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Lisa D. Lieberman
Montclair State University, liebermanl@montclair.edu

Noreeen Clark
The University Of Michigan

Karen V. Krone
American Health Foundation

Mario Orlandi
American Health Foundation

Ernst L. Wynder
American Health Foundation

HEALTH EDUCATION RESEARCH
Theory & Practice

Vol.7 no.3 1992
Pages 391–401

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Lisa D.Lieberman, Noreen M.Clark[1], Karen V.Krone[2], Mario A.Orlandi[2] and Ernst L.Wynder[2]

Abstract

This study of urban, multi-ethnic children was undertaken to explore the relationships between age, cognitive developmental capability (termed 'cognitive maturity') and accuracy of information about health problems. A total of 299 children in the first, second and third grades from six public and one private school in New York City were individually interviewed using an open-ended set of questions. Findings indicated that having accurate health information is not the same as comprehending the abstract internal nature of the 'facts'. Results supported Piaget's levels of cognitive development applied to the area of health. Findings also showed that age is a better predictor of children's accuracy about health information than their cognitive maturity. The findings underscore the need for those providing health education to place emphasis on the cognitive abilities of children and not to mistake recitation of factual information for understanding of conceptual elements of a health problem.

Introduction

A variety of health education programs for children have been successful in increasing children's health knowledge (Connell *et al.*, 1985; Walter *et al.*, 1988). Developmental psychologists have suggested, however, that the information a child can provide about a health topic may or may not reflect the level of the child's cognitive ability, i.e. being factually accurate may be different from understanding a problem conceptually (Nagy, 1953a–c; Siegler, 1978; Vygotsky, 1978; Kagan, 1984).

The study of school age children reported here was undertaken to explore the relationships between age, cognitive developmental capability (termed 'cognitive maturity') and accuracy of information about health problems. The investigation is unique in several ways. Most studies of children's knowledge, attitudes and beliefs have focused on specific diseases or on the concept of illness in general (Bibace and Walsh, 1980, 1981; Perrin and Gerrity, 1981; Clark and Shope, 1986; Lau and Klepper, 1988). Few have looked at children's understanding of health-related behaviors, such as smoking and drinking. Furthermore, understanding of health or illness typically has been examined in terms of children's 'level of cognitive development' (Natapoff, 1982; Michela and Contento, 1984) or their ability to 'provide accurate information' (Nagy, 1953a–c; Siegler, 1978), but few studies have explored both.

This study sought to distinguish accuracy and cognitive maturity related to health issues and hypothesized that the two would be positively related. It also hypothesized that while the development of both cognitive ability and accuracy about a health problem would be related to age and therefore be parallel, one might lag behind the other. Thus, the strength of the relationship between level of cognitive maturity and age may differ from that of accuracy and age.

Department of Health Education, New York University, 35 West 4th Street, 12th Floor, New York, NY 10003, [1]School of Public Health, University of Michigan, Michigan, MI 48109 and [2]American Health Foundation, New York, NY 10017, USA

Background

The research of Jean Piaget has provided some of the most comprehensive descriptions of children's cognitive capabilities and development. He maintained that children progress sequentially through a series of stages in which cognitive abilities develop. The stages are typically identified with certain age ranges, although Piaget holds that it is experience with the environment and not maturation *per se* that facilitates the building of cognitive structures (Piaget and Inhelder, 1969). The developmental sequence is characterized as follows: sensory–motor period (ages 0–2), preoperational (2–7), concrete operations (7–11) and formal operations (11–15). The transitions from sensory–motor through preoperational, concrete and formal operational thought are characterized as a continuum in which children move from a subjective to an objective realm (Formanek and Gurian, 1976). That is, reliance on overt perceptual cues dependent upon the child's egocentric world view gives way to hypothetical or abstract concepts which are independent of the child's own experience.

The child in the sensory–motor stage, infancy through the beginnings of language, is involved with the discovery of his physical environment. Reflexes give way to intentional behavior and little exists outside of the child himself. By the time the child reaches the age of 2, a symbolic form of representation (language) is developing which leads the child to the egocentric, magical stage of preoperational thought. The child at this stage cannot take the viewpoint of others and his sense of causality is 'phenomenistic', i.e. two events happening together is sufficient to make them causally related. In addition the child's thinking is extremely 'magical', i.e. things just happen. The child's understanding is based strictly on overt, perceptual cues.

