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CHILDREN'S MACROSPATIAL REPRESENTATIONS

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CHILDREN'S MACROSPATIAL REPRESENTATIONS

by

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ABSTRACT

CHILDREN'S MACROSPATIAL REPRESENTATIONS

by

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This study investigated the development of spatial abilities as reflected by six- through nine-year old children's maps of familiar environments; age differences in mapping were of particular interest as indicating the Piagetian transition from preoperations to concrete operations. This study also attempted to induce disequilibrium shifts via novel visual stimuli, and to see if such shifts could account for an earlier than expected transition. Possible gender differences were also of interest since there exists ample evidence for gender differences in spatial abilities during adolescence and beyond, but evidence for its occurrence at earlier ages is mixed.

The results strongly supported a developmental acquisition of spatial abilities with evidence for a Piagetian transition. Some evidence was found that the novel visual stimuli interfered with performance on a map drawing task and enhanced performance on a subsequent map reading task. Substantial gender differences were found on both tasks, indicating that complex measures of spatial abilities may involve more difficulties for girls than for boys.

This work is dedicated to my father,
Chin Jin Pon/Loy Chin, a "paper son"
who died January 23, 1978.

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TABLE OF CONTENTS

TABLE AND FIGURE LIST

Chapter 1

INTRODUCTION AND REVIEW OF RELATED LITERATURE

Tolman (1948) used the term "cognitive maps" to refer to the internal representations that both rats and men used to define and travel in their environments. Today "cognitive mapping" is a widely used metaphor to represent not only how spatial knowledge is coded but also how all information is processed (Kaplan, 1976). It incorporates the fields of anthropology, planning, education, sociology, philosophy, as well as psychology and geography. The term "map" must not be taken too literally for it is used only in the metaphorical sense and as such these cognitions are not analogous to cartographic representations (Downs, 1981). Put in another way, the "world according to Rand McNally" is unlike a cognitive map which is subject to alteration by memory (Acredolo, Pick & Olsen, 1975), physical experience (Laurendeau & Pinard, 1970), viewer's perspective (Huttenlocher & Presson, 1973), cognitive style (Gildnmeister & Friedman, 1978), age (Piaget & Inhelder, 1956), environmental landmarks (Allen, Kirasic, Siegel & Herman, 1979), socialization (Mugny & Doise, 1978), and sex related factors (Vandenberg & Kuse, 1979).

Down and Siegel (1981) present an excellent overview of the varied research in cognitive mapping, done by themselves and colleagues. Their work explores the fundamental question of whether "maps in the mind" are truly reflective of environmental perceptions, be they represented by models, drawings or performance on tasks. They caution us to consider carefully the a priori assumptions before evaluating the information and conclusions drawn from the models, drawings or task performances. An important assumption regards the investigator's attitude towards the numerous difficulties in transforming individual spatial perceptions into quantifiable and reliable measures for analysis. Those who emphasize naturalistic vs. laboratory experiments characteristically seek "richness" instead of "precision" in data. For example, Hart's method emphasizes uncontrolled, extensive and self determined experiences yielding richness of data, whereas, Siegel's information processing approach is characterized by experimentally strict methodology yielding precise and parsimonious explanations. Then there is Downs, who has adopted a middle ground position, believeing neither approach can adequately infer the process of organizing the environment. His solution is to accept the "best" product of spatial organization, namely map drawings (Downs & Siegel, 1981, p. 247).

Downs (1981) emphasizes his preference for using map drawings as the vehicle for data collection because it represents a bridge between "competence"--perceiving the environment and successfully moving about it, and "performance"--perceiving the environment and portraying it. Just as walking to and from school by the child represents the problem and solution of locomotion, likewise the map represents the problem and solution of spatial representation. Thus, the "map is a creative device for solving a particular problem, more akin to a plan of action than an inventory of what is known" (p. 162). Downs' methodology is emphasized here since the present investigation relies on data derived from map drawing tasks.

Additionally, there is a steadily growing emphasis in the developmental literature (see Cohen, 1982; Baird & Merrill, 1978; Acredolo, 1976) on macrospatial cognitive mapping (viewer encompassing space) as against microspatial mapping (e.g. Piaget's three-mountain task or model village mapping) Geographic information is of crucial importance across all cultures both phylo- and onto-genetically (consider primitive man's hunt for food and getting to and from work in the modern world), and may represent a viable developmental and mechanistic model for other cognitive processes (Siegel & White, 1975; Acredolo et al, 1975).

There are numerous studies of children's spatial abilities, most of which owe their origin to the work of Piaget and Inhelder (1956). Typically these studies show developmental differences according to the stages proprosed by these theorists. Until recently, the mechanism of stage transitions has not been investigated. One such study, concerning the transition from concrete to formal operations, was undertaken by Snyder and Feldman (1977). They analyzed the map drawings of 11 year olds and found evidence for a gradual stage transition involving various levels of task-specific maturation. The mapping tasks involved the traditional Piagetian model village and not macrospace, and therefore the results may not be generalizable to real life mobility. Also, come critics (e.g. Marmor, 1975) warn of potential confounds in quantifying drawings since subjective interpretations are involved. However, Howard, Chase and Rothman (1973) demonstrated that distance estimation by methods of 1) representation, i.e. maps, 2) modeling, 3) absolute judgements, and 4) ratio estimation yielded equally valid data.

In the development of children's spatial abilities, Piaget and Inhelder (1956) reported significant achievements during the transition from the preoperational to the concrete operational stage. They described improved map drawing skills as evidenced by a decrease in topological feature-making concomitant with the appearance of simple projective and Euclidian strategies which necessitate the coordination of multiple perspectives. Typically the map drawings of "transitioning" children do not resemble more sophisticated cartographic maps, since their drawing skills are crude and extraneous details relevant for storytelling, are often included at the expense of absent critical landmarks. However, closer scrutiny of these maps reveals developmental patterns similar to those seen in non-drawing spatial tasks, such as perspective taking (Huttenlocher, 1973); model representation (Siegel & Schadler, 1977), mental rotation (Marmor, 1975; Arnold, 1978), locative memory (Shannon, 1978; Siegel, Allik & Herman, 1976), distance estimation (Cohen & Weatherford 1980) and route taking (Hazen, Lockman & Pick, 1978). Each of these can be studied in children's drawings and their transition from pre-operational to operational quality can be charted thereby. This study will investigate the nature of the transition from pre-operations to concrete operations as seen in the map drawings of a familiar classroom and the decoding of a map of the school executed by six- through nine-year-old students.

Stage Differences

Specifically, the development from topological to projective representations will be examined as characteristic of this transition. The term topological refers here to a reliance on objects; i.e. landmarks, as features for map-making. This limitation is evident in the map drawings of pre-operational children, which often lack logical spatial relationships beween objects, that is, distance and position relationships. On the other hand, projective mapping skills begin emerging at the concrete operational stage. Unlike the earlier topological map, the projective map coordinates landmarks by means of logical directional and distal inter-relationships in a roughly accurate fashion (Laurendeau & Pinard, 1970). Both Mitchell (1963) and Rushdoony (1968) further describe this process in their taxonomies for the teaching of map skills as part of geography curricula for elementary school.

Another characteristic of preoperational maps is the reliance on a single viewpoint (SVP) as representative of an encompassing environment. For example, when asked to draw a map of a familiar room, the young child will often only draw a wall or two walls joined by a corner to represent its entirety. This phenomenon has been explained by Piaget and Inhelder (1956) as a function of the preoperational child's egocentrism, that is, his/her inability to imagine views other than his/her own. In contrast, the concrete operational child, according to Piaget, is capable of roughly organizing multiple viewpoints (MVP) of the environment by integrating them into a SVP (visually, a bird's eye view); the concrete operational child can then project this information onto paper or a model. It should be noted that this projective map does not yet possess all the features of the familiar cartographic map, which includes accurate scaling, landmark proportions and symbolism that ranges from simple legends to distance and time estimations. Such a map is produced no earlier than the formal operations stage (usually not reached until adolescence) and, not surprisingly, is often called a Euclidian map.

Since projective mapping requires MVP's, it is incompatible with egocentric thinking. On the other hand, allocentrism refers to non-egocentric thinking. This ability to coordinate perspectives other than one's own is essential to advanced mapmaking. Harris (1977) argues convincingly that a simple egocentric-preoperational vs. allocentric-concrete operational model is insufficient to analyze the various types of perspective taking problems. He contends that there exists a gradual coordination of egocentrism and allocentrism or to put it another way, an integration of numerous self-orientations with predominantly stationary environmental landmarks. A study by Harris and Bassett (1976) posits that egocentric errors need not be interpreted as proof of the child's lack of awareness of perspective changes, but rather as proof of his/her awareness of the invariance of the relation between a display and adjacent landmarks despite movement of the observer. This interpretation fits nicely into Flavell's (1971) concepts of concurrence, evocation and utilization. Concurrence means that various items within a given stage develop concurrently, i.e., in synchrony with one another. Evocation and utilization refer to levels of a "cognitive unveiling process". Evocation is the awareness of relevant problem solving strategies; utilization is the ability to take the previously evoked strategies and apply them to the actual problem solving process. Borrowing from the psycholinguists, cognitive mappers use the terms "competence" and "performance" interchangebly with evocation and utilization, respectively (Siegel & White, 1975). For example, Stea (1976) differentiates between knowing the spatial environment in the sense of location and traveling, and knowing, in the sense of constructing and representing the environment. Or, more specifically, a study by Marmor (1975) has shown that five-year-old children do evoke mental imagery when solving mental rotation problems. This contradicts Piaget and Inhelder's (1956) earlier studies which posit that only children seven years old or older are capable of kinetic imagery. Thus Piaget and Inhelder may have observed the successful "performance" of latent "competencies." Such discrepanices do not weaken Piaget and Inhelder's essential paradigm for the development of spatial abilities, rather, they prod researchers to further distinctions between age of "competence" and age of "performance."

