of getting a yellow bead if he were to pick one bead from the envelope. The subject was asked to give a reason for his answer. He was then asked to pick one bead from the envelope and was asked what his chances would be of getting another bead of the same colour. Again, he was asked to give a reason for his response.

11. Correlations: The subject was presented with the card with the 12 faces (See Appendix G) and was asked if he could find a relationship between hair colour and eye colour based on the 12 faces. The subject was asked to give a reason for his response. He was then asked what the chances would be of a person being blond haired and brown eyed based on the 12 faces on the card and was again asked to give a reason for his response.

12. Combinations: The subject was presented with an electronic box with a light and 5 buttons. The examiner demonstrated that pressing some of the buttons would cause the light to go on. The subject was not permitted to view which buttons were being pressed. The subject was then asked to try and find out which buttons to press in order to make the light go on. The examiner observed which tactics were being employed.

13. Proportions: The subject was presented with the pictures of Mr. Big and Mr. Small (See Appendix H). The examiner measured Mr. Big with big paper clips (6 big paper

clips) and Mr. Small with big paper clips (4 big paper clips). The examiner then measured Mr. Small with small paper clips (6 small paper clips) and asked the subject to estimate how tall Mr. Big would be if measured with small paper clips. The subject was asked to give a reason for his answer.

The Peabody Picture Vocabulary Test-Revised (PPVT-R) had been administered during the first interview for the Preadmission Preparation Program, approximately one week prior to surgery, and the results obtained were used to establish verbal ability.

3.4 SCORING

Performance criteria for the Children's Health Questionnaire were inferred from the descriptions of Bibace and Walsh (1980, 1981) with respect to the characteristics of each category of explanations. Questions 1 and 3 were used for clarification of the concepts of sickness and health and responses were not scored. Answers to the remaining questions were rated from 0-6 for a maximum total of 30 points. Table 4 represents the scoring categories.

Inter-rater reliability, using a random sample of 10 protocols, resulted in 76% agreement. It was noted that 67% of the disagreements involved only a .5 point difference in scoring; 33% involved a 1.0 point difference in scoring.

Table 4

Scoring Categories for Developmental Conceptions of Illness

Category 0: Incomprehension
Category 1: Phenomenism
Category 2: Contagion
Category 3: Contamination
Category 4: Internalization
Category 5: Physiological Explanations
Category 6: Psychophysiological Explanations

(Bibace & Walsh, 1980)

For the Piagetian tasks, criteria followed that of Arlin (1981, 1982) based on work by Inhelder and Piaget. Each task was rated out of 2 points for a total score of 26 points. Inter-rater reliability, using a random sample of 10 protocols, resulted in 96% agreement.

3.5 STATISTICAL ANALYSIS

A stepwise multiple regression analysis will be performed on the data with level of concept as the dependent variable (criterion variable). Cognitive level will be the first variable to enter into the prediction equation and will account for the greatest proportion of the variance. Age and verbal ability will also be significant predictors of level of concept but will enter into the prediction equation at the second and third steps respectively.

The data will be analyzed both quantitatively and qualitatively in order to examine the development of concepts in relation to each of the independent variables. The results will be reported in Chapter IV.

Chapter 4

RESULTS

This chapter will present the results of the study and will include both a quantitative and a qualitative analysis of the data. The quantitative analysis will consist of the summary statistics for each of the variables, the results of the stepwise multiple regression analysis, and the subsequent construction of contingency tables and computation of Chi Square statistics. The qualitative analysis will examine the raw data in an attempt to offer additional insight into the results of the study.

4.1 QUANTITATIVE ANALYSIS

4.1.1 LEVEL OF CONCEPT OF HEALTH AND ILLNESS

Level of concept of health and illness was assessed by means of a Health Questionnaire (HTOT). Each question had a maximum score of 6 points rated according to which category of explanation had been elicited. The range of scores for the Health Questionnaire (HTOT) was from 10 to 26 out of a possible total of 30 points. The mean score was 17.95 with a standard deviation of 3.10 (N=40). There was only one response which was scored at the lowest category, that of phenomenism (1), and only one response which was scored at the highest category, that of psychophysiological explanations (6). The remaining responses received scores from 2 to 5 representing the corresponding explanations of contagion (2), contamination (3), internalization (4), and physiological causes (5). Table 5 indicates the distribution of Health Questionnaire scores (HTOT).

It is apparent from Table 5 that the scores tend to cluster about the mean which indicates a restricted range, a condition which may attenuate correlation (Glass & Stanley, 1970; Ferguson, 1981).

Table 5: Frequency table for Health Questionnaire (HTOT)

HTOT	FREQUENCY	PERCENT
10-10.5	1	2.5
11-11.5	1	2.5
12-12.5	1	2.5
13-13.5	0	----
14-14.5	1	2.5
15-15.5	5	12.5
16-16.5	4	10.0
17-17.5	1	2.5
18-18.5	10	25.0
19-19.5	5	12.5
20-20.5	3	7.5
21-21.5	6	15.0
22-22.5	1	2.5
23-23.5	0	----
24-24.5	0	----
25-25.5	0	----
26-26.5	1	2.5

4.1.2 PIAGETIAN ASSESSMENT OF COGNITIVE LEVEL

Cognitive developmental level was assessed through a battery of Piagetian tasks representing concrete operational thinking skills and formal operational thinking skills. Each task had a maximum score of 2 points for a total of 26 points. The range of scores for the Piagetian assessment battery (PTOT) was from 2 to 23 with a mean score of 12.60 and a standard deviation of 5.35 (N=40). PTOT scores up to 10 points represent low concrete; PTOT scores from 11 to 16 represent mid concrete; PTOT scores from 17 to 26 represent the transitional stage and include high concrete operational and beginning formal operational thinking. A minimum score of 2 suggests that even the subjects with the lowest scores had at least some attainment of concrete operational skills. There were 6 subjects who showed some sign of attaining formal operational thought; 4 of those subjects were in the 10-13 age group while the remaining 2 were in the 9-10 age group. Only one of the subjects scoring points for formal operational tasks had obtained complete scores for all the concrete tasks. From the following table then, it appears evident that the large majority of subjects fell within the concrete operational group. Table 6 indicates the distribution of scores for the Piagetian assessment (PTOT).

Table 6: Frequency table for Piagetian Assessment (PTOT)

PTOT	FREQUENCY	PERCENT
1-2	2	5.0
3-4	4	10.0
5-6	2	5.0
7-8	3	7.5
9-10	1	2.5
11-12	2	5.0
13-14	7	17.5
15-16	11	27.5
17-18	5	12.5
19-20	2	5.0
21-22	0	----
23-24	1	2.5

From Table 6 it is again evident that there is a somewhat restricted range of scores which statistically tends to reduce the size of the correlation coefficients when the relationship of PTOT to other variables is established.

4.1.3 INDEX OF AGE

Chronological age was another prediction variable and ranged from 5.58 to 13.17 years. The age range of the subjects from the Preadmission Preparation Program had been from 5 to 12 years with age determined as of day of surgery; however, as most of the data for this study was collected 6 months after surgery, the maximum age had advanced to include 2 subjects who were 13 years of age. The mean age for this study was 8.87 with a standard deviation of 2.37 (N=40). The subjects had been selected from 4 age groups: 5-6, 7-8, 9-10, 11-13. Table 7 shows the age breakdown at the time of the present assessment.