Around the age of 7, children move into a phase which enables them to use logic such as reversal of concepts, multiple classification and mental ordering or seriation in their thinking. As such they can begin to solve problems, but those limited to real observable objects or events, based on their own experiences.

The period of formal operations, beginning around the age of 11, is characterized by the ability to think as adults, i.e. to explore a range of logically possible solutions and to reason on the basis of an assumption or a hypothetical situation. Thinking becomes more abstract such that children do not need to rely only on what they see, hear or experience.

The concepts of risk, prevention and long-term causality are often the basis of health education programs which aim to encourage healthy behaviors. These concepts are, by nature, complex and abstract. Children in the period of concrete operations, for example, probably would not be able to hypothesize about the nature of the risks of smoking and the potential damage to the lungs and other body systems because these are internal, not tangible. Furthermore, children see many examples of seemingly healthy smokers, thus what they actually see and what they learn may seem to conflict. The concept of prevention requires an understanding of reversal, i.e. if A causes B, then one can prevent B by avoiding A. Presumably a child at the preoperational stage would not be able to comprehend this.

Piaget's work was primarily related to cognitive schema and was not applied to children's thinking in specific content areas. Other developmental psychologists (Vygotsky, 1978; Kagan, 1984) have suggested that cognitive capabilities are highly specific. Children may therefore exhibit higher order thinking about some topics over others.

Several investigators have been interested in examining the cognitive development of children related to problems of health and illness. Nuehauser *et al.* (1978), in a study of 5 and 9 year olds, found that younger children were better able to describe concrete, external phenomena than internal, abstract ones, i.e. they more easily described the healing of a cut than recovery from a cold and 'sickness' was more easily defined than 'health'. Natapoff (1978) studied first, fourth and seventh graders' descriptions of health. Consistent with Piagetian expectations, first graders provided long lists of concrete, observable criteria for health and could not conceive of being simultaneously 'part healthy' and 'part not healthy'. Fourth graders were more concerned with global body states, feeling good and 'being in shape', while seventh graders expressed doubts about being able to define health, viewed health as long-term and sickness as short-term, and were more likely to include mental health in their definitions.

In trying to predict how cognition, as defined by Piaget, would be manifested in the particular content area of health, Bibace and Walsh (1980, 1981) developed specific categories using Piagetian developmental criteria from which to code interview data from 4, 7 and 11 year olds. The results confirmed the validity of the overall theory that children's conceptions of illness reflect the more general process or stages of cognitive development as articulated by Piaget (Bibace and Walsh, 1981).

Perrin and Gerrity (1981) used a similar coding scheme to classify the responses of children in kindergarten, second, fourth, sixth and eighth grade regarding the causes and treatment of illness. They found a great deal of variability among children within a given age group. Understanding of illness for each age group significantly increased by grade level. The more abstract questions were consistently harder for all children and generally resulted in lower mean scores. The investigators also concluded that illness understanding paralleled, but lagged behind, causal understanding in general.

In a study of children aged 3–15, Banks (1985) described the tendencies for younger children to be more egocentric and magical in their accounts of illness, and for older children to move toward standard medical and cultural explanations of colds, germs and illness in general. Michela and Contento's (1984) study of children's spontaneous food categorizations was one of only a few studies classifying children by performance on Piagetian tasks rather than age. In their sample, of 5–11 year olds, classified as preoperational or concrete thinkers by a conservation and classification task, there were significant differences between the two groups. The preoperational thinkers used more perceptual, functional and physical properties to classify foods such as sweet versus non-sweet, breakfast foods, green foods, etc. The concrete operational thinkers were influenced by more abstract underlying dimensions such as degree of processing or plant versus animal origin of foods.

Developmental level, rather than age, *per se* has been shown to be an important variable in children's understanding of health and illness. In most cases, however, the connection between increasing developmental level and increasing accuracy of information has not been made. Crider (1981) described increasing developmental capability as accompanied by increasing accuracy. Being more conceptually sophisticated, however, may not necessarily mean being more accurate. Nagy (1953a–c), in early studies of 5–10 year olds' ideas about bodily functions, birth theories and germs, found that age had no correlation with correctness of response, and that only children over age 8 years had any correct understanding of birth. Siegler (1978), who worked with young children, posited that changes in ability to learn and mental processes occur first, followed by a change in the existing level of knowledge or information. The studies of Nagy (1953a–c) and Siegler (1978) suggest that accuracy of information and cognitive level are separate phenomena, and one should not be mistaken for the other.