Disequilibrium

According to Flavell's (1977) interpretation of Piaget, the mechanism by which the child learns is a process of assimilation and accomodation through which he continuously assesses existing knowledge modified by newer perceptions. Disequilibrium occurs when such perceptions are incompatible with pre-existing knowledge. The child either maintains the same ideas, thus rejecting the new perceptions or vice versa, and in some instances recognizes the possible exception to his/her repertoire of rules, thereby creating a new category. For the developing child this process causes his/her knowledge to be in a state of flux, that is, constantly being tested, modified and codified. With respect to the acquisition of perspective taking abilities, Cox's (1978) work gives support for Piaget and Inhelder's (1956) stages of development. Briefly, Piaget and Inhelder describe three sequential steps: at first the young child can correctly represent only the location of the object nearest another observer; later, he can correctly represent a before-behind relationship between objects as seen by another observer; lastly, he is able to represent a left-right relationship between objects as seen by another observer (p. 421).

On the other hand, Cox (1977) trained five-year-old children to perform Piaget's famous "three-mountain task" as well as normal ten- or eleven-year-olds. He found that providing either visual or verbal cues from another perspective (experimenter's view which was opposite the child's position) was equally effective in producing the results. This is contrary to Piaget and Inhelder's notion that the most effective way to acquire perspective taking ability is through occupation of another position.

An explanation for this discrepancy is posited by Siegel and White (1975); they affirm the crucial effect of experience for acquiring spatial knowledge but also demonstrate that it is inextricably intertwined with visual information processing. "Although spatial representations arise and jell out of practical activity, that which is "jelled" has a massive visual component in normally visually sighted individuals." (p. 38)

As mentioned earlier, Snyder and Feldman (1977) have also posited that such a disequilibrium process accounts for the transitioning from concrete to formal operations by eleven year olds. Feldman and Acredolo (1979) further elaborate thi point in a study that shows self-directed activity serves to increase the attention of preoperational children, due to their knowledge of projective space; they demonstrate increased capacity to encode spatial information regardless of mode of exploration.

The preceding discussion demonstrates the need for an elaboration of long held spatial theories, most notably those of Piaget. On the other hand, disequilibrium or conceptual conflict, a fundamental tenet of both Piaget's theory of cognitive development and Berlyne's neo-associationist account of the dynamics of problem-solving, seems to be the accepted mechanism. Likewise, Cox (1977) considered his training as visually or verbally inducing a state of disequilibrium which consequently allowed for his subjects' precocious performances.

Map Reading

The transition from topological to projective mapping can be further elucidated by digressing to the related process of map reading. Bluestein and Acredolo (1979) have discerned two processes in the ability to read maps. The first is "semantic interpretation" (Blaut, McCleary and Blaut, 1970; Erreich & Valian, 1979) in which there is an understanding that two dimensional pictographs refer to "real life", three-dimensional counterparts. The second process is the ability to project or superimpose the drawn map on an environmental space. For example, Blaut et al's (1970) study demonstrated that first graders from an American and a Puerto Rican school were able to 1) interpret aerial photographs, 2) identify landmarks, and 3) plan routes, all of which are evidence of semantic interpreting. Despite this ability, few students were able to replicate the aerial photographs by means of map drawing. Thus, map reading is not the same as map drawing. The former is necessary, but not sufficient for the latter (Catling, 1978). Willats (1977), in an elegant study of 5-17 year-old children's perspective drawing abilities, demonstrated that projective drawing systems do not appear until 8 years of age. This finding lends support for Flavell's (1971) concept of evocation and utilization, that is, map reading experiments tap the existence of (evoked) projective abilities in preoperational children, but are not representationally "utilizable" until a later time.

Thus, "semantic interpretation" is equatable to recognizing landmark representations in maps and clearly precedes projection or superimposition skills. Furthermore, these two processes fall roughly into the preoperational and concrete operational stages, respectively. The mechanism for this transition is the concern of this research.

Conclusion

Cognitive mapping has importance for a wide range of disciplines, at both theoretical and applied levels. Presently spatial theories are being tested and applied in real life situations; that is, cognitive mappers have themselves transitioned from micro- to macro-space. Developmental substrates underlie all spatial theories. Thus, acquisition of spatial cognition is thought to have a logical ontogenesis and therefore be capable of being deciphered. Such illuminations of spatial cognition are doubly important--initially, as an integral segment of our conceptalization of human development and, maybe more importantly, as a model for all cognitive processing.

Chapter 2

HYPOTHESES

Transitional Differences

Based on the work of Piaget and Inhelder (1956) and Laurendeau and Pinard (1970), this research will further elucidate the developmental transition in the macrospatial representations of six- through nine-year-olds. Specifically, students will complete a Room Map Task (RMT) generating maps of a familiar art room which will be analyzed for two variables: 1) number of landmarks (NL) and 2) accuracy of landmark location (LA). The former should reflect the topographic skills which appear during the preoperational period and beyond, while the latter is a function of "MVP's" and projective abilities, which typically first manifest themselves during the stage of concrete operations. Thus higher scores on the LA variable would signify a transition, whereas the NL variable would not. Laurendeau and Pinard (1970) postulated that the number of landmarks needed for routing is inversely related to one's knowledge of projective and Euclidian concepts. As one grows older, landmark dependency lessens as one develops more sophisticated routing systems. Pragmatically restated, this coincides with Gatty's and Lewis' (cited in Downs, 1981) similar notion that there exist at least two kinds of navigational systems: 1) home centered and 2) compass centered. The former is landmark dependent, simple-minded and practical, whereas the latter is astronomically derived, independent of landmarks (save oneself) but riskier. Thus, the two systems are analogous to topological versus projected systems and should serve to distinguish between preoperational and concrete operational children. Therefore, Hypothesis 1 states: "Older age groups will position landmarks (LA) more accurately than younger age groups, irrespective of differences in number of landmarks portrayed (NL)."

Visual Disequilibrium

Piaget and Inhelder (1956), and Laurendeau & Pinard (1970) posited that personal experience is the necessary ingredient for the accumulation of spatial knowledge. This notion is further supported by Huttenlocher and Presson's study (1973, 1979), in which subjects' movement was found to enhance perspective-taking abilities. It should be noted that Cox (1977) found that verbal and visual cues alone from another perspective were equally sufficient inducements for better performance. To resolve this discrepancy, the six- through nine-year-olders were equally divided into experimental and control groups prior to the art room map task and these groups were administered separate slide presentations. The experimental group were shown "aerial view" slides of their art room while the control group were shown eye-level view slides of the same art room. The former should present new information (assuming no child had been previously elevated to the ceiling) possibly inducing a state of disequilibrium, whereas the latter, presenting no new information, is expected to induce no change. If Cox (1977) is correct, then the experimental group should produce better maps. Hypothesis 2 states: "Novel, vicariously experienced visual cues (aerial views) are sufficient to produce a state of disequilibrium which will result in significantly better LA scores for the experimental children as opposed to their control counterparts."

It is also anticipated that the "transitioned" (concrete operational) children will show a greater effect of "landmark positioning" than non-transitioned (pre-operational) children. This is based on the extensive studies of Laurendeau and Pinard (1970), and Moore (1976), which demonstrated that seven-year-old children show a marked decrease in their use of topological strategies coinciding with an increased use of projective and Euclidian strategies. Thus, Hypothesis 3 states: "There will be a significant interaction between grade and treatment conditions for all scores."

Transformation

In a second task given, the School Map Task (SMT), the students were asked to locate certain rooms on a scaled, aerial outline of the entire school. This task tested the subjects' ability to orient themselves mentally within the larger, familiar school environment. Such a task involves memory of the array of travelled routes and landmarks, that is, the ability to project a cognitive map onto a two dimensional surface. It can be argued (following Kaplan, 1976; Downs & Siegel, 1981) that the Room Map Task (RMT) and the School Map Task (SMT) represent two different tasks of which the latter is more important because of its scope and functional necessity. However, individual differences in the two skills should be associated. It was expected that, in general, children who scored high in the Room Map Task (RMT) would also score higher on this task, and vice versa. Therefore, Hypothesis 4 states: "The NL and LA scores will significantly and positively correlate with the SMT scores."

It was also predicted that group effects on the RMT would be reflected on the SMT, that is that the experimental and control groups would differ on the SMT. In other words, performance on the previous task should transfer to this task. Thus Hypothesis 2a states "The effect stated in Hypothesis 2 will transfer to the SMT, resulting in higher scores for the experimental group.

Gender Differences

Consistently better performance by males in spatial tasks has been reported by Liben and Golbeck (1980); Signorella and Jamison (1978); and Macoby and Jacklin (1974). However, these gender differences have seldom been found before the age of nine years, with maximal differences appearing at adolescence (Harris, 1977). For example, no gender differences were found in tasks involving coordination of perspectives (Fishbein, Lewis & Keiffer, 1972) or in tasks involving memory for environmental location (Acredolo et al., 1975; Hazen et al., 1978; Kosslyn, Pick & Fariellos, 1974) or small environments (Fehr & Fishbein, 1976). However, a recent study in our laboratory (Ferguson, Note 1) found differences between male and female kindergarten children on a psychometric measure of spatial ability based on mazes and block design from the WPPSI, and the Embedded Figures Test. The latter has often been considered a measure of field dependence and the former two probably involve mental rotation and simple "map reading."