Table 7: Frequency table for the index of age

AGE	FREQUENCY	PERCENT
5 years	5	12.5
6 years	5	12.5
7 years	7	17.5
8 years	3	7.5
9 years	9	22.5
10 years	1	2.5
11 years	5	12.5
12 years	3	7.5
13 years	2	5.0

4.1.4 VERBAL ABILITY

Verbal ability was assessed by the Peabody Picture Vocabulary Test - Revised (PPVT-R) which is a measure of receptive vocabulary. The scores are standardized as a language quotient (LQ) with a mean of 100 and a standard deviation of 15. The range of LQ scores for this study was from 78 to 133 with a mean of 104.08 and a standard deviation of 13.95 (N=40). Table 8 indicates the distribution of LQ scores.

Table 9 provides a summary of the means and standard deviations for the criterion variable of Health Total (HTOT) and for the three predictor variables of Piagetian Total (PTOT), Age, and Verbal Ability (LQ).

Table 8: Frequency table for verbal ability (LQ)

LQ	FREQUENCY	PERCENT
75-79	1	2.5
80-84	4	10.0
85-89	1	2.5
90-94	4	10.0
95-99	4	10.0
100-104	11	27.5
105-109	3	7.5
110-114	3	7.5
115-119	2	5.0
120-124	3	7.5
125-129	2	5.0
130-134	2	5.0

Table 9: Means and standard deviations for Health Total (HTOT), Piagetian Total (PTOT), Age, and Verbal Ability (LQ)

Variable	Mean	Standard Deviation	Cases
HTOT	17.95	3.10	40
PTOT	12.60	5.35	40
Age	8.87	2.37	40
LQ	104.08	13.95	40

4.1.5 CORRELATIONS BETWEEN VARIABLES

The data reported in Table 10 indicate the relationship between the independent (predictor) variables of PTOT, Age, and LQ and the dependent (criterion) variable of HTOT. The correlation coefficients obtained indicate that all of the predictor variables are significantly correlated with the criterion variable. Age, however, is more highly correlated with HTOT than is PTOT, which is contrary to the direction of the first hypothesis. The correlation between Age and HTOT is .75 ($p < .01$); the correlation between PTOT and HTOT is .66 ($p < .01$). There is also a very high correlation between the two predictor variables of Age and PTOT which would be expected according to developmental theory; the correlation between Age and PTOT is .77 ($p < .01$). LQ has a significant correlation with HTOT (.32, $p < .05$) but correlations with Age (.02) and PTOT (.09) are not significant. A significant correlation between LQ and Age would not be expected as age has been controlled for within the standardized language quotient. The correlations between variables will influence their entry into the regression equation and will be further discussed in the results of the multiple regression analysis.

Table 10: Correlation coefficients for Health Total (HTOT), Piagetian Total (PTOT), Age and Verbal Ability (LQ)

	PTOT	AGE	LQ
HTOT	.66**	.75**	.32**
PTOT		.77**	.09
AGE			.02

N=40; * p < .05; ** p < .01

4.1.6 STEPWISE MULTIPLE REGRESSION ANALYSIS

The results of the stepwise multiple regression analysis only partially support the hypotheses. The first hypothesis states that cognitive level (PTOT) would enter the regression equation on the first step and that age would enter on the second step when, in fact, age entered first and PTOT was not selected to enter the equation.

The second hypothesis states that chronological age together with cognitive level (PTOT) would be a stronger predictor than either index on its own. The results only partially support the second hypothesis. The composite of cognitive level and age does account for more of the variance than that accounted for by cognitive level but does not account for a significant increase in the amount of variance over and above that accounted for by age. There is no significant effect of PTOT with HTOT when age is partialed out. The combination of age and PTOT is only minimally stronger than age on its own with PTOT contributing a negligible additional amount of variance to the efficacy of prediction.

The third hypothesis states that verbal ability would account for a significant portion of the variance with respect to level of concept over and above that accounted for by age and cognitive level. The results of the study support this final hypothesis. Verbal ability does account for a small but significant portion of the variance.

A stepwise regression model was chosen as it is one of the most commonly used methods and is essentially a combination of both forward and backward procedures (Norušis, 1985). As in the forward procedure, the first variable to be considered for entry into the equation is the one with the strongest correlation with the dependent variable. If this variable meets the criterion for inclusion (the probability of F-to-enter is PIN = 0.05), the second variable then to be selected among the remaining variables is that which has the highest partial correlation with the dependent variable. If this second variable meets the criterion for inclusion, the first variable is then examined to see whether is should be removed according to the removal criterion as in backward elimination (the probability of F-to-remove is POUT = 0.10). The process continues alternating between forward and backward procedures and terminates when there are no longer any variables that meet the entry and removal criteria. A further criterion that must be met before a variable is entered into the prediction equation is the tolerance of that variable with other independent variables already in the equation. The default tolerance value is 0.01. Thus in the stepwise regression model three criteria must be met by each of the independent variables (Kerlinger & Pedhazur, 1973; Pedhazur, 1982; Norušis, 1985; Lai, 1986).

The major statistical findings from the stepwise multiple regression analyses are reported in two tables. Table 11 represents the results of the stepwise multiple regression (see steps 1 and 2) and the results of a second regression analysis with PTOT forced into the regression equation (see step 3). From the first analysis, with only Age and LQ being selected to enter the equation, a multiple R of .81 was obtained which accounts for 65% of the variance. Age accounts for 56% of this variance. When LQ is entered into the prediction equation, it accounts for an additional 9% of the variance. In the first stepwise analysis, PTOT was not selected to enter into the prediction equation. The data in Table 11 then do not support the hypothesis that cognitive level is a stronger predictor of level of concept than age; rather, the data support age as the stronger predictor.

Table 11: Multiple R for the criterion variable of Health Total (HTOT) with the three predictors of Age, Verbal Ability (LQ), and Piagetian Total (PTOT)

Step	Variable	Multiple R	RSQ	RSQ Change	F
1	Age	.75	.56	.56	48.55**
2	LQ	.81	.65	.09	35.07**
3	PTOT	.82	.66	.01	23.83**

* p<.05 ** p<.01

A second multiple regression analysis was conducted on the data in which operational level (PTOT) was forced into the prediction equation. A multiple R of .82 was obtained (see Table 11, step 3) which accounts for 67% of the variance; operational level (PTOT) accounts for only 1% of this variance. The results then only partially support the second hypothesis. The combination of PTOT and Age is only minimally stronger than Age on its own. However, the composite of PTOT and Age accounts for a significantly greater portion of the variance than that accounted for by PTOT when PTOT is forced to enter the equation on step 1 in a further analysis.

The third hypothesis states that Verbal Ability (LQ) would account for a significant portion of the variance with respect to level of concept (HTOT). The results of the study support this final hypothesis. LQ accounts for a small but significant portion of the variance (9%) and together with Age provides the best weighted composite of predictor variables for this study.

The F ratio statistics reported in Table 11 test the overall regression model for each step (Lai, 1986). A decrease in F values is evident in Table 11; nevertheless, all the F values for the overall model computed for each step are significant ($p < .01$). An explanation of the decrease in F values is provided below:

> Each time a variable is added to the equation, a degree of freedom is lost from the residual sum of squares and one is gained for the regression sum of squares. The standard error may increase when the decrease in the residual sum of squares is very slight and not sufficient to make up for the loss of a degree of freedom for the residual sum of squares. The F value for the test of the overall regression decreases when the regression sum of squares does not increase as fast as the degrees of freedom for the regression. (Norušis, 1985, p. 44)

Table 12 indicates the Beta coefficients of the independent variables. The Beta coefficients permit a further interpretation of the relative importance of variables by providing a correlation of each independent variable with the dependent variable while partialing out the effects of the other independent variables. From Table 12 it is evident that when age is entered into the prediction equation, it accounts for the greatest percentage of the variance. LQ maintains a significant portion of the variance because in fact age is controlled for within the formulation of the language quotient (LQ). Although PTOT has a high correlation with HTOT when the effects of Age and LQ are partialed out, PTOT accounts for a very small proportion of the variance. In Table 12, the F ratio statistics test the significance of each independent variable with the effects of the other independent variables in the equation partialed out. The F values indicate that the Beta coefficients for Age and LQ are significant ($p<.01$); however the Beta coefficient for PTOT is not significant. These F values determine whether or not a variable will enter the regression equation.