To date, few studies have distinguished cognitive development from accuracy of health information. In addition, studies have tended to focus on health and illness concepts in general and not on understanding of consequences of behavior. Such behavioral risks are the focus of many current health education programs for school-aged children. Most of the studies described here have chosen children at widely disparate ages, assuming that children will differ in their cognitive levels or stages. This study chose children within a small 'transitional' age range in order to assess the contribution of age as well as other factors to cognitive maturity. The purpose of the exploration discussed here was to examine children's developmental capabilities in the area of health, to see if these were distinct from accurate health knowledge and to examine the relationship of age to both.

Methods

The sample

A total of 299 children in grades one, two and three from six public schools and one private elementary school in New York City were interviewed. The data reported here were collected as part of a larger study of multi-ethnic populations which served as the basis for a primary grades health education curriculum (Vogt *et al.*, 1984). The schools selected for inclusion were chosen because they represented a range of income levels and ethnicities and, therefore, constitute a convenience sample which is not necessarily representative of a single larger population. Nevertheless, the study subjects are a reasonable reflection of urban dwelling first, second and third graders of varying social and economic levels from diverse ethnic backgrounds. Eligibility for children to participate in the interviews was determined by parental consent. Of the 700 total children, enrolled in grades one, two and three in the seven schools, only 10 were ineligible due to parental refusal. The actual study sample was a random sample of the eligible children, stratified by grade, sex and ethnicity. The study sample of 292 children was 23% Black, 23% Hispanic, 18% Chinese, 31% Caucasian and 5% other (Japanese, Indian, etc., as identified by school records). The sample was approximately equally divided by grade, with 31% in grade one, 34% in grade two and 35% in grade three. Of the sample, 49% were boys and 51% were girls.

The interview

Questions for the children were designed to be open-ended with successively more specific probes built into each in the 'clinical method' used by Piaget (Formanek and Gurian, 1976). Six basic questions were posed using this method, each covering a separate subject: how do you know when you're sick; how do you know when you're healthy; how do you get colds; what is a germ; what happens inside or to your body when you smoke cigarettes; what happens inside or to your body when you drink alcohol? Visual aids (pictures of someone smoking, bottles of beer, wine, liquor, etc.) were used to facilitate the discussion. The questionnaire was pilot-tested with 40 children and adjustments made for clarity before interviews began with the study sample of 299 children.

Interviews were conducted by three interviewers with training in elementary education, health education, and curriculum and instruction, respectively. Interviewers of Chinese and Spanish speaking children were fluent in those languages and used them as necessary. Each child was removed from the classroom for 45 min to 1 h and interviewed individually. Interviews were tape recorded and transcribed.

Coding of the open-ended interview data

Cognitive maturity: a set of criteria was developed, that identified specific characteristics of increasingly mature thought or increasing cognitive development in Piagetian terms. Using a methodology similar to that of Perrin and Gerrity (1981) and Bibace and Walsh (1980) to determine cognitive developmental features from open-ended interview data, the cognitive maturity coding scheme was devised, in an attempt to separate cognitive features of the response (i.e. cognitive maturity) from factual knowledge (i.e. accuracy). Using the method for coding qualitative data as described by Patton (1980), which derives coding categories from the data themselves, 15 interviews were used initially to develop the coding scheme. Consultation from two Piagetian psychologists was received. Another 20 interviews were then coded by four experts: a pediatrician, a clinical child psychologist, a developmental psychologist and a health behavior specialist. Each provided a score and rationale for the score, general comments, questions, and problems related to the coding. A final manual was developed based on this experience which served as a guide for coders to rate all 299 interviews. Coders for cognitive maturity were three master's level individuals with experience and training in child development.