Likewise, Siegel and Schadler (1977) reported significant gender differences in favor of males for their study involving five year olders' ability to reconstruct their classroom using scaled "dollhouse" miniatures. They explained their findings as a function of task load, that is, previous experiments that had found no gender differences were simple as compared to this complex test of spatial memory. Consequently, their task "overloaded" the lesser spatial abilities of the girls.

The task involved in the present investigation is similar to Siegel and Schadler's (1977), with the exception that drawing replaces their model manipulations. Based on the preceding discussion, Hypothesis 5 states: "Males will perform better than females on all tasks."

Chapter 3

METHOD

Overview

First, second and third grade students participated in this experiment. Each grade was divided into experimental and control groups. A slide presentation appropriate to the experimental or control condition was administered to the respective groups. Afterwards they were asked to draw a map of the art room--Room Map Task (RMT). A week later, the students were asked to do another task, this time mapping the school--School Map Task (SMT).

Both maps were analyzed for 1) developmental differences as indications of transitions from preoperational to concrete operations, 2) disequilibrium as induced by the experimental manipulations as cause for transition, and 3) gender differences.

Subjects

Forty-nine first graders, 42 second graders and 45 third graders from a local elementary school in a suburb near Michigan State University participated in this experiment. Mean ages for the eighty-four first, second and third graders were 6-8, 7-8 and 8-8, respectively. From this group, fourteen males and fourteen females were randomly selected from each grade and distributed equally into experimental and control groups with each cell consisting of seven subjects. Thus, 84 student's maps were actually analyzed while all 136 students participated. This was done to account for attrition between testing sessions and so that no students would feel ostracized. The children were predominately Caucasian, with a few minority group members. There was no indication of any severe student difficulties either intellectually or behaviorally.

Pilot Study

Room maps were drawn by fifteen children ranging in age from 5-1 to 8-1 years at another elementary school within the Michigan State University area one month prior to the start of this experiment. It is unlikely that these children would have discussed the task with the other students or that such potential discussion would matter since there are no correct ways to draw a map and the rooms are different. The results of this pilot study suggested 1) administering the tasks to no more than twelve students at a time, 2) providing a "frame of walls" on each paper, and 3) incorporating a "get acquainted" art lesson. All of these precautions were subsequently utilized.

Art Lessons

Prior to the experiment, every classroom received an art lesson from the investigator, who is a certified art teacher. This was thought necessary in order to familiarize the children with the investigator and to elicit their best performance for the actual experiment. As a result, the investigator gained insight into the most comfortable working conditions for the children while in the art room. Moreover, the art lessons were considered reimbursement for the use of the school facilities and actually fostered closer cooperation with the six classroom teachers and the principal. It should be noted that the art lessons did not pertain to map making skills in any way.

Room Map Task (RMT)

Stimuli

The RMT slides were projected via a standard Kodak Carousel Projector (Model 760 H) with a F 2.8, 135 mm lens onto a five by five foot projection screen in the art room.

The control slides were shot from the center of the art room with the camera at a height of 50 inches and the focal plane parallel to the walls. Ten slides, each encompassing 38 degrees of the rotated view were taken. A slight overlap occurred between slides for continuity of the viewer's "rotation." A Pentax K-1000 camera with 50 mm lens set at f22 for maximum depth of field was used. The same conditions existed for the set of experimental slides except that the camera was elevated to the height of 10 feet, shooting downwards at a focal plane angle of 45 degrees to the ceiling and the walls. Thus, this set of ten slides shows a bird's eye view of the art room--a view which could not have been physically experienced by the students. Herein the former will be called the "placebo" slide set since no new information is conveyed to the students, and the latter, the "disequilbrium" slides, since the view, which they could not have seen before, should augment their cognitive maps.

Procedure

After each control and experimental group was exposed to their respective placebo or disequilibrium slide set, each child was asked to draw a map of the art room while in it. This was done to insure that memory distortions would not interfere with the map drawing as well as to observe how well the student could integrate surrounding information. While all children remained at a table, they were allowed to change places at the tables as their views dictated. In an effort to lessen noise and confusion as well as to remove difficult-to-draw items, all chairs were removed. (In the previous pilot study many students spent inordinate amounts of time drawing detailed pictures of single objects rather than the entire room.)

Only pencils and "incomplete maps" were necessary for the students to manipulate. Maps were drawn on an 8½ x 11 inch sheets depicting the four walls in scale with a significant landmark on each wall (Appendix 1). These precuations were necessary to avoid paper rotation miscues (evidenced by the pilot study) and to provide a "landmark" for orientation. Directions were given to "map the entire room and to include landmarks which help you to get around in the art room" (see

Procedures). The map drawings were collected, coded and scored for number of landmarks (NL) and accuracy of placement of landmarks (LA) (see Scoring).

Each grade consisted of two classrooms and each classroom was randomly divided into experimental and control groups. Thus, there were four individually tested groups for each grade. Each entire grade was tested the same day to minimize collusion between grades, using a counter-balanced design (half experimental and half control groups in the morning, other halves in the afternoon). Classroom teachers were not aware of the treatment status of their students. Each testing session was run by an undergraduate assistant and the investigator. Detailed instructions for the RMT administration are provided in Appendix 1.

School Map Task (SMT)

This second task was given to the students a week after the last group of students were given the RMT. The SMT was administered to entire classrooms since it only involved reading a set of 15 location questions by the investigator to which the students responded to by writing a number on an outline of the school to indicate their concept of familiar school locations. Detailed instructions for SMT administration are provided in Appendix 2.

Scoring

Room Map Task (RMT)

A schematic diagram of the layout of items in the art classroom is presented in Appendix 3. Children's performances are scored in two different ways, the first reflecting number of landmarks (NL) and the second, accurate projection of existing landmarks (LA) from cognitive maps to paper. A description follows:

NL Score: This measure depends only on the number of existing items drawn, irrespective of position in the art room or perspective, e.g., from ground level to aerial view. One point is given for each correct item with 29 as the highest attainable score, that is, inclusion of all 29 numbered items (Appendix 3).

LA Score: This measure is designed to reflect the accuracy of the item drawn with respect to that item's position in the art room. Only items 21 through 29 (all tables) were used to calculate this score. Appendix 4 duplicates a clear overlay representing these 9 items. Centers for each of the target items for every child's map were found by the method of intercepting diagonals from the opposing corners. The dotted sections within each item represent a target area of highest accuracy. These sections are one-third the table's total area and centrally located. If the center of the drawn table fell within this corresponding area then 5 points were scored. Should these centers fall within the item's outline then 4 points were scored; in the case of the center falling outside of either target area but the drawing partially overlapping it, 1 point was scored for inclusion or intersection of any side by the drawing for a score ranging from 1 to 3. A maximum score of 45 points was possible. (More detailed directions are provided in Appendix 6.)

School Map Task (SMT)

This task was scored simply by comparing the student's maps with a master score sheet (Appendix 5). All answers (numbers) were the same for each class except for question one which required an "X" placed in the individual's regular classroom. These were socred individually for each classroom. Scores ranged from 1 to 14, with 14 representing a perfect score.

Experimenters and Raters

A total of eight experimenters, including the investigator, worked with the children. Six of the experimenters previously served as student art teachers at this elementary school. One was assigned to each classroom to help administer and monitor both tasks. As previously mentioned, the investigator had already introduced himself via art lessons given one month earlier. The remaining two experimenters were undergraduate art therapy students, one known and the other unknown to the students. Together they alternated assisting the principal investigator presenting tasks to the classes. The presentation and monitoring procedure for the task were rehearsed by all before the actual experiment.

Inter-rater Agreement

Six scorers attended a four hour training session during which they were given: 1) scoring instructions (Appendix 6, 2) six RMT practice maps--two from each grade, and 3) three SMT practice maps. (The practice maps were actual student maps selected out because of the particular student's absence from either RMT or SMT administration.) Virtually perfect inter-rater agreement was achieved for the SMT scoring since the addition of correct answers required no interpretation. NL was similarly easy to score, the raters having only to count the number of objects portrayed in the room. It should be noted that every object was scored regardless of its position. Initially some student's drawings of extraneous objects caused confusion for the scorers. For example, two clotheslines for hanging wet paintings, venetian blinds, and a pencil sharpener were often included by the students. The experimenters who were familiar with the depiction of these objects (otherwise unrecognizable because of the student's lack of drawing skill) instructed the scorers to disregard these extraneous objects in an attempt to decrease scoring error. Subsequently a 93% inter-rater agreement was reached for the NL score. Scoring for LA was the most difficult procedure because of the elaborate scoring protocol. After careful practice, an inter-rater agreement of 85% was achieved based on the practice maps.

Three teams of two raters each were randomly assigned drawings. Each member of the team scored all the drawings assigned to that team. Two weeks later, after double scoring every drawing, we met to discuss any scoring discrepancies. Only eight of 119 drawings were in dispute. For these, consensus judgements were arrived at by the investigator and the two co-experimenters.