Table 12: B weights, Standard Error of B, and Beta weights for Multiple R for the criterion variable of Health Total (HTOT) with the three predictor variables of Age, Verbal Ability (LQ), and Piagetian Total (PTOT)

Variable	B	SE B	Beta	F
Age	.81	.20	.62	16.76**
LQ	.06	.02	.29	9.16**
PTOT	.09	.09	.16	1.12

* p<.05 ** p<.01

All possible combinations of predictor variables were entered into regression equations with all possible positions of entry for each variable in order to find the most meaningful combination. Pedhazur (1982) refers to "meaningfulness" being in part "situation-specific" and not necessarily equivalent to statistical significance. Because it is clear that PTOT has a high correlation with HTOT, the regression equation will be examined in which PTOT enters on the first step and Age enters on the second step. When PTOT is forced into the regression equation on step 1, the multiple R is .66 (RSQ=.44, RSQ Change=.44, F=29.91, $p < .01$). When Age is entered on step 2, the multiple R increases to .76 (RSQ=.58, RSQ Change=.16, F=25.54, $p < .01$). However, when the Beta coefficients are examined for this analysis, the Beta coefficient for PTOT is only .22 while the Beta coefficient for Age is .58. Thus when age is partialed out the influence of PTOT is greatly diminished. When PTOT is partialed out from Age, the strength of Age is retained.

Frequency tables were computed in order to regroup the data into high, medium, and low ranges of scores. Table 13 indicates the percentage of scores/ages for high, medium and low groupings for the criterion variable (HTOT) and the three predictor variables of PTOT, Age, and LQ.

Table 13: Distribution of variables with regrouping in effect

VARIABLE	LOW	MEDIUM	HIGH
HTOT	32.5%	40.0%	27.5%
PTOT	30.0%	50.0%	20.0%
Age	25.0%	47.5%	27.5%
LQ	35.0%	35.0%	30.0%

4.1.7 CONTINGENCY TABLES AND CHI SQUARE STATISTICS

Contingency tables were then constructed with the regrouping in effect so that the data could be more closely examined. HTOT was regrouped into low (10-16.5), medium (17-19.5), and high (20-26.5) ranges of scores. PTOT was regrouped into low (1-10), medium (11-16), and high (17-24) ranges of scores corresponding approximately to low concrete, mid concrete, and transitional Piagetian stages of operational level. The high range of PTOT scores represents the transition from high concrete operational thinking to beginning formal operational thinking. Ages were regrouped into low (5-6), medium (7-9), and high (10-13). The breakpoints for the age groupings occurred where there were natural gaps in the frequency of age representation. (See Tables 5, 6, and 7 for frequency distributions with regrouping represented.)

Chi square analyses indicated that the following combinations of variables were not independent of each other: Age by PTOT ($\chi^2 = 34.94$, df=4, $p < .01$), Age by HTOT ($\chi^2 = 21.24$, df=4, $p < .01$), and PTOT by HTOT ($\chi^2 = 15.91$, df=4, $p < .01$). Table 14 indicates the results of the Chi Square analyses.

Table 14: Chi Square analysis

Variable	Chi Square	df
Age by PTOT	34.94**	4
Age by HTOT	21.24**	4
PTOT by HTOT	15.91**	4
LQ by HTOT	8.27	4
Age by LQ	6.15	4
PTOT by LQ	2.19	4

*p<.05 ** p<.01

Table 15: Crosstabulation of AGE by PTOT

		COUNT ROW PCT	PTOT Low 1-10 1.00	PTOT Med 11-16 2.00	PTOT High 17-24 3.00	ROW TOTAL
AGE	Low 5-6	1.00	10 100.0			10 25.0%
	Med 7-9	2.00	2 10.5	14 73.7	3 15.8	19 47.5%
	High 10-13	3.00		6 54.5	5 45.5	11 27.5%
		COLUMN TOTAL	12 30.0%	20 50.0%	8 20.0%	40 100.0%

The crosstabulation of Age by HTOT (Table 15) indicates that while the majority of subjects (73%) in the 3 age groupings were concordant with the corresponding grouping for PTOT, there were, nevertheless, a number of subjects (27%) who were either higher or lower than would be expected. From this table, it is apparent that all of the children in the low Age group also had low scores for PTOT. For the middle Age group, 73.7% had corresponding medium PTOT scores; however, 10.5% had low PTOT scores while 15.8% had high PTOT scores. For the high Age group, 45.5% had corresponding high PTOT scores while the remaining 54.5% fell within the medium PTOT range. It appears then that less than half of the high age range subjects had entered the transitional Piagetian stage between high concrete operational skills and beginning formal operational skills.

Table 16: Crosstabulation of AGE by HTOT

		COUNT ROW PCT	HTOT Low 10-16 1.00	HTOT Med 17-19 2.00	HTOT High 20-26 3.00	ROW TOTAL
AGE	Low 5-6	1.00	7 70.0	3 30.0		10 25.0%
	Med 7-9	2.00	6 31.6	10 52.6	3 15.8	19 47.5%
	High 10-13	3.00		3 27.3	8 72.7	11 27.5%
		COLUMN TOTAL	13 32.5%	16 40.0%	11 27.5%	40 100.0%

The crosstabulation of Age by HTOT (Table 16) indicates that the majority of subjects in the low and high Age groups were concordant with the corresponding groupings for HTOT. However, for the medium Age group, only 52.6% fell within the corresponding mid HTOT grouping, while 31.6% fell in the low HTOT group and 15.8% fell in the high HTOT group. It is apparent then that the greatest discrepancies occurred within the middle Age group with almost half of the subjects falling out of the expected HTOT grouping.

Table 17: Crosstabulation of HTOT by PTOT

PTOT		COUNT ROW PCT	HTOT Low 10-16 1.00	 Med 17-19 2.00	 High 20-26 3.00	ROW TOTAL
	Low 1-10	1.00	9 75.0	3 25.0		12 30.0%
	Med 11-16	2.00	3 15.0	10 50.0	7 35.0	20 50.0%
	High 17-24	3.00	1	3 12.5	4 50.0	8 20.0%
		COLUMN TOTAL	13 32.5%	16 40.0%	11 27.5%	40 100.0%

The crosstabulation of PTOT by HTOT (Table 17) indicates that while the majority of subjects with low scores for PTOT also obtained low scores for HTOT, there were many discrepancies for both the medium PTOT range and high PTOT range. Only 50% of the subjects in the medium PTOT group obtained scores that fell within the medium HTOT group; 15% fell within the low HTOT group, while 35% fell within the high HTOT group. Again, only 50% of the subjects with high PTOT scores obtained scores that were in the high HTOT range; 37.5% fell within the medium HTOT range while 12.5% fell within the low HTOT range. As there were so few subjects in the high PTOT group, 12.5% refers to just one subject whose PTOT score is just a half point away from obtaining a medium HTOT score.

4.2 QUALITATIVE ANALYSIS

4.2.1 LEVEL OF CONCEPT OF HEALTH AND ILLNESS

The responses to the Health Questionnaire (HTOT) will be examined in terms of their concordance with the categories delineated by Bibace and Walsh (1980).