The cognitive maturity score was an ordinal rating reflecting increasing developmental capabilities and based on a Piagetian sequence. Cognitive maturity scores were derived for six topic areas: healthy, sick, germs, colds, smoking and drinking; and a total summed score called the cognitive maturity index was created. Table I describes each of the five coding levels and provides examples of responses in each category. The first level indicates an off task response or a response in which there is no evidence of understanding. Level two begins to reflect Piagetian characteristics of preoperational thought: overt

Table I. *Examples of responses in each category of the cognitive maturity scale and accuracy score for that response: what happens inside or to your body when you smoke cigarettes?*

Levels of cognitive maturity	Example	Accuracy score
1 = Off task responses	"I don't know" "When is it lunch-time?"	0
2 = External, circular, description responses	"You taste it"	1
3 = Concrete, specific, catalogued responses	"Your germs and your bones don't feel too good, you have bad breath and stuff"	1
4 = Perspective of internalization	"Your lungs sort of smoke, it gets into your body in your lungs, you can get cancer"	2
5 = Bodily reactions, internal mechanisms	"It's bad for your lungs, because they can turn yellow and when they turn yellow, you can't breathe as much because it stops the lungs"	2

perceptual cues, circular reasoning and essentially a descriptive response. At level three, characteristics of early concrete operational thought are seen, with responses that are catalogued lists of symptoms, or the linking of events that occur together, but are still essentially observable and tangible. Level four reflects more advanced concrete operational thinking with the child expressing theories and logical sequences. Causal relationships can be mediated by other factors and they begin to reverse themselves (concept of 'prevention'). The existence of processes inside the body begins to be discussed. Finally, level five reflects responses of a more abstract nature, discussion of hypothetical problems that are not necessarily concrete or observable, multiple causes for a specific outcome and a particular focus on internal mechanisms and systems.

Accuracy: a list of factual statements related to each of four subject areas was generated: colds, germs, smoking and drinking. A total accuracy index score was also calculated as the sum of the four scores. Accuracy for being healthy and being sick was not assessed as these were subjective feelings which could not be classified as correct or incorrect. The accuracy score was a count of the correct 'pieces' of information provided in a particular set of responses, according to accepted available medical and health information. Using Patton's method, a list was generated from the first 15 interviews. Twenty more interviews were coded and additional comments were added to the original list. The list was reviewed by a panel of experts for correctness given accepted medical fact. Accuracy was rated, using the list, by one doctoral level and two master level health educators. Coders were trained by the study investigators and went through a series of training rounds aimed at improving inter-rater reliability. Table I includes the appropriate accuracy score for each of the response examples.

Intra- and inter-rater reliability was examined using Pearson correlation coefficients. Inter-rater reliability was calculated using Pearson product-moment correlations of scores on 40 randomly selected interviews. Correlations for cognitive maturity were high, with 16 of 18 intercorrelations being 0.69 or better. Inter-rater reliability for accuracy was high, ranging from 0.61 to 0.92 on individual scores (with one exception of 0.48), and the majority were well over 0.75. Intra-rater correlations for both accuracy and cognitive maturity based on a recoding of a 15% random subsample of interviews were 0.75 or higher. Over two-thirds of the intercorrelations were 0.9 or higher.

A strong case can be made that the best way to assess Piagetian levels is to utilize the classic Piagetian tasks (Formanek and Gurian, 1976) to discern children's levels of cognitive development. An example of this approach is Michela and Contento's (1984) study of children's food classifications. The rich qualitative data that children provided here, however, enabled Piagetian trained individuals to identify responses consistent with Piagetian developmental concepts. This approach has the advantage of being able to compare the two constructs (cognitive maturity and accuracy) as they are functioning together in the same response.

This study was not an attempt to determine Piagetian developmental capability in the traditional sense, i.e. ability to perform specific operations or tasks. Rather, the Piagetian framework was the theoretical basis used to determine the underlying capabilities of children to understand health information. Although coding both of these independent variables from the same set of data had inherent methodological difficulties, the coding was conducted by two different sets of raters, one set with expertise in developmental psychology and the other with expertise in health. Thus, the two sets of raters were looking for different things from the same data, a method that is consistent with the basis of qualitative research, i.e. that findings emerge from the data and that the interpretation of data depends on the theoretical and practical perspectives of the observer, in this case, the coders (Bogdan and Biklen, 1982).