Research Design

Of the 136 first, second and third grade students who participated, 84 were randomly selected to fill 12 cells of 7 students each. Each cell was matched for grade, gender and treatment. The dependent variables of NL, LA and SMT were analyzed separately using a 3(grade) x 2(gender) x 2(treatment: disequilibrium vs. placebo slides) ANOVA with additional post hoc analyses of significant interactions and correlations between tasks. All tests of significance were two-tailed, unless otherwise noted.

Ethics

A preliminary proposal submitted to the University Committee on Research Involving Human Subjects indicating the purpose, procedures and safeguards for this research was reviewed and formally approved on November 24, 1981 (see Appendix 7).

Chapter 4

RESULTS

Each dependent variable: LA, NL, and SMT was analyzed in conjunction with the appropriate hypotheses. In order to facilitate the reading of this chapter, the hypotheses are restated below.

H1. Older age groups will position landmarks (LA) more accurately than younger age groups, irrespective of differences in number of landmarks portrayed (NL).

H2. Novel, vicariously experienced visual cues (aerial views) are sufficient to produce a state of disequilibrium which will result in significantly better LA scores for the experimental children as opposed to their control counterparts.

H2a. The effect stated in Hypothesis 2 will transfer to the SMT, resulting in higher scores for the experimental group.

H3. There will be a significant interaction between grade and treatment conditions for all scores.

H4. The NL and LA scores will significantly and positively correlate with the SMT scores.

H5. Males will perform better than females on all tasks.

The mean scores for each measure in each condition, presented separately by grade and gender, are shown in Table 1 and graphed in Figure 1. Effects of these independent variables on each measure were tested by means of 3-way ANOVAS (grade x gender x treatment) and correlations. (All tests of significance are two-tailed unless otherwise noted.)

Room Map Task

Landmark Accuracy (LA)

A significant main effect for grade was found, $F(2, 72) = 8.72$, $p < .001$ (Table 2). Third graders did significantly better than second graders ($t = 2.12$, $p < .05$) who in turn did better than first graders ($t = 2.00$, $p < .05$), thus H1 was supported. A significant gender effect, reflecting better performance by males, was also evident, $F(1, 72) = 3.66$, $p < .05$ (one-tailed), which gave support to H5. However, the experimental group did not perform significantly better than the control group as predicted in H2 and H3. In fact, an eta-squared analysis revealed that significant amounts of the variances were accounted for by grade and gender (42% and 19%, respectively), whereas treatment contributed very little (4%).

Number of Landmarks (NL)

This ANOVA (Table 3) yielded highly significant main effects for grade and gender, and a significant two-way interaction between grade and gender ($F(2, 72) = 3.40$, $p < .05$), with males depicting more landmarks than females at every grade. While females showed steady increases with age, the males leveled off at the third grade; differences between boys and girls in the first and second grades were significant ($t = 4.53$, $p < .001$ and $t = 3.06$, p F .01, respectively) but not at the third grade. Data from this measure supported H5. A significant three-way interaction (grade x gender x treatment) was also found, $F(2, 72) = 2.58$, $p < .05$ (one tailed), which gave support for H2 and partial support for H3. Treatment enhanced all third graders and second grade boys' performance while decreasing performance for all others. Most of the variance was accounted for by grade and gender effects while treatment effects were rather small (eta-square analysis: 44%, 39% and 3%, respectively).

School Map Task (SMT)

The ANOVA (Table 4) yielded a significant main effect for grade, $F(2, 72) = 11.33$, $p < .001$. This was similar to results found for LA, namely each successive grade performed significantly better than the previous grade: first graders vs. second graders ($t = 2.02$, $p < .05$) and second graders vs. third graders ($t = 2.33$, $p < .05$). Thus, H1 was supported with indications that the two tasks may reflect the same developmental process.

A significant main effect for gender, $F(1, 72) = 10.78$, $p < .01$, was evident as well as a significant interaction between gender and treatment, $F(1, 72) = 4.00$, $p < .05$. Thus, H6 was supported with partial support for H2. H2a was not supported since there was no main effect for treatment.

A significant grade by treatment effect was also evident ($F(2, 72) = 2.55$, $p < .05$, one tailed) with the experimental second and third graders doing better than their control counterparts. A reverse trend was evident for the first graders (Table 5). Thus, H3 was supported.

Finally, most of the variances were attributed to by grade and gender effects while treatment effects again were rather small (eta-square analysis: 44%, 30% and 2% respectively).

Correlational Analysis

Correlations between SMT and NL ($r = .53$, $p < .001$), between SMT and LA ($r = .46$, $p < .001$), and between NL and LA ($r = .67$, $p < .001$) were all found to be significant. To explore the inter-relationships of these measures, correlations were also performed in which LA, NL and SMT were systematically partialled out and yielded: SMT with NL ($r = .34$, $p < .01$); SMT with LA ($r = .17$, ns; and LA with NL ($r = .57$, $p < .01$). This demonstrated that of the two RMT variables; NL and LA, NL demonstrated a greater relationship to SMT than LA.

A further series of partial correlations was performed. The correlation between LA and Age (in months) ($r - .41$, $p < .001$) substantially decreased when NL was partialled out, $r = .24$, $p < .05$. On the other hand, the correlation between NL and Age ($r = .36$, $p < .001$) increased slightly when LA was partialled out, $r = .39$, $p < .05$. Thus, both the NL and LA variables were significantly correlated with age, and NL accounted for substantial portions of the variance.

Next partial correlations were computed separately for each Gender with Age partialled out. The results are presented in Table 6. They indicated that, the NL, LA and SMT variables were all significantly correlated for boys, whereas only the RMT variables (NL and LA) were significantly correlated for girls. In other words, the map reading scores (SMT) clearly discriminated between girls' and boys' map drawing scores (NL and LA). This helps to explain the nature of the previously found gender differences.

Further Analysis

A comparison of the grade by gender by treatment cell means for LA, NL and SMT highlight this study's trends (Table 1, Figure 1). Females, except in two cases (LA, third grade, control; SMT second grade, control) scored lower than males for all grades and treatments. For all tasks, females in the experimental group scored lower than their control counterparts for all tasks in the first and second grades with the reverse occurring in the third grade. Experimental males scored lower than their control counterparts for all tasks in the first grade and only in LA at the second grade. Otherwise, the males in the experimental group outscored their control counterparts. Thus the experimental treatment seemed to interfere with performance among the youngest children (especially first-grade girls), but to enhance performance with increasing age (by second grade for boys and by third grade for girls).

Table 1. Cell Means (Grade x Gender x Treatment) LA, NL, and SMR Variables (N = 84)

	LA			
	Control		Experimental	
Grade	Females	Males	Females	Males
1	4.14	11.00	4.43	7.29
2	10.14	14.57	7.71	11.29
3	14.29	12.14	14.86	16.86
	NL			
1	6.57	13.71	6.57	12.00
2	12.86	15.14	7.57	19.00
3	14.57	15.14	16.71	18.00
	SMT			
1	6.00	8.43	3.00	7.29
2	8.14	7.43	6.29	10.14
3	8.86	9.57	9.57	11.43

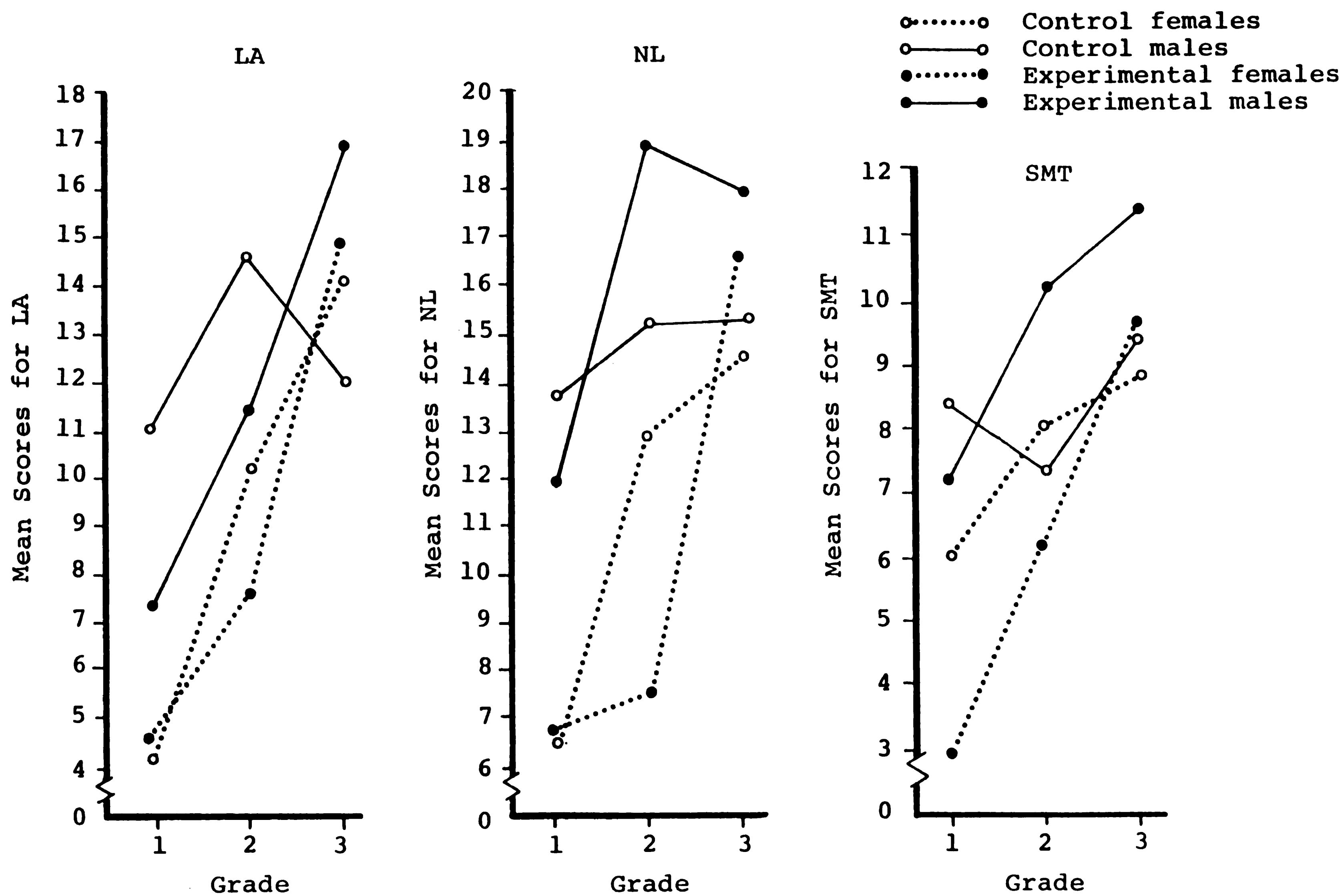

Figure 1. Graphs of Cell Means, LA, NL and SMT, respectively.