There was only one response which fell within the lowest category, that of phenomenism. This response was elicited from a 6 year old boy with a Piagetian score (PTOT) of 3, and a low average PPVT-R score (LQ). This subject had a developmental delay in expressive language and a long history of health complications. The following is an example of his responses.

> (What makes you get better?) The sunshine (How does it help you get better?) When it's sunny (Tell me more about it.) Go away (What goes away?) Sick (What makes it go away?) The sunshine goes in the house. (How does that make the sickness go away?) I don't know.

The responses in the category of phenomenism are characterized by the cause of illness being an external concrete phenomenon that may co-occur with the illness but is otherwise remote. It is not surprising that only one response fell within this category as the population used by Bibace and Walsh for the preoperational level consisted of 4 year olds.

The second category specified by Bibace and Walsh was that of contagion where the cause of illness was located in objects or people that are in close proximity to the child. There were only 4 subjects from whom some category 2 responses were elicited. All of these subjects fell within the 5-6 age group and had PTOT scores ranging from 4 to 7. Three of the subjects had average PPVT-R scores (LQ); one subject had a below average score. An example of a category 2 response is as follows:

> (Why do children get sick?) Germs (What are germs?) A cold (How do germs make you sick?) Germs come when somebody else has a cold. (Tell me more.) I don't know.

The large majority of responses were at the 3rd and 4th category levels, which corresponds with the fact that most of the subjects were within some phase of concrete operational thought. The third category was that of contamination characterized by a person, object, or action that is harmful to the body causing illness through contact with the object or person or through participation in the action. Of the total population of subjects, 28 or 70% had some responses that fell within category 3; category 3 responses were found within all age groups. The following represents an example of a category 3 response.

> (Why is it that some children get sick and other children don't?) Cause some people eat good food and some people don't. (Suppose the children eat good food and they still get sick.) They go out in the cold without a jacket on and get cold. (How does that make them get sick?) Cold air makes you get cold--you catch a cold.

Category 4 involves the concept of internalization which is characterized by responses where the illness is located inside the body although the cause may be external; there may be some confusion about internal functions. In all, there were 27 subjects (67.5%) who gave some category 4 responses; again, all age groups were represented. The following example is taken from a category 4 response.

> (What makes you get sick?) I have an allergy - from pollen - you breathe in the pollen and get a sore throat and start to sneeze. (How does it make you sneeze?) I don't know.

As it was at the high range of Health Questionnaire scores (HTOT) that Piagetian scores (PTOT) had the weakest prediction strength, this section of the qualitative analysis will examine the responses of the subjects with high HTOT scores. According to Bibace and Walsh, the formal-logical explanations included two categories, that of the physiological type (category 5) and that of the psychophysiological type (category 6). There were very few subjects who had attained category 5 and 6 responses. Only 5 subjects had any category 5 responses and only 1 subject had a category 6 response.

Category 5, that of physiological explanations, is characterized by the cause of illness being understood in terms of internal physiological structures and functions. This example was taken from a category 5 response.

> (What should children do to stay healthy?) Eat good foods - eat something from each of the 4 food groups - get lots of exercise (How does exercise and good food help you stay healthy?) Makes you strong in your arms and legs so you can swim better (How does it make you strong?) Keeps your blood running healthy - it gives energy to your heart so it can pump the blood.

There was only one reponse that gave a psychophysiological exaplanation. This response was elicited from a 13 year old subject who had achieved success on some of the formal operational tasks and had an above average PPVT-R (LQ) score. This subject had a long history of hospitalizations involving surgical procedures. The following example is reproduced from the subject's Health Questionnaire.

> (What should children do to stay healthy?) Get exercise. (How does that help you stay healthy?) Gets your muscles exercised and stretched so they don't shrink and it won't be hard for you to run a mile. (Anything else?) Keeps you mentally alert - makes you feel good that you've done something.

4.2.2 OBSERVATIONS FROM THE QUALITATIVE ANALYSIS

In general, the responses reflect the fact that the majority of children were concrete operational in terms of cognitive developmental level. The large majority of responses were scored within categories 3 and 4 representing explanations involving contamination and internalization. The process of scoring these responses was often difficult because within the framework of each category the quality of explanation would vary considerably.

Only 15% of the subjects had some responses within categories 5 and 6. Bibace and Walsh (1980) found that 42% of 11 years olds fell within categories 5 and 6. However, another 54% of their 11 year olds gave explanations involving internalization and 4% gave explanations involving contamination. There is then considerable overlap which is to be expected as not all 11 year olds are at the formal operational stage of thought processes. Their findings and the findings of the present study suggest that level of concept for children of this age level may be the most difficult to predict.

It would appear that the responses in the present study basically adhere to the developmental sequence of responses proposed by Bibace and Walsh; however, for categories 5 and 6, it would seem that an older group of children must be included in order to support these categories as being typical for the upper age group, particularly for support of category 6. A study by Meltzer, Bibace and Walsh (1984) on children's conceptions of smoking confined both physiological and psychophysiological responses to one level (level 5) and found that 58% of 11 year olds gave level 5 responses to questions about smoking.

At the lower end of the scale, there were only 5 subjects from the present study (12.5%) whose responses fell within the first two categories of phenomenism and contagion. this reflects the fact that the lowest age range was, in fact, approaching concrete operational thinking. Bibace and Walsh used a group of 4 year olds to represent their preoperational group and found that 54% of their 4 year olds fell within the area of categories designated for preoperational thinkers. They fell, however, in category 2, that of contagion; there were no subjects falling in category 1, that of phenomenism. Thus, again, the category system appears to have the greatest strength within the concrete operational stage.

In the concluding chapter, the results of the qualitative and quantitative analyses will be further discussed in terms of the relative strengths and weaknesses of the the study and in terms of directions for future research.

Chapter 5

DISCUSSION

This final chapter will provide a discussion of the results of the study and will offer possible explanations for the lack of support for the first two hypotheses. Attention will then focus on the relative merits and limitations of the study with a view to suggesting directions for further research and implications for child health education.

The general problem to be investigated in this study was to what extent the variables of cognitive developmental level, age, and verbal ability contribute to the prediction of a child's level of conceptualization of health and illness. The results of the Pearson correlations indicate that all three predictor variables, taken individually, correlate significantly with the criterion variable. However, the expected entry sequence of variables into the stepwise multiple regression equation and the expected net effect of combined variables were not supported by the data analyses.

In the present research, it was hypothesized that in a stepwise multiple regression equation with level of concept as the criterion variable and cognitive level, age, and verbal ability as the predictor variables, (1) cognitive level would be a stronger predictor of level of concept than the predictors of age and verbal ability, (2) cognitive level together with age would account for more of the variance in the prediction of level of concept than either index on its own, and (3) verbal ability would account for a significant portion of the variance with regard to level of concept over and above that already accounted for by cognitive level and age. In statistical terms, it was expected that in the regression equation, cognitive level would enter on step 1, age would enter on step 2, and verbal ability would enter on step 3. Each of the three hypotheses will now be discussed.