The weakness of this approach is that the items used to express cognitive maturity about health are not synonymous with Piagetian tasks. They are instead an expression of cognitive structure in the language children used to respond to questions, from which one can test whether Piagetian theory can be applied to the area of health. The levels expressed in the children's responses were reviewed by a panel of experts for face validity and can be viewed as highly similar, if not exactly the same as Piagetian levels.

One problem in using the same response to measure the expression of both cognitive maturity and accuracy is the potential for the two to be confounded. Indeed, correlations between cognitive maturity and accuracy scores within content areas were significant ($P < 0.001$) ranging from 0.41 to 0.56. The use of the same response for both, however, also allowed the researchers to determine that they were, in fact, different constructs. As a test of the difference between the two constructs, an analysis of the constructs as indices was conducted. The Cronbach alpha for cognitive maturity was 0.696 and for accuracy was 0.505, suggesting that the relationship across subject domains was stronger for cognitive maturity than for accuracy.

To further examine whether or not the two constructs were distinct from each other, analyses were conducted of the relationship between them and other variables of interest. Cognitive maturity and accuracy were both significantly associated with IQ ($P < 0.001$). Accuracy was more strongly associated with age ($P < 0.001$) than was cognitive maturity ($P < 0.05$). Cognitive maturity was significantly associated ($P < 0.001$) with maternal education and family income, while accuracy was not associated with either. These correlations were further evidence that the two constructs were associated, but clearly different.

Data analysis

Data were analyzed using the Statistical Package for the Social Sciences for the IMB PC/XT. To ascertain if cognitive maturity and accuracy increased with age, one way analysis of variance tested the differences in mean cognitive maturity and accuracy scores for each age group. Residuals were examined for violations of assumptions. To test whether the association between cognitive maturity and age differed from that between accuracy and age, the r^2 for the regression of age on cognitive maturity and for the regression of age on accuracy were compared.

Findings

Table II presents the means, standard deviations and ranges for each of the cognitive maturity and accuracy items. As can be seen in Table II, the mean score for each of the cognitive maturity items fell between coding levels two and three. This fact reflects the transition between preoperational and concrete operational characteristics of thought, as would be expected of children of this age, according to Piaget's theory. Mean scores for accuracy were low. Study children provided more accurate information about drinking than about any other health area.

As can be seen in mean scores in Table II, there was great variability in the amount of accurate knowledge across each of the topic areas. This was true for the group, as well as for individual children. This variability in health information across topic areas held true even within age levels, as seen in Table III, which presents the means and standard deviations for both cognitive maturity and accuracy scores at each age level.

Table II. *Mean scores for each of the cognitive maturity and accuracy items*

Item	Mean	Standard deviation	Range
Cognitive maturity (CM)			
SICK	3.06	0.84	1–5
HEALTHY	2.81	1.08	1–5
COLD	2.32	0.68	1–5
GERM	2.82	0.76	1–5
SMOKE	2.88	0.80	1–5
DRINK	2.67	0.79	1–5
Accuracy (AC)			
COLD	0.25	0.66	0–4
GERM	1.89	0.95	0–5
SMOKE	1.85	1.24	0–5
DRINK	2.17	1.37	0–5
CM INDEX	16.58	3.10	8–26
AC INDEX	6.21	2.77	1–15

Table III. *Mean cognitive maturity and accuracy scores by age (standard deviation in parentheses)*

Variable	Age			
	6 (n = 80)	7 (n = 87)	8 (n = 94)	9 (n = 23)
CMSICK	2.91	3.13	3.16	3.00
	(0.86)	(0.86)	(0.82)	(0.74)
CMHEALTH	2.68	2.90	2.93	2.48
	(1.13)	(1.06)	(1.05)	(1.20)
CMCOLD	2.21	2.37	2.40	2.36
	(0.62)	(0.71)	(0.72)	(0.66)
CMGERM	2.58	2.98	2.86	2.78
	(0.79)	(0.76)	(0.73)	(0.74)
CMSMOKE	2.61	2.99	3.00	3.22
	(0.70)	(0.76)	(0.83)	(0.85)
CMDRINK	2.48	2.77	2.80	2.68
	(0.69)	(0.91)	(0.73)	(0.65)
CMINDEX	15.50	17.05	17.21	16.50
	(2.64)	(3.24)	(3.08)	(3.4)
ACCOLD	0.10	0.27	0.35	0.41
	(0.50)	(0.63)	(0.77)	(0.91)
ACGERM	1.64	1.87	2.11	1.91
	(0.90)	(0.98)	(0.83)	(0.99)
ACSMOKE	1.43	1.86	2.12	2.26
	(1.07)	(1.21)	(1.23)	(1.48)
ACDRINK	1.64	2.29	2.37	2.86
	(1.25)	(1.41)	(1.29)	(1.13)
ACINDEX	4.83	6.41	6.96	7.33
	(2.40)	(2.69)	(2.56)	(2.89)