Table 2. ANOVA for Landmark Accuracy (LA)

Source of Variation	Sum of Squares	DF	Mean Square	F
Main Effects				
Grade	858.167	2	429.083	8.719***
Gender	180.107	1	180.107	3.660*+
Treatment	8.679	1	8.679	.176
2-Way Interactions				
Grade x Gender	97.071	2	48.536	.986
Grade x Treatment	117.929	2	58.964	1.198
Gender x Treatment	.298	1	.298	.006
3-Way Interactions				
Grade x Gender x Treatment	59.024	2	29.512	.600
Error	3543.429	72	49.214	
Total	4864.702	83	58.611	

*Significant at the .05 level

***Significant at the .001 level

+One-tailed test

Table 3. ANOVA for Number of Landmarks (NL)

Source of Variation	Sum of Squares	DF	Mean Square	F
Main Effects				
Grade	582.167	2	291.083	13.212***
Gender	462.012	1	462.012	20.970***
Treatment	2.012	1	2.012	.091
2-Way Interactions				
Grade x Gender	149.738	2	74.869	3.398*
Grade x Treatment	50.452	2	25.226	1.145
Gender x Treatment	38.679	1	38.679	1.756
3-Way Interactions				
Grade x Gender x Treatment	113.643	2	56.821	2.579*+
Error	1586.286	72	22.032	
Total	2984.988	83	35.964	

*Significant at the .05 level

***Significant at the .001 level

+One-tailed test

Table 4. ANOVA for School Map Task (SMT)

Source of Variation	Sum of Squares	DF	Mean Square	
Main Effects				
Grade	189.452	2	94.726	11.329***
Gender	90.197	1	90.107	10.777**
Treatment	.298	1	.298	.036
2-Way Interactions				
Grade x Gender	17.643	2	8.821	1.055
Grade x Treatment	42.595	2	21.298	2.547*+
Gender x Treatment	33.440	1	33.440	4.000*
3-Way Interactions				
Grade x Gender x Treatment	11.452	2	5.726	.685
Error	602.000	72	8.361	
Total	986.988	83	11.891	

*Significant at the .05 level

**Significant at the .01 level

***Significant at the .001 level

+One-tailed test

Table 5. Grade by Treatment Cell Means for School Map Task (SMT)

Grade	Control	Experimental
1	7.21	5.14
2	7.79	8.21
3	9.21	10.50

N = 14 for all cells

Table 6. Correlations for LA, NL and SMT by Gender, with Age Partialled Out

	Boys	Girls
NL x SMT	.52***	.18
LA x SMT	.45**	.07
NL x LA	.55***	.69***

**Significant at .01 level

***Significant at .001 level

Chapter 5

DISCUSSION

The present investigation strongly supported a developmental acquisition of spatial abilities as postulated by Piaget and Inhelder (1956). Also there existed evidence that a cognitive shift or transition occurs within this age period as predicted by Piaget. Some evidence was found that the disequilibrium slide treatment interfered with performance on map drawing (RMT) and enhanced performance on map reading (SMT). Strong evidence for gender differences were found for all tasks, indicating that complex spatial abilities tasks are more difficult for girls than for boys. These findings confirm the few earlier reports of gender differences for this age group.

Developmental Transition

The results supporting Hypothesis 1 indicated that increasing spatial abilities are a function of development. There was some evidence for a preoperations to concrete-operations transition when the LA and NL scores were compared. In contrast to the increasing LA scores, the NL scores were not significantly different for boys at all grades, nor between second and third grade girls. By third grade both genders showed a roughly equal ability to enumerate landmarks (NL) and accurately locate the (LA). Thus, landmark enumeration (NL) and landmark accuracy leveled-off at the third grade. Such a process would be characteristic of a decreasing reliance on simple routing systems based primarily on landmarks or SVP's, as the child acquires more sophisticated routing systems, incorporating MVP's and Euclidian geometry.

These results were consistent with the original findings of Piaget and Inhelder (1956) and Laurendeau and Pinard (1970) using microspatial tasks. More recent macrospatial studies with children of similar ages have found equivalent results while focusing on the underlying mechanisms. For example, Kirasic (personal communication, Note 2) found that young children's performance leveled-off at the third grade when she tested first through sixth grade students' ability to navigate a large-scale maze. Acredolo et al (1975) attributed better performance on route knowledge by eight year olds vs preschoolers to their increased memory capacity. Herman and Siegel (1978) concluded that repeated practice was responsible for second graders' better performance on a model reconstruction task when compared to kindergarteners' performance. Watkin and Schadler (1978) explained the increasingly better performance with age (first, second and third graders) on a model zoo reconstruction task as a function of the ability to incorporate a mnemonic strategy which enhanced memory through repetition. One concludes that the acquisition of spatial abilities either micro- or macrospatially is a function of age and more dependent on general cognitive development than the specific task.

Disequilibrium

As for the question of disequilibrium, Hypotheses 2 and Hypothesis 3 were not born out by the RMT variables (LA, NL) and only partially for the SMT, where treatment interacted with gender. The MST task which was given a week later showed trends for the treatment to be effective, both to interfere with and to enhance performance. While the control girls and boys were not significantly different at any grade level on this task, the directions of the mean differences suggest that the experimental condition caused the first and second grade girls to perform worse and the second and third grade boys to perform better. Thus, the treatment may have been interfering for the girls and enhancing for the boys.

It may be argued that the lack of results found for the RMT may have been caused by the task situation, where the children drew a map of the art room while in the room itself. It was originally thought that such a task would give ample cues to perform well. However, the obverse may have occurred, sensory overload may have disrupted cognitive mapping. Support for this argument was provided by Presson (1982); Bluestein and Acredolo (1979); and Hardwick, McIntyre and Pick (1976), all of whom noted that young children trying to orient themselves within a room environment made more egocentric errors than when outside the room. Kosslyn et al (1974) and

Weatherford and Cohen (1980) also found that elementary school children made more distance estimation errors on barrier interfering walks than on barrierless walks. Thus, the art room (RMT) may have been perceived with barriers (tables) which prevented a direct route from landmark to landmark whereas the school corridors (SMT) were construed as barrier-less (compare Appendix 3 with Appendix 5). The amount of landmarks in this task were generally greater than in other previous studies, except for Siegel and Schadler's (1977) in which an entire classroom was reconstructed via a model. Also the RMT was less specific than most in that the children were asked to draw a map of their art room with the best landmarks.

The SMT was different from the RMT in two other ways. First, the former incorporated the school and its immediate surroundings (parking lot and playground) whereas the latter was restricted to the art room. Both were previously termed macrospatial, however Weatherford (1982) distinguishes between truly "large scale spaces" (e.g. the school or wilderness) and "navigable/small scale spaces" (e.g. any room). Therefore the tasks may not have been equatable. Secondly, the SMT task was primarily a map reading task while the RMT was a map reconstruction task. To reiterate, Blaut et al (1970) previously demonstrated that five-year-olds were capable of map reading skills. On the other hand Hazen et al (1978) concluded that such skills were not sufficient for map drawing. Thus, the disequilibrium slide presentation may have been interfering for map drawing (RMT) while enhancing for map reading (SMT).

Returning to Cox's (1977) study from which Hypothesis 2 was derived, the three mountain task was more akin to map reading since it involved interpretation of perspectives and no reproduction skills. Another difference was the much longer time and training which Cox used (19 sessions @ 15 minutes each) as compared to this procedure, which lasted 30 minutes. Thus, disequilibrium exposure for a map drawing task should probably involve extensive training in drawing techniques and perspective taking if it is to result in better performance.

Nature of the Variables

Initially the tasks seemed to measure the same spatial skills, as predicted by Hypothesis 4. Calculating partial correlations between pairs of the three variables with the third held constant, revealed that NL had a greater relationship to SMT than did LA to SMT. Thus, the SMT task appeared to require more rudimentary spatial skills (NL) as opposed to those measured by LA. These findings shed more light on the already mentioned differences between the RMT and the SMT. Since the SMT (map reading) was described as more rudimentary than the RMT (map construction), it follows that the more rudimentary NL variable (topography) would have a closer relationship with SMT than the LA variable (projection).