5.1 DISCUSSION OF HYPOTHESIS 1

The first hypothesis states that cognitive developmental level would be a stronger predictor of level of concept than the index of age or verbal ability and would enter the stepwise multiple regression equation on the first step. While both of the predictor variables of cognitive level and age are highly correlated with level of concept and each variable individually is a significant predictor of level of concept, it was age that emerged as the strongest predictor, entering the prediction equation on step 1. Although cognitive level had the second highest correlation with level of concept, it was not selected for entry into the prediction equation. When forced into the prediction equation in a further analysis, cognitive level was found to contribute a negligible additional amount of variance to the efficacy of prediction. The Beta coefficient for cognitive level indicates that when the effects of age and verbal ability are partialed out, the contribution of cognitive level is not significant. When just cognitive level and age are presented as predictor variables and cognitive level is forced into the prediction equation on step 1 with age entering on step 2, the Beta coefficient for cognitive level indicates that when the effects of age are partialed out, again the contribution of cognitive level is not significant. Only when age is not presented as a predictor variable, and cognitive level together with verbal ability are entered into a prediction equation does cognitive level account for a significant portion of the variance. However, when evaluating meaningfulness as situation-specific from statistical significance (Pedhazur, 1982), in terms of ease of accessibility, it is evident that the index of age is more easily accessible than a Piagetian measure of cognitive level and is also, in this study, statistically more significant.

From the above discussion it appears that age is both an easily accessible predictor of level of concept and a significant predictor of level of concept. Nevertheless, it may still be argued that the first hypothesis would be tenable under a different set of experimental conditions. It is theoretically congruent that both age and cognitive level follow along the same continuum of general developmental sequence. The formulation of the first hypothesis was based on the premise that a Piagetian assessment of cognitive skills would tap into the process of the gradual acquisition of skills and perhaps be a more precise index than that of age. It has already been noted in the reporting of results that frequency distributions for the variables of cognitive level and level of concept had somewhat restricted ranges. From the results of this study, it was apparent that the majority of the subjects were in some phase of concrete operational thinking and that the majority of responses to the Health Questionnaire were scored within the categories that corresponded to the concrete stage. Had the study consisted of a larger representation of pre-operational and formal operational thinkers in addition to concrete operational thinkers, there may have been a stronger correlation between cognitive level and level of concept. This argument, particularly in terms of the acquisition of formal operational skills will be further discussed when the criterion variable is examined.

5.2 DISCUSSION OF HYPOTHESIS 2

The second hypothesis states that cognitive developmental level together with age would be a stronger predictor than either index on its own and the amount of variance accounted for by the composite of cognitive level and age would be greater than that accounted for by either index on its own. In fact the composite of cognitive level and age does account for more of the variance than that accounted for by cognitive level but does not account for a significant increase in the amount of variance over and above that accounted for solely by the index of age. Therefore, the second hypothesis was only partially supported. The fact that age and cognitive level correlate about equally with level of concept (with age correlating slightly higher) and that age and cognitive level are highly inter-correlated implies that there will be a minimal net effect of combining the two predictors. The net effect of combining two predictors increases when the factors are both substantially correlated with the criterion variable but have a low correlation with each other (Glass & Stanley, 1970). Although cognitive level as well as age is a strong predictor of level of concept, when the effects of age are partialed out from cognitive level, the effect of cognitive level on the efficacy of prediction is minimal. Given the strong relationship between cognitive level and age it may be that the value of a Piagetian assessment of cognitive skills becomes that of understanding the specific cognitive skills underlying the development of conceptualization of health and illness rather than that of prediction strength.

5.3 DISCUSSION OF HYPOTHESIS 3

The results do support the third hypothesis that verbal ability would have a significant effect in the prediction of level of concept; however, verbal ability entered the prediction equation on step 2 rather than on step 3 as was expected. Although cognitive level had a much stronger correlation with level of concept than did verbal ability, when the effects of age are partialed out from cognitive levels, the effect of cognitive level in the prediction equation is not significant. Verbal ability, therefore, was selected to enter the prediction equation on step 2.

Verbal ability was measured in terms of a standardized language quotient (LQ) in which age is controlled for. The PPVT-R was standardized on age reference groups (Dunn & Dunn, 1981). In obtaining the language quotient (LQ) the raw scores are converted to standardized scores so that a subject's scores can then be compared with those of a group of subjects of the same chronological age. In comparison, the Piagetian assessment score (PTOT) was composed of raw scores which, according to developmental theory, are expected to increase with age. Verbal ability then did not have a significant correlation with age but did have a significant correlation with level of concept and was selected along with age as the best weighted composite of variables in the prediction equation to the exclusion of cognitive level. The data analysis then lends support to verbal ability, independent of age, as a significant variable in predicting level of concept.

The third hypothesis supports the view held by Peters (1978) that linguistic ability is a relevant factor when communicating to children about health and illness. It should be recalled at this point that verbal ability as defined in this study measured only receptive vocabulary and was not a comprehensive measure of linguistic ability. Nevertheless, it does serve to give an indication of the relevance of language in predicting level of concept. A more comprehensive measure of language development including both receptive and expressive language skills is recommended for use in future research.

With regard to linguistic competence, Peters (1978) cautions that a good facility with language can be misleading and can mask inability to conceptualize at mature levels. Brewster (1982) notes from clinical experience that the most articulate children are not necessarily the ones who cope well with their illnesses. As in the discussion of the second hypothesis, perhaps the nature of the relationship between verbal ability and level of concept is of more importance than the evaluation of verbal ability as a predictor of level of concept.

5.4 DISCUSSION OF THE CRITERION VARIABLE (HTOT)

It has already been observed that there is a restriction of range in the Health Questionnaire scores (HTOT), a condition which may attenuate correlation coefficients when the relationship of level of concept with other variables is computed. In re-examining the Bibace and Walsh (1980, 1982) research, it is apparent that there is considerable overlap of categories of explanation of level of concept of health and illness across different age groups. While the categories of contamination (3) and internalization (4), designated as being congruent with the concrete operational stage, are manifested by the large majority (89%) of 7 year olds, the age group selected to represent the concrete stage, this consistency is not found for the categories representing pre-operational and formal operational stages. Bibace and Walsh selected 4 year olds for their pre-operational group and found that 4% gave category 2 responses of contagion representing a pre-operational stage; however, a further 38% gave category 3 responses. For the group designated to be formal operational, 11 year olds were selected. Only 34% of the subjects in this age group scored within category 5 and

8% scored within category 6 while a further 54% gave category 4 responses and 4% gave category 3 responses. It is evident then that the categories corresponding to formal operational thinking are not necessarily representative of the majority of 11 year olds. This would be congruent with theoretical expectations, as not all 11 year olds are formal thinkers; in fact, a child of 11 is likely to be just beginning the transitional stage between high concrete and beginning formal operational thinking (Arlin, 1982). It may well be that a child must have acquired the "frames of reference" formal operational concept before being able to give a multicausality explanation or an interactive treatment prescription.

5.5 DISCUSSION OF THE QUALITATIVE ANALYSIS

When the protocols from the Health Questionnaire were examined qualitatively, the general sequence of development generally followed that of Bibace and Walsh (1980, 1981). The overlap of categories across ages has already been discussed; however, another question comes to mind in that if 4 year old, 7 year old, and 11 year old subjects all give a category 3 response or a category 4 response, does the quality of the response within a particular category differ from one age group to another and, if so, should this qualitative difference be accounted for within the scoring system? This researcher found some difficulties with scoring particularly between categories 3 and 4 and between categories 4 and 5. Some of the children were somewhat reticent and it was sometimes felt that they perhaps understood more than what they were willing or able to communicate. A measure of expressive language ability would appear to be an appropriate factor to be investigated in future research. The ability to comprehend questions and explanations as well as the ability to communicate effectively would be likely to influence an adult's perception of a child's level of concept (Peters, 1978; Brewster, 1982; Haight, Black, & Di Matteo, 1985).

