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CLOTHING FASTENER MANIPULATIVE ABILITY OF PRESCHOOL CHILDREN

A Thesis

Presented to

the Faculty of the Graduate School

University of Manitoba

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

By

Leola Eleanor Falk Becker

March 1984

THE UNIVERSITY OF MANITOBA

FACULTY OF GRADUATE STUDIES

The undersigned certify that they have read a Master's thesis entitled: CLOTHING FASTENER MANIPULATIVE ABILITY OF PRESCHOOL CHILDREN

submitted by Leola Eleanor Falk Becker

in partial fulfillment of the requirements for the degree of

Master of Science

The Thesis Examining Committee certifies that the thesis (and the oral examination, if required) is:

Approved [X] Not Approved [ ]

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CLOTHING FASTENER MANIPULATIVE ABILITY OF PRESCHOOL CHILDREN

by

Leola Eleanor Falk Becker

A thesis submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of

MASTER OF SCIENCE

ABSTRACT

The purpose of this study was (1) to determine the clothing fasteners preschool children could manipulate at six month age intervals from 24 to 54 months, (2) to determine if sex, fastener size, and vertical position of the fastener influenced the fastening ability of children, and (3) to recommend clothing fasteners which would facilitate independent dressing. One hundred, thirty-two children from licensed Winnipeg day care centers were timed, to the tenth of a second, while closing and opening vests with 1 cm buttons, 2 cm buttons, hammer-on snaps, hook and loop fasteners (Velcro), conventional zippers, and large separating zippers. The results indicated that age significantly affected the children's ability to manipulate fasteners, that sex affected children's buttoning abilities, that fastener size affected boys' unbuttoning abilities, and that fastener position only affected children who were developing fastening skills. Statistical calculations indicated the age ranges when 80% of normal children learn to manipulate each fastener. Fasteners, which 75% of the children in each age level could manipulate, were recommended for self-help clothing.

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Chapter I

INTRODUCTION

Acquiring independence in dressing tasks is a goal of each child's preschool development. Dressing and fastener manipulation have various degrees of manipulative difficulty naturally occurring within the tasks. The specific skills can only be mastered as a child develops the necessary motor coordination and cognitive understanding. When learning to dress or manipulate fasteners, a child can progress from easy to harder tasks. The individual task achievements not only enable increased dressing independence but also contribute to the child's self-confidence and mastery of other motor tasks.

Dressing independence has physiological and psychological advantages for a child. The ability to dress and manipulate fasteners frees a child from a caregiver's assistance, permits the child to make his/her own clothing adjustments to meet environmental changes, and permits participation in day care, nursery school, or other group learning situations. Psychologists report that dressing accomplishments foster self-esteem, resourcefulness, initiative, concentration, and a sense of judgment. By conquering the complex motor techniques and assuming responsibility for the accompanying decisions in dressing, a child obtains a basis for pursuing other manipulative and judgmental tasks.

Caregivers, educators, clothing designers, and clothing manufacturers who are aware of self-help issues realize that appropriate clothing and clothing fasteners can enable a child to dress indepen-

dently at a younger age. Proper clothing will utilize a child's full manipulative capabilities, without demanding more than the child's development would warrant. An ideal garment will both facilitate dressing and undressing, and will have a minimum of carefully located, easily manipulated fasteners. Appropriate design and selection of preschool children's clothing are imperative if a child's interest, success, and dignity are to be maintained.

Fastener manipulation is the most difficult of the dressing tasks to master as it requires finger dexterity, hand strength, and fine motor coordination. Normative studies, which have attempted to establish central tendencies in child development, have found that although children start unzipping zippers as early as 18 months of age, most cannot manage to tie bows before 6 or 7 years of age. These studies qualify that the range of fastening accomplishments vary with individual children and specific fastening situations.

As fastener manipulation is a critical achievement in child development, screening tests use it as a criteria to evaluate whether a child's development is normal or abnormal. Several assessment tests use parental report to indicate if a child can unbutton or button a single button or garment. Other tests use representative fasteners on form boards to assess fastening abilities. However, these tests do not specify garment fastening conditions or judge garment fastening skills. Neither method really indicates whether a specific child's manipulation of his/her fasteners on his/her clothing is normal or abnormal. The tests simply propose that most five year old children should be able to handle most clothing fasteners independently.

Because current information on children's fastening abilities is limited, this study will attempt to determine the ages at which children learn to manipulate different types of clothing fasteners. Attention will be given to the affects of the subject's age and sex and the fastener's type, size, and vertical location on manipulative performance. Appropriate fasteners will then be recommended for each age group's clothing.