Table IV presents the analysis of variance for the mean cognitive maturity scores and mean accuracy scores by age. This table illustrates that both cognitive maturity and accuracy index scores increase significantly with age. Scheffe multiple comparison techniques indicated that there were significant differences between the 6 year old children and the 8 year old children on cognitive maturity index, and between the 6 year olds and each other age group (7, 8 and 9 year olds) regarding accurate health information. Several individual cognitive maturity and accuracy items also increased with age, most notably those that were related to behavioral consequences (i.e. smoking and drinking), although multiple comparison techniques found no significant differences between any two age groups on the individual cognitive maturity items.

Finally, there was a difference in the strength of the relationship between age and cognitive maturity compared to the strength of the relationship between age and accuracy. In the regression analysis, age accounted for 11% of the variance on the total accuracy index and only 1.7% on the cognitive maturity index, a significant difference of $P < 0.01$. Furthermore, age accounted for a significant ($P < 0.05$) amount of variance on only one of the six individual cognitive maturity variables and on all four of the accuracy variables. Table V indicates the r^2 for each of the individual variables and the two indexes by age. In this sample, increasing age meant greater accuracy in providing health information more than it meant higher scores for cognitive maturity.

Discussion

An implicit assumption of most previous work related to children's understanding of health was that increased knowledge reflected increased developmental capabilities. The data in this study indicate that while cognitive maturity and accuracy were significantly associated, having correct factual information was not equivalent to having the capabilities to comprehend the abstract, internal nature of the 'facts'. It may be that the relationships between cognitive maturity and accuracy related to

Table IV. *ANOVA tables for cognitive maturity and accuracy variables by age*

Variable	Degrees of freedom	Sum of squares	*F*	*P*
CMSICK	3	3.126	1.042	0.219
	280	196.603		
CMHEALTH	3	5.896	1.658	0.176
	280	331.837		
CMCOLD	3	1.584	1.132	0.337
	268	124.972		
CMGERM	3	6.704	3.897	0.009
	276	158.264		
CMSMOKE	3	10.544	5.862	0.001
	280	167.889		
CMDRINK	3	5.351	2.925	0.03
	279	167.285		
CMINDEX	3	140.029	5.02	0.002
	265	2462.537		
ACCOLD	3	3.132		
	269	121.403	2.313	0.076
ACGERM	3	9.402		
	273	226.129	3.784	0.011
ACSMOKE	3	25.039		
	280	404.042	5.784	0.001
ACDRINK	3	38.304		
	279	474.863	7.502	0.000
ACINDEX	3	223.774		
	264	1760.793	11.184	0.000

Table V. *Variance accounted for by age on cognitive maturity and accuracy items*

Dependent variable	r^2 for age
CMINDEX	0.017[c]
ACINDEX	0.116[b]
CMSICK	0.005
CMHEALTH	0.000
CMCOLD	0.005
CMGERM	0.002
CMSMOKE	0.023[c]
CMDRINK	0.027[a]
ACCOLD	0.021[c]
ACGERM	0.023[c]
ACSMOKE	0.050[b]
ACDRINK	0.096[b]

[a]$P < 0.001$; [b]$P < 0.01$; [c]$P < 0.05$.

a particular subject area are even weaker than is indicated by these data. In each subject area in this study, the score for cognitive maturity and the score for accuracy were derived from the same response by the child. This, in part, may explain the relatively high correlations between the two constructs. In fact, it is likely that the conclusions of this study (i.e. that accurate health knowledge and developmental capability are separate but related), might be stronger if the potential confounding effects of using the same data to measure both were eliminated. Further study comparing accuracy scores with other measures of cognitive development or cognitive maturity with other tests of knowledge would be desirable. In addition, the administration of Piagetian operational tasks and high correlations between them and the cognitive maturity scale would constitute additional evidence of the scale's validity.