Other interesting observations were made during the qualitative analysis. It was noted that in this study, very few of the children regarded their present condition as an illness; the concept of illness to most of them meant having "a cold" or "the flu". In very few of the cases did surgery get recognition as a treatment for illness although surgery of one form or another was part of their current treatment plan. It should be acknowledged here that the surgery involved was elective surgery and the conditions requiring surgery were not life-threatening. It is difficult to speculate then how much the current state of health of the subjects or their hospitalization experiences would have influenced their responses and in what direction - more mature or less mature. These factors may very well have influenced the results in that the population of subjects included in the study did already have some experience with medical personnel, hospitalization, and surgical procedures. Each subject had at least one hospitalization experience which involved surgery as each was a participant in the Preadmission Preparation Programs Study at B.C.'s Children's Hospital. Some of these children would have received a preparation treatment as part of the experimental group while others in the control group would not have received this additional treatment. Some of the subjects had long term conditions which had required frequent hospitalizations. Current state of health may also have been a factor. Researchers vary in terms of their findings with regard to the effect of illness on cognitive level and on explanations of causality. Some find lower scores than would be expected and suggest that the lower scores may reflect a regressive reaction to stress (Cook, 1975); others find higher scores than would be expected which they attribute to increased sophistication with regard to medical procedures and explanations of causality of illness and effects of treatment (Feldman & Varni, 1985).

Semantics can play an important role in terms of questioning (Cook, 1975). It may be that leaving sickness as an open-ended condition elicits different responses than specifying a particular condition. The fact that the questions in this study were open-ended probably led to the frequent response to sickness as "a cold" as that was a condition very familiar to most children.

The findings of the present study also support Cook's contention that spontaneous responses tend to be less mature and to have moral overtones while probing elicited more mature responses that went beyond the concepts of wrong-doing and punishment. Different questioning techniques then appear to elicit different types of responses.

5.6 LIMITATIONS OF THE STUDY

The present study was limited in terms of sample size and restriction of range for Health Questionnaire scores and the Piagetian assessment scores. The sample included in this study was largely concrete operational and the Health Questionnaire scores reflected this limitation in that the large majority of responses were those delineated as being concordant with the concrete operational stage. The sample should have included a greater representation of formal operational thinkers in order to test the prediction strength for the higher categories of health concept.

Although the study involved a more comprehensive Piagetian assessment than other studies discussed in the review of the literature, time restrictions and ease of administration did somewhat limit the choice of tests in the battery. It is recommended that in future research, the battery be extended to include conservation of volume as it is considered to be a traditional task in assessing the transition from concrete to formal reasoning and it was the subjects in this transitional stage that the present study did not adequately represent. The assessment battery then should also include a more comprehensive selection of formal operational tasks so that a measure of high and low stages of formal reasoning can be obtained to correspond with the two categories for the highest level of health concepts. It is suggested that for future research a group of 12 year olds be selected to further test the hypotheses on the assumption that this age group would be representative of a combination of both concrete operational and formal operational thinkers and, with age restricted, the contribution of cognitive level to the prediction of level of concept could then be measured.

The study sample consisted of a group of subjects from a particular population, that of children who had experienced hospitalization and surgery. A similar study conducted on a sample of school children randomly selected would eliminate some of the possible confounding effects of medical experiences beyond those of a normal population.

Verbal ability in this study was restricted to a measure of receptive vocabulary. A more comprehensive measure of linguistic ability assessing both expressive and receptive language skills as suggested in the discussion of the qualitative analysis may account for a greater portion of the variance than that accounted for by a measure of receptive vocabulary and may be more meaningful in helping to understand the relationship between linguistic ability and level of health concepts.

5.7 DIRECTIONS FOR FUTURE RESEARCH

Suggestions for future research extend in two directions. Perhaps the first centre of focus would be to conduct a further study with a greater representation of subjects who are formal operational as suggested in the discussion of the limitations of the study. With age restricted (12 year old subjects), it would then be possible to test the efficacy of cognitive level as a predictor of level of health concept. It is of particular interest to test the relationship of formal operational concepts to level of health concept as in the research by Bibace and Walsh (1980, 1981). The group of 11 year olds selected by them to represent the formal operational stage did not consistently give responses in the categories designated to be formal operational. This is to be expected as few 11 year olds are formal operational, but what then would the relation be for subjects who are formal operational?

A further suggestion for future research is to focus on the interaction of specific cognitive concepts with health concepts. In the Bibace and Walsh study, there were very few 11 years olds who had psychophysiological explanations. Is it necessary for a subject to have acquired the formal operational concept of "frames of reference" before being able to offer multicausality explanations of illness or interactive treatment prescriptions? A measure of the prediction strength of specific cognitive concepts in relation to level of health concept may provide a greater understanding of the developmental sequence of conceptualization of health and illness.

The relevance of cognitive developmental level to child health education will be discussed in the following section.

5.8 IMPLICATIONS FOR CHILD HEALTH EDUCATION

From this vantage point, one must then consider again the value of increased knowledge about concept development and the contributions made to improve strategies used by medical personnel to impart information to their young patients. It has already been noted that some researchers question the value of explanations with very young children. Others question the validity of trying to change concepts which though sometimes erroneous may serve as a defence mechanism in allowing the child to cope with his medical problems (Vernon et al., 1965). Whatever the personal philosphy or preferred strategy of the medical practitioner, it would seem that an awareness of cognitive level would assist in making a judgement about which approach to take.

Other problems persist, however, as Pantell et al. (1982) acknowledge, in that the physician's theoretical knowledge of children's cognitive understanding is poor. Also, many paediatricians sill adhere to the more traditional approach of dealing primarily with the parents, excluding the young patients from understanding and participating in the management of their illness.

While there has been much discussion about developmental level being related to concepts of health and illness and the importance of strategies in health education based on developmental level, there has been little research conducted to test the success of particular strategies. A recent study by Potter and Roberts (1984) represents an attempt to test the efficacy of strategies for explaining illnesses to children at differing ages. The results of their study indicate that children's comprehension of illnesses can be improved significantly with the provision of explanatory information, although preoperational children are less able to retain specific information.

Few researchers have proposed strategies and/or guidelines for explaining illness to children at different ages. In addition to Potter and Roberts who have made a contribution in this direction, Whitt et al. (1979) have proposed the use of metaphorical explanations, especially when dealing with young children. They feel that because of limited cognitive and language abilities, children are at a disadvantage in interpreting medical information. Using the Piagetian stages as guidelines, they have devised methods for using cues from the child's perceptions and experiences to form metaphorical analogies as part of the explanation process. However, some researchers have noted that children's comprehension of metaphors is limited (Billow, 1975; Boswell, 1979).

5.9 SUMMARY OF DISCUSSION

In conclusion, it seems appropriate to suggest that although not all of the hypotheses were supported by the results of the current study, there is some evidence within the data to suggest that with a different population of subjects and a somewhat revised methodology another study might provide this support. In any case, it is apparent that cognitive level does correlate significantly with level of concept and can help to predict level of health concept. Overall, this investigation has provided some additional insight into the interrelationships of cognitive level, age, and verbal ability and the relationship of each with level of concept of health and illness. In addition, some new strategies have been demonstrated in terms of comprehensiveness of assessment which indicate possible new directions in methodology for future research. In terms of implications for patient education, only further research can measure the value of cognitive theory in planning intervention but it is encouraging that research efforts have begun to systematically evaluate the efficacy of various strategies.