Chapter II

REVIEW OF LITERATURE

Literature in child development and clothing provide limited information concerning preschool children's ability to manipulate clothing fasteners, as little attempt has been made to relate chronological age to the ability to manipulate various fasteners. Thus, this literature review has been designed to provide an overview of fasteners, dressing independence, manipulative ability, and fastening ability.

Fasteners

A fastener is an item which can be used to join elements together and a fastening system is any method either inherent in the composition of a material or applied to it which is used to either temporarily or permanently join elements (Kammermeyer, 45, pp. 6-7). A fastener operates as a single device, and a fastening system operates by the interaction of two or more parts. A clothing fastener or fastening system functions:

1. to hold a garment on the body,
2. to facilitate donning and doffing,
3. to adjust for different sizes or uses,
4. to attach modular elements together,
5. to make a garment airtight or watertight,
6. to accommodate special needs, or
7. to add decoration (Watkins, 74, Sept. 3).

Theoretically, a garment's fastening system can include factors

other than the conventionally accepted fasteners: A garment can be held on the body by (1) gravity, as in hanging, (2) resistance of the body, as in garment shape, (3) pressure, as in tight bands or air splints, and (4) friction, as in attraction to the body or other garment surfaces (Watkins, 74, Sept. 5). For instance, a skirt is fastened by a zipper and a hook and eye combination. But the skirt is fastened to the body by gravity, resistance of the wearer's hips, pressure of the waistband, and friction with the wearer's undergarments.

Kammermeyer (45) developed a theory of fastening systems based on the premise that physical fasteners operate by either bodily attraction (including the forces evident in magnetism, electrical charges, and mass attraction) or friction (including the interaction of molecules when surfaces attempt to pass each other). Kammermeyer postulated that most fasteners are designed to maximize friction. He stated that:

> Man has not been able to eliminate useless friction, however, he has found ways to control it to his advantage. By enlarging the scale of the surface irregularities and controlling their shape he began to make useful fasteners (45, p. 15).

Depending on the particular fastener, this friction could be classified as either "applied force" or "restraining force." (See Figure 1.) Kammermeyer concluded that designers should understand the patterns and relationships in fastening systems as broadly based analogies could stimulate novel design solutions.

Each garment presents special conditions to the designer. The specific clothing fastener selected in any given situation may depend on such factors as:

1. the style and design of the garment,
2. the type of garment,

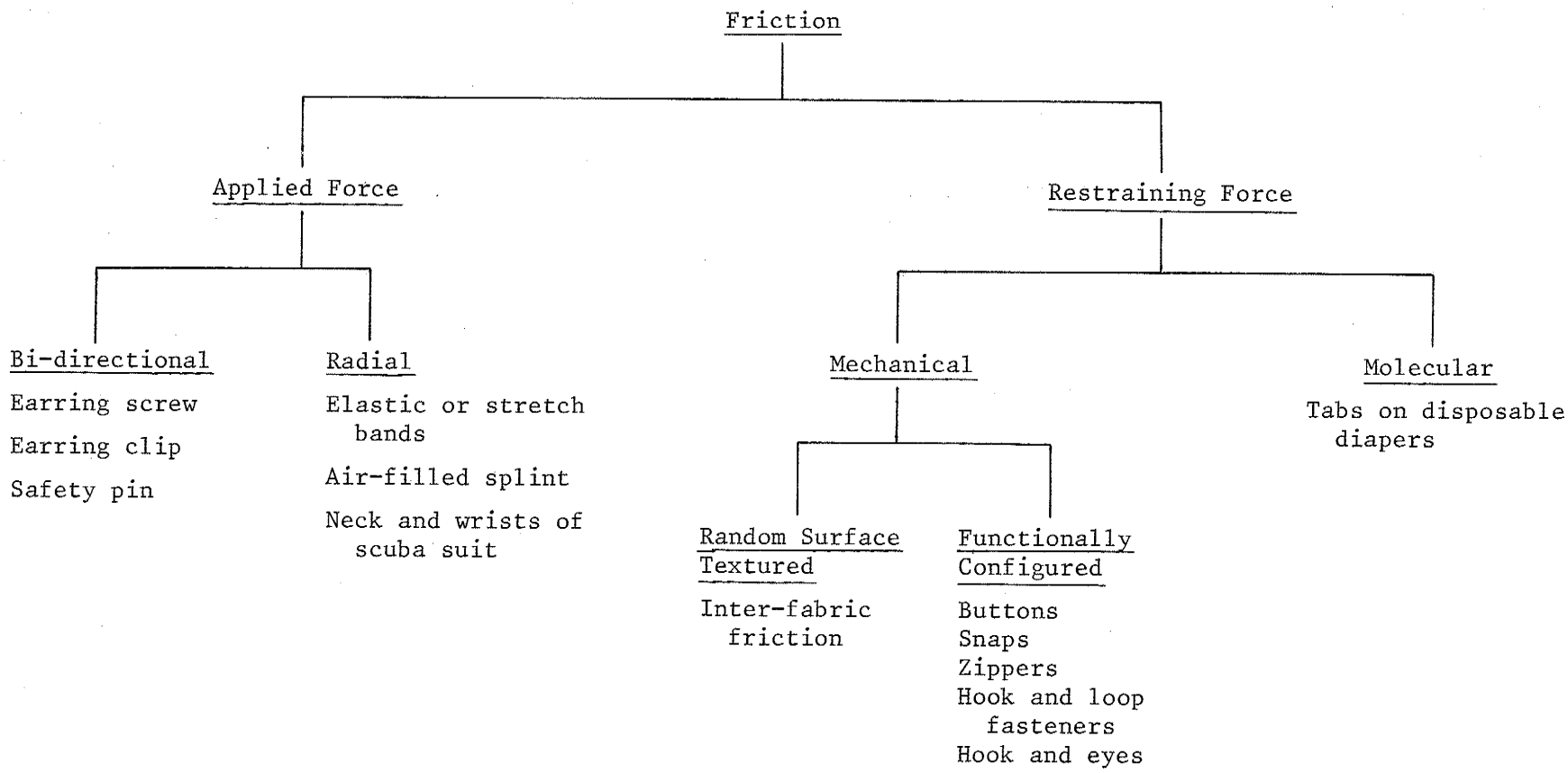

Figure 1

Principles of Mechanical Fastening

Compiled from Kammermeyer's figure (45, p. 20), definitions, and examples.

3. the type of garment closure,
4. the garment's use,
5. the garment's care,
6. the placement and position of each fastener,
7. the method of application, and
8. the weight, type, and texture of the fabric (Gioello & Berke, 30, p. 182).

Or, the fastener selection may depend on wearer factors such a preference or manipulative ability. Wearer factors are extremely critical if garments are to permit dressing independence of preschool, handicapped, or elderly individuals.

Dressing Independence

Self-help skills such as dressing and fastening are among the most important skills a child can learn. Mastering dressing skills (1) makes a child a specialist in motor achievement, (2) boosts his/her self-concept and self-confidence, (3) brings the child closer to independence, and (4) liberates the caregiver's time and energy. Young states that dressing trains a child:

(1) to exercise his hands and feet and to coordinate his movements;

(2) to think and concentrate upon one of the first real tasks which later, of course, become mere habits;

(3) to exercise judgment in putting on clothes properly and fastening them correctly;

(4) to develop resourcefulness in accomplishment; and

(5) to develop independence and power of action rather than dependence upon others (76, p. 74).

Dressing independence can help establish personality characteristics such as discernment, self-reliance, and initiative. Usually a child

who is encouraged and manages to successfully fasten his/her clothes at an early age will also act independently in other situations. Bare, Boettke, and Waggoner state that:

> Few parents realize how seriously they can handicap the physical, mental and emotional growth of their children by limiting their independence in the performance of daily functions (3, p. 2).

Dressing and manipulating clothing fasteners are complex activities. The list of variables affecting manipulative independence could include numerous developmental, psychological, environmental, and clothing factors.

Some authors believe that an interest in adornment, display, or social approval may motivate a child to dress independently. The initial stimulus is created by the child's consciousness of clothing's social significance. Jaffe says that a child:

> ...becomes aware of clothes as he realizes that they will bring him attention and approval from adults. New garments are particularly important, for adults will notice and make pleasant comments. To the child, his clothing appears to be an extension of the concept of self (41, p. 15).

Hurlock concurs that:

> ...The child's keen pleasure in clothing come from the fact that every child craves attention and admiration even more than an adult does; but, since he has so little with which to command attention, he soon learns that clothes serve this purpose well (39, p. 302).

This clothing consciousness, together with increased maturity, yield the "interested pleasure in the activity" and the "ability to lend his attention to it" which Young defines as the necessary prerequisites for self-help dressing (76, p. 76).