The fact that the mean score for these 6–9 year old children on cognitive maturity fell at the transition point from preoperational to concrete operational characteristics of thought lends support to the validity of Piagetian levels of cognitive development applied to the specific area of health and to the age relatedness of these levels. In this study, however, age was a stronger predictor of accuracy about health than of cognitive maturity. Although the overall index score was significantly associated with age, there were no significant differences between any two age groups on any of the individual cognitive maturity scores. In contrast, there were significant between group differences for the accuracy index, as well as for three of the four individual accuracy items.

Using the number of discrete facts or pieces of information children presented as the measure of accurate health knowledge, the study found that, overall, children had the most accurate knowledge about drinking, followed by smoking, germs and the least accurate knowledge about colds. From a Piagetian perspective, children in this age range would be expected to focus on observable consequences or those with which they were very familiar. Indeed, much of the accurate knowledge portrayed by these children regarding drinking was focused on drunken behavior and sleepiness. Although many consequences of smoking are not observable, the majority of responses focused on coughing, odor and other more visible features.

Germs, while themselves not observable, have a series of consequences (i.e. diseases), which children have experienced. The ability to 'catch' germs from other people was a common response and experience with which children are likely to be familiar. Colds, however, were the subject of much misunderstanding, with most children associating colds with 'being cold' and stating little else. Even children who demonstrated higher order thinking abilities, using complex descriptions of internal processes, were often incorrect in their assessments, thus demonstrating the difference between accurate knowledge and cognitive capability.

Higher correlations over the entire age range of children in this study suggested a steady improvement in accuracy of health information with age. Cognitive maturity, however, did not increase steadily with age. Rather, after an apparent shift at age 7 in the overall index score, a certain level was achieved and did not change considerably. Furthermore, in individual topic areas, these age group differences were not significant. According to Piagetian theory, the next major shift in cognitive maturity would probably occur outside the age range of this study, nearer age 11. Such major shifts would account for the more significant age trends in health understanding found in other studies, the focus of which has been widely disparate age groups.

Although mean scores reflected thought processes consistent with Piagetian expectations, there was great variability among the children. Some children showed evidence of higher order, abstract thinking yet such thinking was not consistent across the six cognitive maturity areas measured. These findings support the idea that cognitive developmental capabilities may be highly subject specific and that other factors besides age affect them.

Young children are often thought to lack cognitive capabilities to understand many health concepts which by nature are complex and abstract. Children in this study, aged 6–9, discussed overt perceptual cues, simple rather than complex body processes and generally exhibited concrete rather than abstract thinking. These data do suggest, however, that after a shift at about age 7, the capabilities to discuss abstract, internal phenomena do begin to be evident. Since age is the most apparent determinant for teaching about health and assumptions about appropriate activities are generally made based on age, study findings indicate that reliance on this variable only is insufficient. As suggested by Piaget and Inhelder (1969), Kagan (1984) and others, such ability in children in this narrow age range are likely influenced as much by intelligence, socioeconomic status or other variables, as by absolute age.

This study used qualitative data to derive categories for quantitative analyses. The coding scheme used could be applied to other studies of cognitive development related to health to provide further information about influences on the development of children's thinking about health.

Conclusions and implications for practice

These findings underscore the need for those providing health education to place emphasis on the cognitive abilities of children and not to mistake recitation of factual information for understanding of cognitive elements of a health problem. Some clinicians and formal health education programs have used children's abilities to provide specific health facts as a measure of success of teaching, yet several researchers have shown the relationship between levels of health knowledge and changes in health behavior to be limited (Iverson and Portnoy, 1975; Green *et al.*, 1980). This study would in part explain such disparity by positing that the ability to provide accurate health information does not necessarily mean that the nature of the facts is understood. Although recent health education programs, both for children and adults, have shifted focus from informational approaches to more skill-oriented and behavioral methods, information may still be an appropriate methodology for younger children, provided the information is presented in a manner consistent with children's developmental capabilities.