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APPENDIX A: MATERIALS FOR PIAGETIAN TASKS

Concrete Stage Tasks

Classification

Simple Classification	12 attribute blocks (red, yellow, blue, circles, squares, triangles, thick, thin, large, small)
Two-way Classification	Matrix requiring classification according to shape and colour
Class Inclusion	10 wooden blocks, 7 of which were green and 3 of which were black
Three-way Classification	Matrix requiring classification according to shape, colour, and direction

Conservation

Number	10 small green blocks and 10 small black blocks
Quantity	2 plasticine balls of approximately 5 cm. diameter each
Length	2 shoelaces - 61 cm. each
Area	2 sheets of "8-1/2 x 11" paper and 20 small, green self-adhesive circles
Weight	2 plasticine balls of approximately 5 cm. diameter each

Formal Stage Tasks

Probability	3 yellow, 3 green, and 3 purple beads and an envelope
Correlations	"8 x 5" card with 12 faces with blue/brown eyes and with blond/brown hair
Combinations	Electronic box with a light bulb and 5 buttons
Proportions	Pictures of "Mr. Big" and "Mr. Small", 10 big paper clips, 10 small paper clips

APPENDIX B: SAMPLE HEALTH QUESTIONNAIRE

Code Number ______________________ Age ______ Date ____________________

CHILDREN'S HEALTH QUESTIONNAIRE

1. What does it mean to be healthy?

____

____

____

2. What should children do to stay healthy?

____

____

____

3. What does it mean to be sick?

____

____

____

4. Why do children get sick?

____

____

____

5. Why is it that some children get sick and other children don't?

____

____

____

6. What makes you get sick?

____

____

____

7. What makes you get better?

____

____

____

(Robinson, Conry, & Harper, 1986)

APPENDIX C: SAMPLE PROTOCOL FOR CONCRETE OPERATIONAL TASKS

Code Number ____________________ Age ______ Date ______________________

CONCRETE TASKS

Classification:

1-Way Classification ____________________________ Choice

____________________________ Shift

2-Way Classification ____________________________ Choice

____________________________ Reason

Class Inclusion ____________________________ Choice

____________________________ Reason

3-Way Classification ____________________________ Choice

____________________________ Reason

Conservation:

Number ______________________________________ Same/More/Less

______________________________________ Reason

Quantity (a) ______________________________________ Same/More/Less

______________________________________ Reason

(b) ______________________________________ Same/More/Less

______________________________________ Reason

Length (a) ______________________________________ Same/Longer/Shorter

______________________________________ Reason

(b) ______________________________________ Same/Longer/Shorter

______________________________________ Reason

Area ______________________________________ Same/More/Less

______________________________________ Reason

Weight ______________________________________ Same/More/Less

______________________________________ Reason

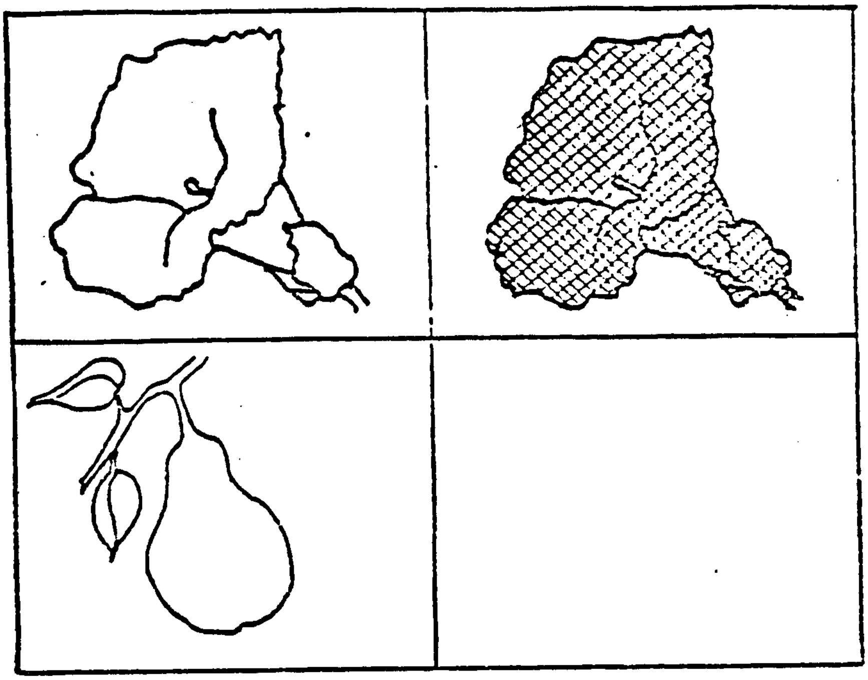
APPENDIX D: SAMPLE PROTOCOL FOR FORMAL OPERATIONAL TASKS

Code Number ______________________ Age______ Date ____________________

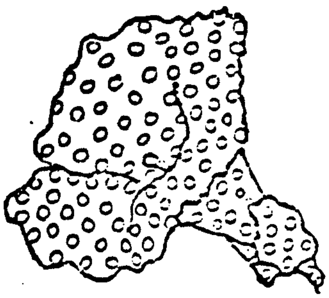
FORMAL TASKS

Probability: (Place in an envelope 3 yellow, 3 green, and 3 purple beads.) "What are your chances of getting a yellow bead if you were to pick one bead from the envelope? Why do you think so?"	Answer: ____________ Reason: ____________ ____________
(Let child pick one bead.) "What are your chances of getting another _____ (name the colour drawn) bead on your 2nd try? Why do you think so?	Answer: ____________ Reason: ____________ ____________
Correlations: (Present the card with the 12 faces.) "This card has 12 faces with blue or brown eyes and with blond or brown hair. Can you find a relationship between hair colour and eye colour based on these 12 faces?" (Probe if necessary) "What could you say about the eye colour of the blond haired people?" etc.	Answer: ____________ Reason: ____________ ____________
"What are the chances of a person being blond haired and brown eyed based on the 12 faces on the card? Why do you think so?	Answer: ____________ Reason: ____________ ____________
Combinations: (Demonstrate for the child that pressing some of the buttons on the electronic box will cause the light to shine. Insert a file card between the light source and the buttons so that the child cannot view which buttons are being pressed.) "Now you try and find out which buttons to press in order to make the light come on." Probe, if necessary, to determine what tactics are being employed. Record child's attempts.	x1 ____________ x2 ____________ x3 ____________ x4 ____________ x5 ____________
Proportions: (Set out the pictures of Mr. Big and Mr. Small.) "I am going to measure Mr. Big with these big paper clips. He is 6 big paper clips tall. Now I am going to measure Mr. Small. He is 4 big paper clips tall. Let's measure the men using these small paper clips. Mr. Small is 6 small paper clips tall. How tall do you think Mr. Big is going to be if I use these small paper clips to measure him? What is your guess? Tell me why you think your answer is right?"	Answer: ____________ Reason: ____________ ____________

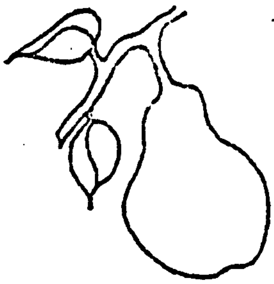
APPENDIX E: MATRIX FOR TWO-WAY CLASSIFICATION



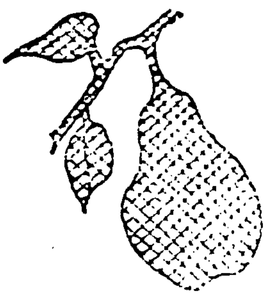
The 3 objects pictured above make a pattern. Which of the following objects will go best with the other 3 objects to complete the pattern?