Usually, success in dressing is dependent on the caregiver's willingness to allow the child the time needed for self-dressing and the caregiver's satisfaction with the results. The amount of indepen-

dence expected of a child should be determined by what the child can achieve in a reasonable time with a minimum of strain (Young, 76, p. 75). Bare et al. stress the setting of realistic goals and the importance of the child's sense of accomplishment (3, p. 6): Care should be taken that the child's initiative is not destroyed, but that a joyous self-discovery is experienced. Rea qualifies that not all children will have the same aptitudes at the same age: Each child should have the opportunity to dress his/herself when he/she wishes to, and no training should be forced on a child before he/she is ready (60, p. 718).

Although differences in clothing features may seem insignificant, the appropriate garment features can help a child achieve dressing independence. Baxter, Latzke, and Andrews specify that fasteners should be reduced to a minimum and located in convenient places (4, p. 435). Craig (19) adds that simple fasteners, lightweight fabrics, raglan sleeves, and comfortable two-piece outfits are helpful. Similarly, Tate and Glisson suggest that large fasteners, long openings, attached belts, one-piece outfits, and ample armholes, sleeves, or necklines facilitate dressing independence (68, pp. 193-194).

Thompson and Rea (70) recommend clothes which fasten at approximately the same place with the same type of fastener: A child should only be given one fastener until it is mastered in order to prevent frustration. They also recommend (1) having a minimum of fasteners, (2) having preschool children learn how to manipulate buttons first, (3) reserving zippers for older aged children, and (4) avoiding bows, sashes, and belts.

Authors disagree on the merits of zippers and one- or two-piece outfits in achieving dressing independence. The discrepancies in

zipper recommendations may stem from the zipper variations available at the time of research: Early metal zippers were more difficult to manipulate than later synthetic versions. The one- versus two-piece outfit recommendations may vary if the authors are (1) only considering dressing, (2) are considering both dressing and toileting, or (3) are primarily considering girls' dresses, or (4) are considering unisex outfits. One-piece outfits may be easier to put on, but may be more difficult for toileting. Dresses are usually easier to handle than shirts, blouses, pants, and overalls.

Obviously, no amount of motivation, encouragement, or proper clothing will compensate for physical maturity and readiness for dressing tasks. A child's motor development will ultimately determine the child's manipulative ability.

Manipulative Ability Development

A child's development is based on the complex interaction of physical, cognitive, affective, social, and other variables. Every variable is at all times interrelated and interdependent. Adequate development in any one area is based upon other processes. For example, motor development is dependent on sensory functions which supply data, perception and other cognitive functions which interpret the information, and physical growth and maturation which permit appropriate responses.

Maturation and learning are both involved in culturally related activities such as dressing and eating with particular utensils. Maturation, which is related to sensorimotor development and the growth of the brain, permits an older child to learn motor skills of greater

complexity at a faster rate than a less mature individual. Learning is the only process to acquire ontogenetic responses, i.e., responses which develop in some individuals and not in others (Munn, 57, p. 312). The learning of these skills is dependent on cultural background and proper stimulation.

Gross and fine motor skills such as balance, appendage movement, and prehension are combined to accomplish dressing goals. Fine motor coordination, especially in prehension, is the greatest contributing factor to dressing and fastening ability.

Prehensile Behavior

Prehensile behavior or development refers to the acquisition of motor control in seizing or grasping an object. Prehensile grasp, which replaces the infant's grasping reflex, quickly matures so that at 60 weeks the child's grasping skill and efficiency approximates an adult's skill and efficiency. This behavior is under voluntary control and can be elicited by visual or tactile stimulation. Prehensile operations generally include four activities: (1) visual location, (2) reach, (3) grasp, and (4) voluntary release of an object.

The development of reach passes through three major phases. In the first "backhand sweep" phase, the infant makes a lateral swipe which cuts short of the object. This movement predominantly involves the shoulder muscles, and occurs at about 20 weeks (4½ months). The second "circuitous approach" phase progresses from a corraling sweep around the object to a more direct motion towards the object. These transitions occur after 24 weeks (5½ months) of age, and display the maturation of shoulder and elbow muscles. The infant reaches the third

phase at about 52 weeks (12 months). In this "direct approach" phase, the child reaches directly to the object, making contact with the upper surface. This motion involves the simultaneous coordination of shoulder, elbow, and wrist muscles (Halverson, 34, pp. 162-185, 273, 279).

The development of grasping also exemplifies the maturation of coarser muscles before fine muscles. At first, the infant will grasp the object in a clawing type of closure, with the fingers and thumb functioning as one unit. At about 28 weeks (6½ months), the infant will use his/her fingers and thumb to force the object securely against the palm. Further refinement, by 52 weeks (12 months), results in objects being grasped by the tips of the first three fingers in opposition with the thumb (Halverson, 34, pp. 211-214, 275-279).