Gender

Gender differences as predicted by Hypothesis 5 were found for all three dependent variables. In particular, gender differences were significant in the first grade, but by the third grade such differences were not statistically significant, thus indicating a leveling by age eight. One could argue that gender differences are a function of this transition period and that boys make the transition earlier than girls.

Further light may be shed on this issue if we examine the gender by grade interaction. Significant differences were found between first and third grade control group females. No significant difference was found between third grade control group females and first grade males. The males' scores increased with age, but not significantly. Thus, either the males were developmentally advanced or the girls' performance was more susceptible to interference. The former explanation is somewhat less parsimonious, since it would not be expected that the genders would equal out at third grade (as in this investigation) and then show well documented differences at puberty and beyond (Liben and Golbeck, 1980; Signorella and Jamison, 1978; Macoby and Jacklin, 1974). Furthermore, only Siegel and Schadler (1977) had previously reported gender differences for this age period. As for the latter explanation, support is given by Gildemeister and Friedman (1978) who tested first graders' abilities with a combination of spatial and verbal tasks as well as cognitive style measures.

A gender difference was found only for field dependence-independence with females more field-dependent and susceptible to environmental interference. Related studies (Liben & Golbeck, 1980; Maxwell, Crooke & Biddle, 1975) using Piaget's water level task also report early gender differences. The mistakes in this task can be interpreted as being stimulus bound to the perimeter of the container, that is, a type of field-dependence. This further substantiates Siegel and Schadler's (1977) explanation that their task was more complex than those used in many other experiments of the same nature, causing an overloading of the girl's ability to process such information. Certainly such reconstruction tasks (map drawing or modeling) are of a more difficult nature than those involving only route and landmark recall.

Further Research

The fundamental question of whether cognitive maps are isomorphic to cartographic maps is clear. They are not. The "world according to Rand McNally" may not be the best criterion for discerning children's cognitive maps since the produced maps will always fall short in accuracy and complexity when compared to the adult models. Rather than use a deficit model, we could accept the fact that cognitive maps are loaded with other moderating psychological factors. For instance, a moderating variable is field dependence-independence which has been already discussed. Another is familiarity as presented in a compelling argument by Acredolo (1979). She tested nine-month-old babies on a typical object permanence task (ball hidden under either a left or right cloth and then rotated) under two conditions, that is, in a laboratory or at home. The "home" babies performed the task correctly 65% of the time, whereas the "laboratory" babies performed the task correctly only 13% of the time. She concluded that unfamiliarity with the laboratory environment caused anxiety which interfered with performance. Conversely, familiarity with an environment relaxed the babies and promoted performance. This effect can easily be understood if we consider our own apprehensions when encountering a "test" in a new environment.

Social competence is another moderating variable. Mugny and Doise (1978) demonstrated that 5-7 year olds performed better on spatial tasks, when paired than when alone, concluding that pairing helped to overcome egocentric thinking. Interestingly, they also found that pairs with different cognitive styles performed better than pairs with similar cognitive styles. Thus, social discrepanices, that is, the process of disequilibration may account for cognitive advancement. Conversely, perspective taking studies involving unpaired children by Fishbein et al (1972) and Fehr (1980) demonstrated that older children made more correct responses than the younger children but they also made more egocentric errors. Thus, it appears we do not outgrow our egocentrism but rather synchronize it with other developing strategies. Such an argument makes sense when one considers that into adulthood our perceptions are often affected by our own biases to the exclusion of other salient viewpoints.

If we accept the fact that adult criteria, such as comparisons to cartographic maps, may not be adequate to assess the child's cognitive map then where are we to proceed? Siegel (1982) proposed a functionalist approach to the study of children's spatial abilities. He advocated a situation specific assessment of cognitive maps. For example he noted that ratings of children's behaviors at home are usually quite different from school ratings. Should we discard the rating scale as unreliable? No, instead accept the fact that children behave differentially across situations. Analogously, map drawing tasks may only tap into specific strategies not necessarily related to cartographic maps. He further added that situational learning is highly dependent on attitudes and motivations (n.b. Acredolo's familiarity and Mugny's and Doise's social competency theories) as well as cognitive styles. Thus a future model for studying children's spatial abilities is necessarily complex having to take into account such mediating factors as cognitive style, memory, social competency and special skills.

The difficulty of incorporating such a model lies in the validity of moderating variable measures, assuming one could give all measures to large enough samples. For example, while familiarity is intuitively significant, how does one measure it as an independent variable? Acredolo's study (1979) treated familiarity as a dependent variable. This example raises a circularity argument often found in individual differences studies. In this case, does familiarity breed better performance on spatial tasks or do spatial abilities breed familiarity with the environment? (Acredolo, 1982). The same argument could apply to social competence or field-dependence.

It was earlier noted that investigators in this field were themselves transitioning towards macrospatial research because of a consideration of the utilitarian needs of the child. The next step appears to be a continuation of this line of reasoning, that is, the investigation of moderating variables.

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APPENDIX 1

ROOM MAP TASK:

INSTRUCTIONS AND FORM

RMT ADMINISTRATION INSTRUCTION

"Today we are going to see how well you can draw a map of the art room. Please pay attention because I want you to do your best. If you have any questions please raise your hand and we will help you.

Does anyone know what a map is? (Write the word "MAP" on the board and listen for answers.) That's right, it's a picture on a piece of paper that helps us to get around. We can have maps of the world, of East Lansing and even one of the art room. (Now distribute "incomplete maps" (Appendix 1) to all children.) A map has landmarks on it. Who can tell me what a landmark is? (Write the word "LANDMARK" on the board and listen for responses.) Yes, that's right. They are things on a map that you remember to help you get from one place to another. These are maps of the art room, just like the big one here. (Display enlarged version.) Who can show me where the door is? Please raise your hand. (Listen for responses.) That's right. Now everyone point to the door on your maps. Keep your finger on the door until (the assistant's name) or I can see if you are correct. Work as long as possible. Good. (Repeat the same procedure for the "TOOL CABINET".) Who knows what this is? (Pointing to the entire window wall.) That's right. It's the only wall that has windows in the room. Now, who can tell me what this is? Think hard (pointing to the cart). That's right, it's the cart. (Repeat for the RUG area.) Now you have found five landmarks: the door, the tool chest, the windows, the cart and the rug.

Next, I am going to show you some slides. (Show the first slide.) What is this slide showing? That's right, it's a slide of this room. Point to the corner of the room. Good. Now please pay attention and look at the next slide and without talking point to that part of the art room. That's right. Now let's go through the rest of the slides. (Continue until all ten slides are shown.) Now you've seen some slides of the art room. I want to show you them again for the last time. Please pay attention. (Repeat slides.) Good. You're all doing so well that I think it's time to let you finish your maps.

"Now I am going to pass out pencils and I want you to write your name on this line. (Point to NAME line of the enlarged version.) If you need help please raise your hand. When you are finished please put all your pencils down so I'll know. (Check all names.) Good, now pay close attention. I want you to look at the room around you and without talking look for landmarks. (Pause 30 seconds.) When I say "begin," I want you to fill in your maps with as many landmarks as possible. Be sure the landmarks are in the right position on your map. This is not a drawing contest, so don't shade or put in any details. Keep your landmarks simple. Please do not talk or look at each other's maps. You will be timed, so work as fast as possible. Are there any questions? (Answer any.) OK, let's begin. (After 15 minutes.) Please stop and we will collect your maps and pencils. How did you like this project? (Listen for responses while maps and pencils are collected.) One last thing. Please don't tell your classmates about this until after school, so they can have a chance to do it, too. OK? You did very well, thank you."