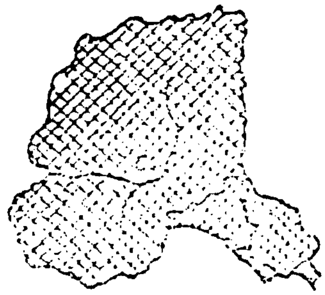
a



c

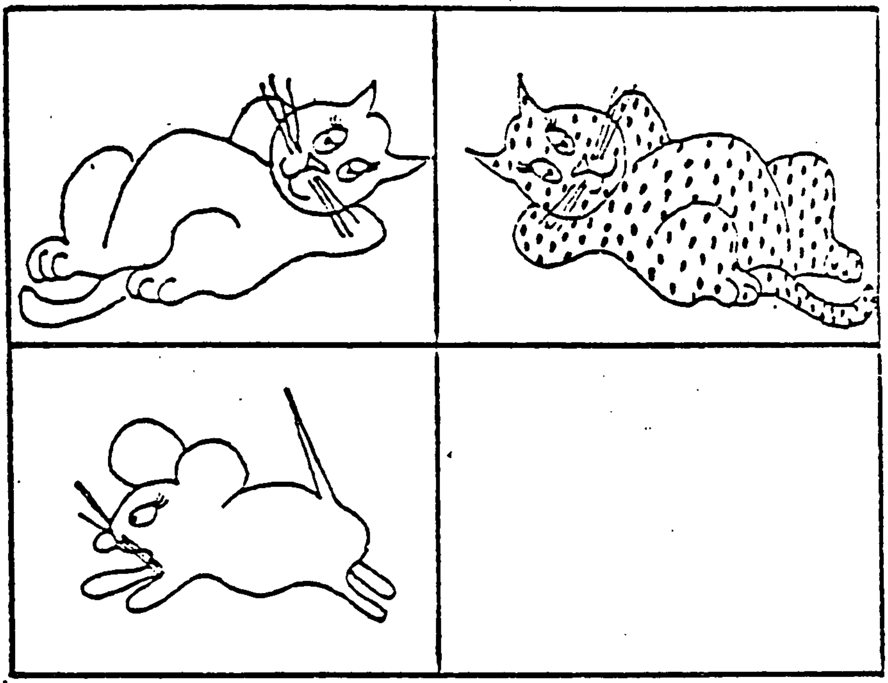


b

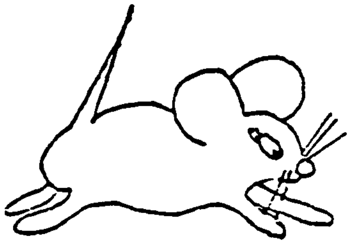


d

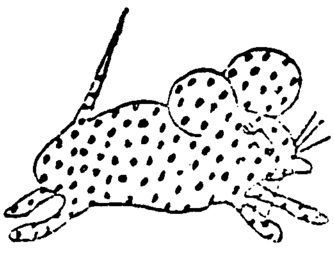
APPENDIX F: MATRIX FOR THREE-WAY CLASSIFICATION



The 3 objects pictured above make a pattern. Which of the following objects will go best with the other 3 objects to complete the pattern?



a



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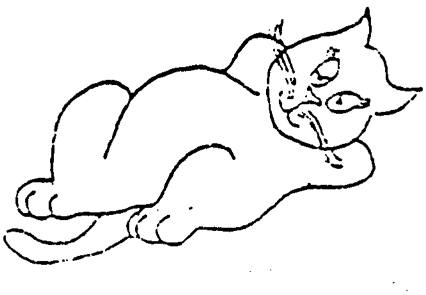

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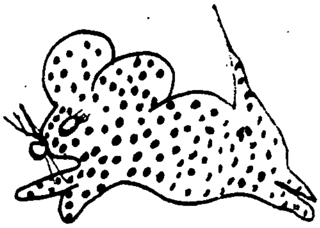
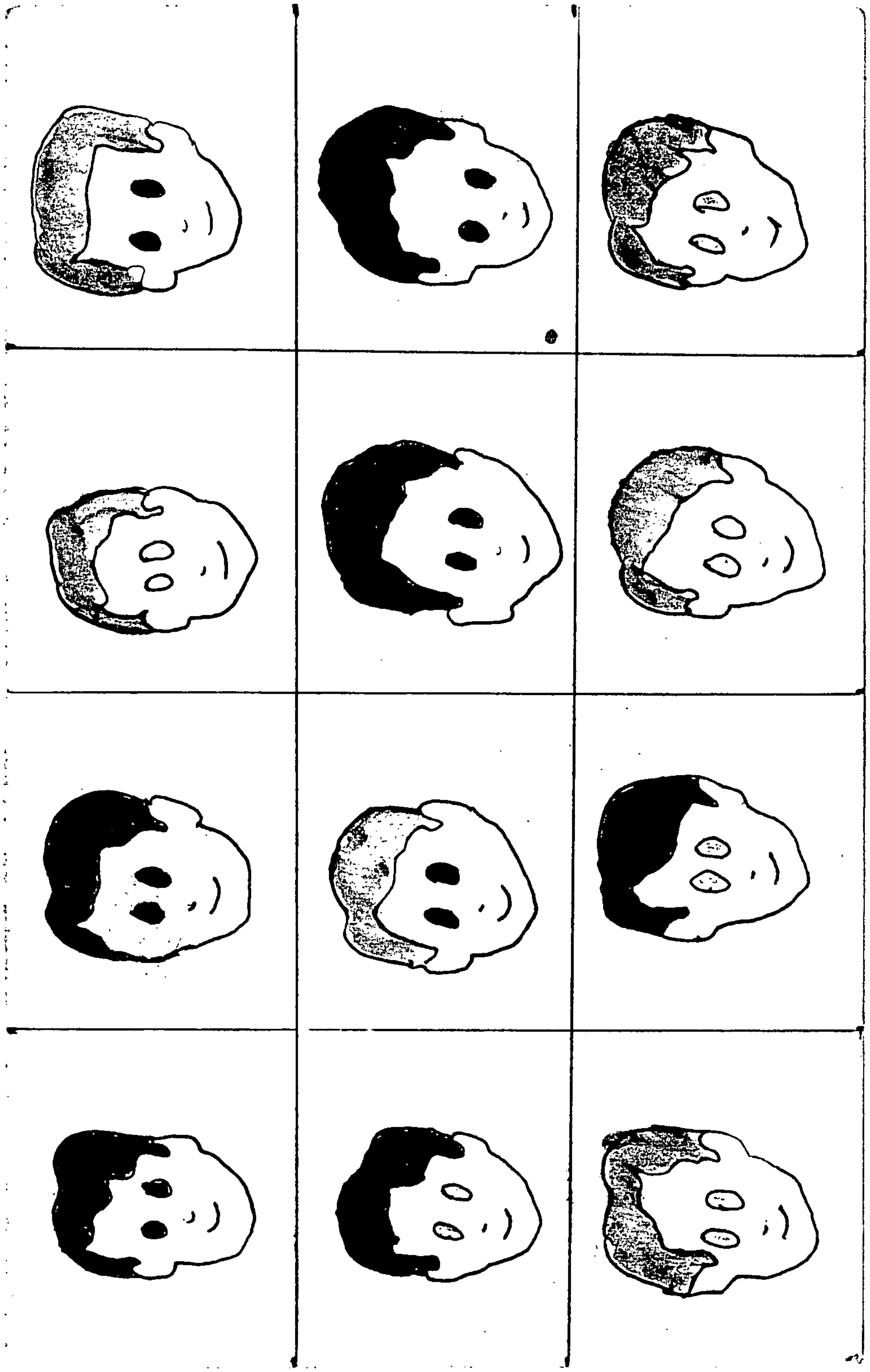


e

APPENDIX G: FORMAL OPERATIONAL TASK OF CORRELATIONS



APPENDIX H: FORMAL OPERATIONAL TASK OF PROPORTIONS