Similarly, the technique of voluntary release goes through developmental changes. At about 6½ months, the infant will simply drop an object when his/her attention shift. At 7½ months, the infant will repeatedly drop an object at will. At about 10 months, the infant will release an object when and where desired. This skill is refined until, at about 11 months, the infant will be able to put a peg into a hole (Department of Family Studies, 20).

Learning and practice can only enhance the body's natural developmental process. Halverson says that:

> The increase in the number of higher types of grasp and the increase in the amount and variety of digital manipulation of the cube in infants from sixteen to fifty-two weeks of age are due in part to anatomical growth of the digits of the hand, in part to maturation of its neuromusculature, in part to training, and in part, perhaps, to increase in cutaneous sensibility of the fingertips (34, pp. 279-80).

As prehension is an ingredient of most dressing and fastening tasks, the ability to perform these tasks is also dependent upon growth, maturation, and training.

Fine Motor Skills

Fine eye-hand coordination in motor skills develops primarily through the intrinsic growth of the child's nervous system. Environmental factors can only support and modify the child's natural developmental progression. However, a favorable environment will provide the child with the opportunities to practice tasks and thus realize his/her growth potential.

Throughout the preschool years, children are actively learning and perfecting fine motor skills. Butler, Botts, and Quisenberry state that the fine motor objectives of these years are:

1. to develop the hand control which is essential for writing, drawing, and handling eating utensils.
2. to develop the eye-hand coordination which is essential for using construction toys and moderately difficult puzzles and form boards.
3. to control scissors when roughly cutting (i.e., when cutting approximately) along the outline of a simple figure or design which the child has drawn.
4. to acquire the coordination needed for lacing, paper folding, buttoning, or loose tying (13, p. 210).

These objectives are met by successively learning the many component skills.

Butler et. al also divide developmental behaviors displayed from 3 through 5 years of age into five levels. Their fine motor development sequence includes information on finger grasp, hand control,

drawing, hand-eye coordination, visual acuity, form recognition, color discrimination, wrist control, manipulative activity, constructive activity, and left-right coordination (See Appendix A).

Children differ widely in the rate at which they pass through the sequence of motor behavior patterns. Children also differ in the efficiency, accuracy, and strength of their motor coordination. Generally, boys have better large muscle coordination and girls have better manual dexterity.

Gesell and Ilg (29) found that a two year old has difficulty with horizontal tasks. Although the two year old child can build a tower of blocks, he/she cannot arrange the blocks in a horizontal row to form a wall. The two year old can easily draw vertical lines, but has difficulty in making horizontal strokes. This partiality for vertical tasks is based on the child's growth geometry. At later ages, the child will first exhibit a similar partiality for horizontal tasks and, finally, will gain equal facility in both directions. These partialities in direction will affect the child's ability to correctly align fastener segments.

Smart and Smart surveyed child development research and compiled a chart of motor development norms. Each skill item was placed at the age where at least fifty percent of the children could perform the task. The eye-hand coordination data indicated that two year old children can build 6 to 7 block high towers, turn single book pages, and imitate circular strokes. Three year old children can build 9 block high towers, pour from a pitcher, and copy circles. Four year old children can cut on a line, catch small balls, and make crude letters and designs. Finally, five year old children can fold paper into

triangles and copy squares, designs, letters, and numbers (66, p. 218). Thus, a five year old child displays most of the manipulative skills of an adult, and could be expected to have similar clothing fastening abilities.

Dressing Abilities

Gesell conducted the most definitive study of a child development norms undertaken to date. Through clinical observation and examination he followed fifty normal children through the first ten years of their lives. Gesell summarized his data in the form of growth gradients embracing ten major fields of behavior. His developmental sequence in dressing is as follows:

1 Year	Interest in taking off hat, shoes, pants. Cooperates in dressing: puts arm into armhole or extends leg for pants.
1½ Years	Removes mittens, hat, socks. Unzips zipper. Cooperates in dressing: puts on shoes.
2 Years	Removes shoes, stockings, pants. Likes to undress. Can put on some clothes though may put both legs in one pant leg and may get hat on backward. Cooperates in dressing.
2½ Years	Better at undressing than at dressing: can take off all clothes. Can put on socks and perhaps shirt, pants, and coat though not always accurately. Allows mother to lay clothes out, correctly oriented. May be completely independent or may demand total help. May run away as he is being dressed.
3 Years	Undresses himself rapidly and well. Can put on pants, socks, sweater, dress. Can unbutton front and side buttons. Cannot tell front from back or lace shoes, though may try.