Piagetian theory suggests that concepts of prevention and risk would begin to be understood in the period of concrete operations, from about age 7, when operations such as reversal and seriation are developed. Causal links and probabilities, as well as

Table VI. *Understanding of specific health concepts for grades one through three and implications for curriculum development*

Grade (age)	Piagetian stage	Conceptual understanding	Implications/examples
One (6)	Preoperational	● observable, immediate consequences of actions are considered causal ● no real concept of risk/prevention	use concrete, observable examples of actions and their results; begin to provide evidence that one cause does not always lead to same outcome (Traveling Germs[a])
Two (7)	Preoperational/ transition to concrete	● limited concept of risk and 'probability' of consequences ● causal relationships essentially based on short-term visible results	use concrete examples, or make less visible consequences observable, provide evidence of probable nature of actions and results (Safety Inspectors[b])
Three (8)	Concrete operational	● concept of risk can be established ● same cause does not always have same consequences ● short-term causal links are understood ● potential causal understanding of long-term effects if results are made visible	demonstrate short- and long-term consequences using visible examples or 'experiments', concept of how to prevent probable consequences is appropriate at this point (Smoking Machine[c])

[a]Traveling germs activity: children use glitter on hands to represent germs. Some children start with glitter on hands while others are 'germ-free'. Children play a game in which they pass an object around a circle and note the transfer of germs from hand to hand, object to hand, and not necesarily to everyone's hands. (From Vogt *et al.*, 1984.)
[b]Safety Inspectors: children are asked to identify potentially hazardous situations in their homes (with parental assistance) and to draw one or more of the hazardous situations. Class discussion focuses on the drawings and children draw pictures of what might happen next and of what the picture would look like without the hazard. (From Vogt *et al.*, 1984.)
[c]Smoking machine activity: use a cigarette attached to a plastic tube and a plastic squeeze bottle filled with cotton. The bottle and cotton represent the lungs. A single cigarette 'smoked' by the machine produces slight discoloration of the cotton. Over time and more cigarettes 'smoked', the lung tissue becomes more and more damaged by the tar. (From Vogt *et al.*, 1984.)

an understanding of internal mechanisms might not become clear until later stages of concrete operations or the shift to formal operational thought, nearer age 11. Table VI provides an overview of how Piagetian based levels of cognitive development, supported by the study data, can be applied to teaching methods in grades one through three.

The shift at age 7 or around the second grade, from preoperational to concrete operational thought suggested by Piaget and supported by these data, would imply that strategies for health education for first graders differ from those of second and third graders. First graders need to focus their attention on personal experiences and feelings and to be presented with very tangible, observable and immediate examples of behaviors and their consequences. Second and third graders can begin to make sense of internal body systems, but only if physical models and pictures allow them to 'see' inside the body. Furthermore, these children may be capable of understanding long-term risks, but only for problems and behaviors with which they are familiar.

As this study found, however, age was not the only predictor of cognitive capabilities. Thus, within grade levels, there is likely to be variability in ability to understand health information. The data showed that children of a similar age were at similar levels regarding their 'knowledge' of accurate information, but they varied in their level of cognitive maturity. Less mature children may be able to 'parrot' accurate information but this should not be mistaken for real understanding. Thus, instruction for all children should be designed to demonstrate concrete examples of behavioral consequences, such as traffic safety or the passing of germs. The more concrete the example, the better all of the children will be able to understand it. The more mature children then may be able to stretch their thinking and apply these concepts to less concrete behavioral risks and consequences, those which are long term, or are not readily demonstrated in the classroom.

The facts that smoking can cause cancer and you can die from cancer were easily and accurately recited by many children of this study. More important to the concept of 'risk', however, is the notion that damage to body systems begins as soon as one starts to smoke and accumulates over time. In addition, other factors interact to make disease more or less likely for individual smokers. These concepts, and others like them, are complex and abstract. Health education programs for young children need to work towards understanding of such ideas, rather than to teach them as 'facts'. If such teaching is carefully targeted to the appropriate developmental capabilities of children, then the information may be more meaningful and the link between the information and behavior may also be strengthened.

Acknowledgement

Support for this research was provided by the W.K.Kellogg Foundation to the American Health Foundation.

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Received on March 20, 1991; accepted on December 13, 1991