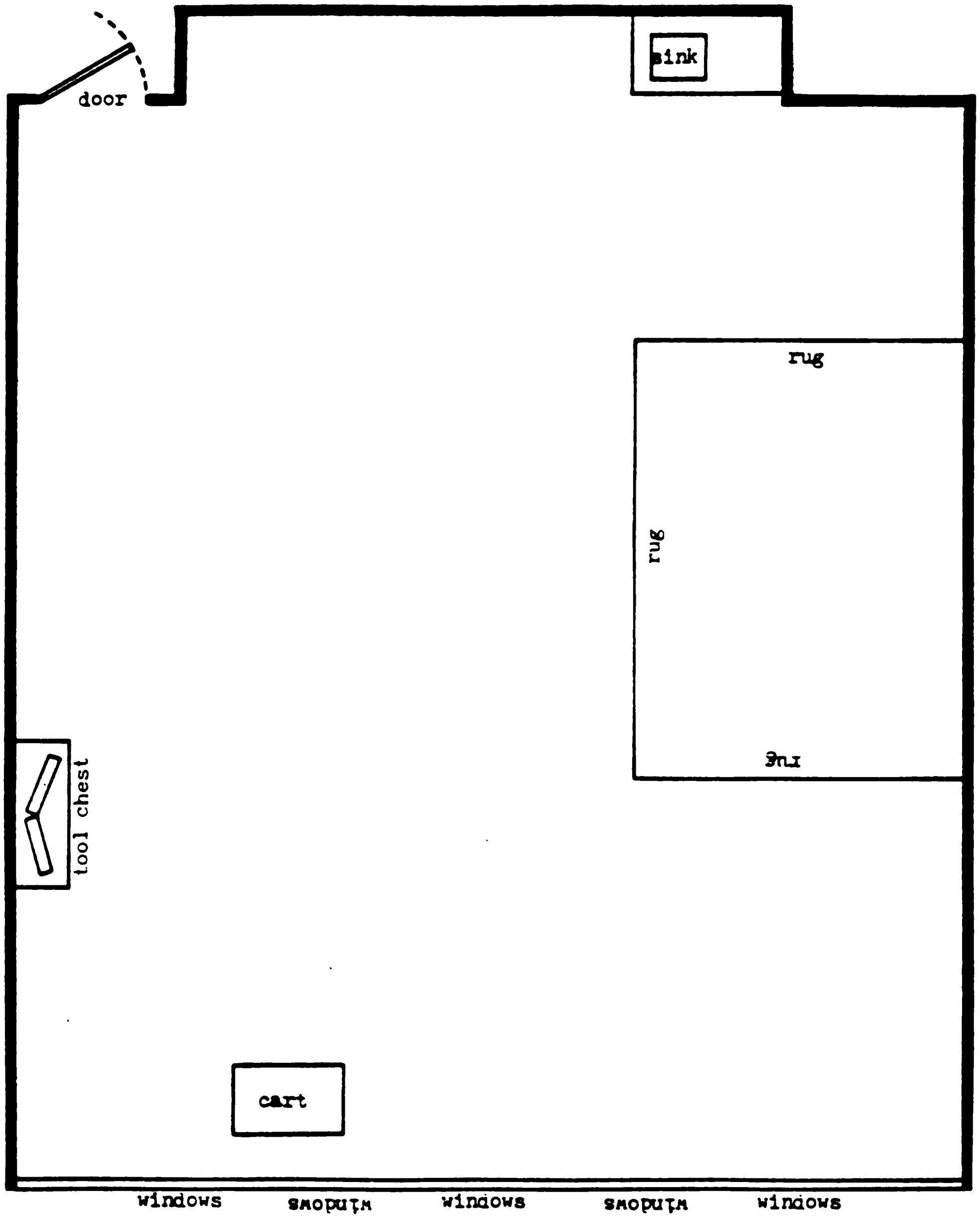
APPENDIX 2

SCHOOL MAP TASK:

INSTRUCTIONS AND FORM

ROOM MAP TASK FORM

(Reduced 25%)



SMT ADMINISTRATION INSTRUCTIONS

"Print your name and your teacher's name on the sheet we've handed out. When you're finished, put your pencils down and listen carefully to my instructions. (Pause.) This represents a map of a building. Can anyone tell me where it is? Correct, it's this school. Now I am going to ask you some questions about locations in the school and I want you to put a number where you think it is. (Give two examples of writing a number on the map. Check for all names and placement of numbers. If all is OK then read the following questions.)

1) Put an X in your regular classroom.
2) Put #1 on the gym.
3) Put the #2 on the main office where the secretary is.
4) Put the #3 on the kindergarten room.
5) Put the #4 on the library area.
6) Put the #5 on where the playground is.
7) Put the #6 on the art room.
8) Put the #7 on the principal's office.
9) Put the #8 on the teacher's lounge.
10) Put the #9 on T__, the janitor's room.
11) Put the #10 where the parking lot is.
12) Put the #11 on the audio-visual supply room.
13) Put the #12 on the front door closest to the secretary's office.

14) Put the #13 where the lost & found box is.

15) Put the #14 where you buy your milk.

Good work, and thanks!"

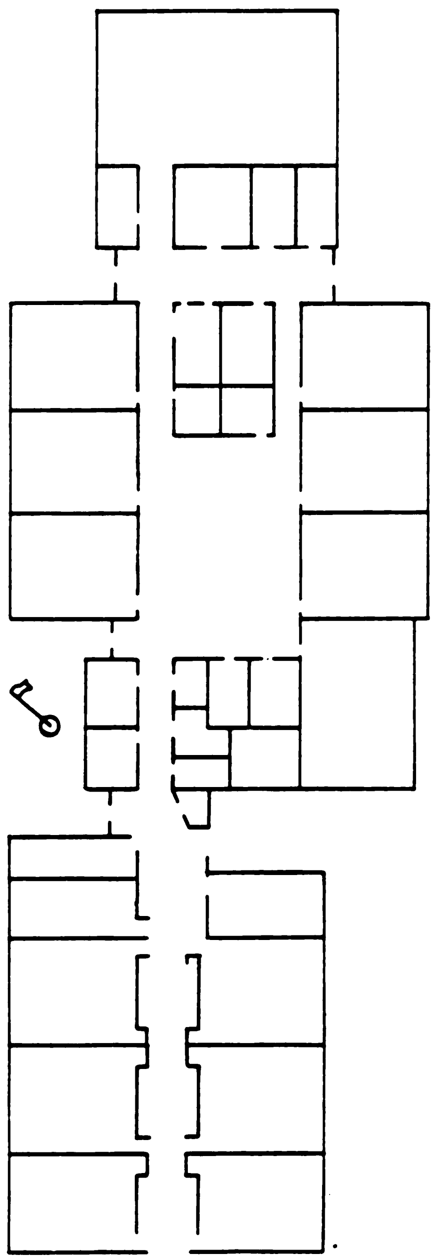
APPENDIX 3

SCORING MASTER FOR

NUMBER OF LANDMARKS (NL)

SCHOOL MAP TASK FORM

(Reduced 25%)



APPENDIX 4

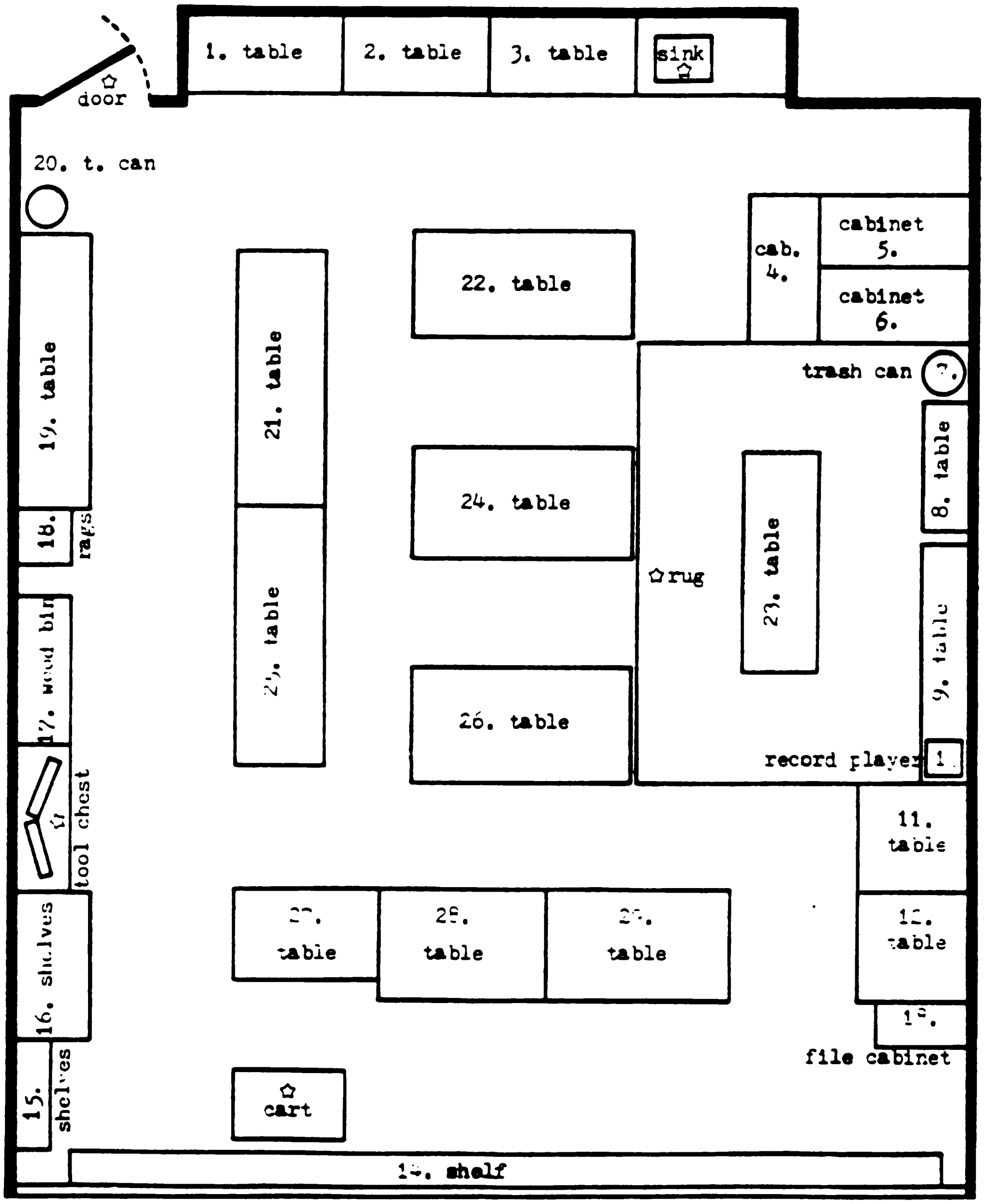
DUPLICATE OF TRANSPARENT OVERLAY

FOR LANDMARK ACCURACY SCORING (LA)

SCORING MASTER FOR

NUMBER OF LANDMARKS (NL)

(Reduced 25%)