4 Years	Dresses and undresses with little assistance, especially if clothes are laid out. Can distinguish front from back. Can lace shoes. May button front buttons.
5 Years	Dresses self completely, lacing shoes, buttoning front buttons. Cannot button back buttons or tie shoe laces. Motivation may be lacking. "He can but he doesn't." Mother responsible for selecting clothes, laying them out, picking them up after they have been removed.
6 Years	Can dress self except for tying shoe laces and buttoning very difficult buttons. If they do tie shoe laces, tie them too loosely. May need some help and is unwilling to accept this help. Mother needs to be nearby to give some assistance. Mother needs to select clothes, and may need to lay them out.
7 Years	Many can dress without any help if clothes are selected for them. Others dawdle, lack interest, and need help. May dawdle till he gets ready to dress, then actually dresses quickly. Can tie shoe laces but does not like to bother.
8 Years	Can dress without assistance. Can choose what dress or suit to wear and may be able to select out-of-door clothing suitable to the weather. No longer allows mother to lay out clothes, and may insist on selecting wearing apparel himself.
9 Years	Does complete job of dressing (Taken from Gesell & Ilg, 29, pp. 266-268).

Recent publications of the Gesell Institute and other authors (Ames et al., 1; Butler et al., 13; Brown & Donovan, 12) present a similar or identical developmental progression. However, these normative scales are limited in the number of and definition of clothing fasteners used to establish the norms. The data do not include many fasteners now commonly found on preschool children's clothing and do not define the fastener's size, location, and other important variables

which influence the child's manipulative ability. Ames et al. recognize the limitations of Gesell's scale and include the following qualification:

> Children's clothes have indeed been simplified within the past few years so that the child not only tries to cooperate in dressing but can actually do many things for himself long before he could do so with more complicated clothing. This fact tends to make us err on the side of expecting too much from the young child. Dressing is so intimately bound up with motor coordination that we should attempt to measure just how much the child can do for himself and not expect him to do more (1, p. 121).

Although Bynum (14) found no significant difference in the buttoning abilities of four year old boys and girls, Gesell and others (& Ilg, 29; Ames et al., 1) have found that girls display dressing efficiency earlier than boys. This difference has been attributed to better fine motor coordination and more flexible wrist rotation in girls, especially at two and three years of age. The absence of customary wrist rotation is evidenced in boys who cannot turn a doorknob far enough to open the door, who simply rub palmar surfaces together in handwashing or who, at the extreme, still have difficulty manipulating buttons and clothing at five or six years of age (Ames et al., 1, p. 121). To what extent the displayed difference in dressing abilities is attributable to differences in physical development or to differences in cultural stimulation has not been established.

Dressing and Fastening Test Items

Because dressing and fastening are important self-help skills, many child development tests include test items which assess preschool children's abilities to dress themselves or fasten their clothing. Generally, these items are either questions to be answered

by parental report or sample buttoning tasks to be performed by the child.

For example, the Denver Developmental Screening Test (Frankenburg, Dodds, & Fandal, 25) asks parents to report whether the child can button any piece of clothing, though the buttons need not be in the correct holes. The Minnesota Child Development Inventory (Ireton & Thwring, 40) asks parents to report if the child can unbutton one button, button one button, or button a shirt, blouse, or coat with all the buttons in the correct holes. The Manual of Developmental Diagnosis (Knoblock, Stevens, & Malone, 48) asks parents to report if a child can unzip zippers, or asks the evaluator to have the child manipulate the zipper, if any, on the clothes the child is wearing. In contrast, Griffith's System of Measurement has children perform a buttoning task in a box (32, p. 104) and the Merrill Palmer testing program has tasks using 5/8 inch buttons and 7/8 inch buttonholes on pink flannelette strips (Siefert, 65, p. 40).

However, these testing methods have evident difficulties. The parental questions require that parents be unbiased and answer accurately. The "garment questions" do not specify garment conditions and thus individual children may be judged on tasks of varying difficulty. In addition, the form board tasks do not duplicate "on-body" conditions. These testing methods do not indicate whether a specific child's manipulation of his/her clothes is normal or abnormal. The test items simply indicate possible problem areas and propose that most five year old children will be able to handle most clothing fasteners independently.

Teaching Dressing and Fastening Skills

Perhaps because most children learn how to manipulate clothing by simply being shown and attempting the task, preschool educational literature says little about clothing manipulation. Available literature only discusses dressing or fastening in respect to classroom play areas and teacher facilitation of washroom or "going outside" activities. A dress-up and/or home center within the classroom is recommended to facilitate imaginative and role playing, and to provide for clothing manipulation. The references to this center usually focus on children's socialization.

Teachers are told to provide toys on which children can practice fastening and are told that their students will probably need help in buttoning, lacing, tying, and starting separating zippers. However, even the most explicit fastener-related statement to be found is not accompanied with any information concerning children's fastening capabilities:

> Different ways of fastening dressing-up clothes give valuable practice in manipulative skill, but care should be taken to ensure that the fasteners are unbroken and within the children's capability (Manning & Sharp, 53, p. 87).

Teachers are simply instructed to encourage students' dressing attempts by providing physical assistance when needed. Warnings are also given that a preschool child's physical readiness to perform a task may not coincide with his/her emotional readiness.

More explicit literature on clothing manipulation, however, has been written to aid physically or mentally handicapped children. The most comprehensive reference in teaching both dressing and fastening

skills is the book, Step-by-Step Dressing, written by Shirley Henderson and Mary McDonald (36) specifically for teaching mentally handicapped children. The book discusses pre-skills for dressing; providing examples, tests, and remedial exercises. Dressing and fastening are broken into small tasks with various teaching methods, recording methods, and other pertinent information. The authors recommend that a child be taught small steps of complex behaviors in their naturally occurring sequences and that fading techniques be used to remove physical guidance as a child's abilities increase. As well, quick, consistant, and appropriate reinforcement should be given for specific, previously-defined dressing behaviors. In total, the book provides a conceptual foundation for developing effective dressing programs for individual children or groups of children, and is an excellent guide for anyone teaching dressing or fastening skills.

Baker, Brightman, Heifty, and Murphy provide a behavior modification approach for teaching dressing and fastening to "problem" children in their Steps to Independence volumes (2). Besides utilizing small teaching steps and generous reinforcements, Baker et al.'s method follows a "working backwards" principle. The child starts by learning the last step in a task. Thus, the caregiver does not need to "take over" to complete the task and the child derives the fullest satisfaction possible by believing that he/she was successful in the task. Baker et al.'s directions and philosophies are worth consideration and can be incorporated with other teaching methods.

Others have devised systems to teach dressing tasks by having subjects learn to manipulate a series of increasingly more difficult garments. Levitan-Rheingold, Hotte, and Mandel (51) designed a series

of six shirts with raglan sleeves and no fasteners. The shirt bodies were kept constant, but the neck openings and sleeve lengths were systematically varied to create a sequence of easy to difficult handling garments. They assumed that shirts with large necklines and short sleeves were easier to manipulate than shirts with small necklines and long sleeves.

Siefert (65) designed form board training mechanisms and "self-help developmental" dresses with hook and loop fasteners, 1 5/8 inch flat buttons, 3/4 inch half-ball buttons, and hammer-on snaps attached to cotton tape. The dresses had short, raglan sleeves and full length, center front openings with the various fasteners.

The above researchers provided teaching instructions with their garments. Their exploratory testing indicated that with regular learning sessions, subjects were able to increase their dressing skills. The subjects also generalized their learning to ready-to-wear garments. These teaching methodologies can be used with other dressing tasks, and may even function with carefully selected commercial garments. However, for the educational process to succeed, the children need to be motivated either by rewards, praise, or easy accomplishment.

Clothing Research on Preschool Children's Ability to Manipulate Clothing Fasteners

The historical attitude that children were miniature adults prevented people from understanding the unique needs of children and their clothing. Thus, for centuries children's clothes were replicas of adults' clothes. Developing chests were tightly bound, growing legs were swathed in heavy fabrics, and small feet were perched on

high heels. Even in early America, five year olds were sometimes seen "wearing a corset of board and steel, tightly wrought with heavy buckram" (Young, 76, p. 38). Children endured elaborate outfits, tight sleeves, minute buttons, ruffs, and wigs.

Gradually, however, views on childhood and children's clothing changed. The impetus began with John Locke's Thoughts on Education and Jean Jacques Rousseau's Emile (Young, 76, pp. 25, 28). Locke advocated that a child's body needed light, warm, loose, and comfortable clothing, not heavy, tight garments which did not allow the body to grow or exercise. Rousseau stated that scientific management should be used to ensure that childhood is a happy, healthy experience. These men initiated the understanding that children are, indeed, unique humans with special needs and interests. From this understanding evolved a simplification of children's clothes.

Contemporary children's clothing, ideally, meets the psychological and physical needs of the child as well as being aesthetic, economic, and well constructed. However, little has been done to determine if children's clothing fasteners allow them to dress independently. Research by home economists has been surprisingly scant considering the obstacles clothing fasteners provide for young children. Most designers and manufacturers simply produce clothes which appeal to caregivers' aesthetic preferences, and hope that other clothing criteria are being met.