APPENDIX 5

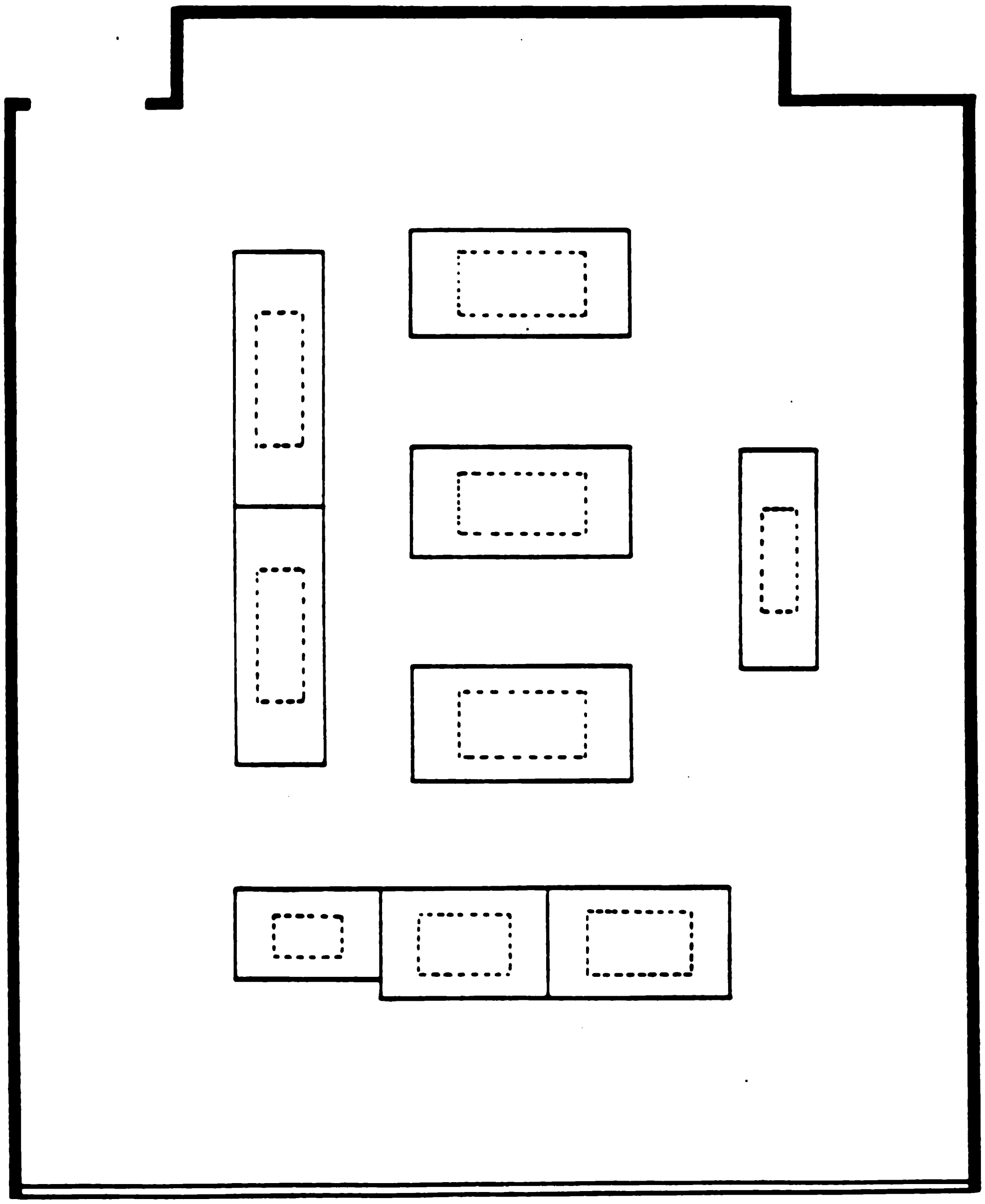
SCORING MASTER FOR SCHOOL

MAP TASK (SMT)

DUPLICATE OF TRANSPARENT OVERLAY

FOR LANDMARK ACCURACY SCORING (LA)

(Reduced 25%)



APPENDIX 6

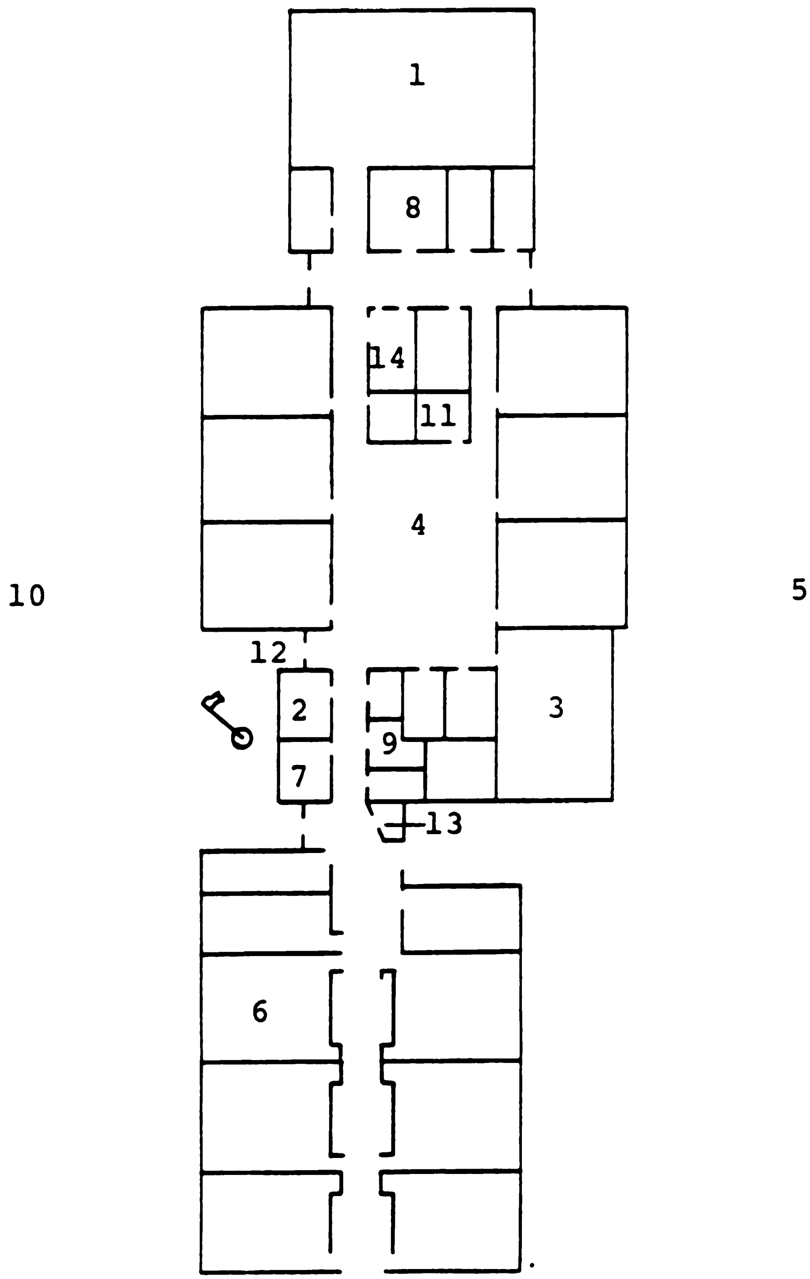
INSTRUCTIONS FOR SCORING

NL, LA, SMT

SCORING MASTER FOR SCHOOL

MAP TASK (SMT)

(Reduced 25%)



APPENDIX 7

UCHRIS APPROVAL

SCORING PROCEDURES

1. Please alphabetize each group of drawings.
2. Please use pencil only when recording scores in appropriate boxes.
3. Please use colored pencils when marking drawings.

MAPS

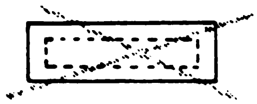
Number of Landmarks (NL)

1. Use scoring sheet and give 1 point for each object present.

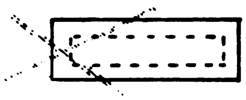
Landmark Accuracy (LA)

1. On the child's drawing, draw diagonal lines from corner to corner of those tables represented in your overlay to determine intersecting center point.

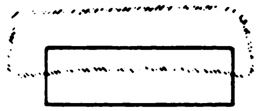
2. Using the overlay score according to the following criteria:



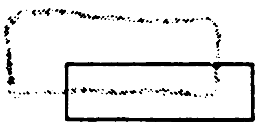
5 pts. if center point falls within dotted area



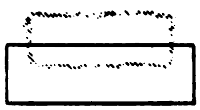
4 pts. if centerpoint falls within solid area



3 pts. if 3 solid overlay lines fall within and/or intersect with drawn area



2 pts. if 2 solid overlay lines intersect with drawn area



1 point if 1 solid overlay line intersects with a drawn area

School Map Task (SMT)

1. Use "Master Score Sheet" and give 1 point for each correctly placed number (check beforehand for location of X).

MICHIGAN STATE UNIVERSITY

UNIVERSITY COMMITTEE ON RESEARCH INVOLVING
HUMAN SUBJECTS (UCRIHS)
238 ADMINISTRATION BUILDING
(517) 355-2186

EAST LANSING • MICHIGAN • 48824

November 24, 1981

Mr. Ray J. Chin
Department of Psychology
23 Snyder Hall

Dear Mr. Chin:

Your request of November 24 for review of your proposed project concerning child development has been received.

I believe that the project is a category 1 exemption and approval is herewith granted for conduct of the project.

Thank you for bringing the study to my attention. If I can be of future help, please do not hesitate to let me know.

Sincerely,

Henry E. Bredeck
Chairman, UCRIHS

HEB/jms

cc: Dr. Ferguson