Fastener Manipulative Studies

Only two investigations were found which sought to determine a normal preschool child's fastener manipulative ability: that of Wagoner

and Armstrong in 1926-27 and that of Bynum in 1975. Both studies primarily examined buttoning abilities. While Wagoner and Armstrong found sexual differences in manipulative ability, Bynum's data revealed no significant difference between the manipulative ability of boys and girls. However, the average age (3 yr. 3 mo.) of the children Wagoner and Armstrong tested was younger than the average age (approx. 4 yr. 10 mo.) of Bynum's subjects. Thus, the discrepancies may be attributed to different rates of development between the two sexes which level off after 4 years of age.

In 1926-27 Wagoner and Armstrong (71) evaluated thirty nursery school children at Iowa State College in an attempt to find the degree of motor control necessary for the manipulation of buttons and buttonholes. Their purpose was to establish a readiness criterion by which caregivers could evaluate when a child's motor coordination was adequate for mastering dressing tasks. They approached the problem with two separate studies.

In the first study a comparison was made of the degree of skill evidenced in buttoning and unbuttoning with scores on standardized tests of fine motor development. Their findings, although inconclusive on account of the small sample and response variability, indicated a positive relationship between ability to manipulate buttons and buttonholes and scores on fine motor skill tests. They also found that fine motor development scores were a better indicator of fastener manipulative ability than were intelligence scores.

The second study evaluated the children's ability to manipulate different sizes and types of buttons and buttonholes located at both the center front and sides of six jackets. Their data did not

recommend a specific button and buttonhole combination, but they thought that fabric loops were both easily handled and convenient for home sewers. Their findings indicated (1) that center front fastenings were easier to manipulate than side fastenings, (2) that lower buttons were easier to manipulate than higher buttons, (3) that unbuttoning was easier than buttoning, and (4) that girls learned to unbutton and button earlier than boys. They also found that interest in the task increased with ability to do the task, and that ability improved with increased age. Their findings seemed to indicate that the ability to manipulate buttons is a function of maturity as well as learning.

Wagoner and Armstrong concluded that further investigation of the motor control involved in the dressing process was necessary. They identified a need to investigate other fasteners for easier manipulation by children and to design and construct self-help children's clothing.

In 1975 Bynum (14) tested sixty-nine four year old Anglo, Mexican-American, and Black children in Lubbock, Texas to determine the ease of manipulation of five selected fasteners, and to determine if a significant difference existed between sex or race and the ability to manipulate fasteners. The children were timed, to the tenth of a second, as they fastened each of five randomly assigned vests, each constructed with three identical fasteners at center front. The data revealed that the toggle button required the least amount of time to fasten, followed by the round 1 inch button, the round 3/4 inch button, the round 7/16 inch button, and the hammer-on snap which required the longest time to fasten. Bynum deduced that the toggle was easiest to

fasten because the shape facilitated grasping. The data revealed no significant difference in manipulative ability according to sex or race.

Self-Help Garment Studies

Research aimed at designing self-help garments for preschool children has yielded some information concerning children's fastener manipulation. However, these studies were conducted in the 1940's and 1950's when buttons were practically the sole fastener for children's clothing. At that time, zippers were made of metal and usually did not operate smoothly. The elastic that was available stretched excessively in laundering. Other fasteners, such as hammer-on snaps or hook and loop fasteners, were either rare or nonexistent. Thus, this descriptive research primarily supported the researchers' assumption that preschool children could manipulate front openings with large buttons.

Johnson (42, 1945) designed six self-help dresses for a four year old girl with the purpose of creating adaptable preschool dress designs which would encourage dressing independence and allow for physical growth. Her preconstruction testing indicated that the girl could manipulate any sized button with a shank to facilitate grasping, but had some difficulties with smooth pearl buttons. The girl's wear testing of the dresses revealed difficulties with shoulder buttons, buttons on wide overlaps, buttons at the extreme side waistline, and hidden snaps. Johnson concluded that 1/2 to 3/4 inch raised surface, cupped buttons in visible locations on three-fourths or full length center or side front garment openings were the most satisfactory in facilitating dressing independence.

MacCloskey (52, 1945) attempted to design children's garments with self-help and ease of care features. Her preliminary survey of mothers of preschool children revealed problems with small buttons, numerous buttons or fasteners, inaccessible fasteners, and concealed openings. She does not report the findings of her designs' wear tests.

Boettke (7, 1953; & Zook, 9, 1956) designed six dresses in an attempt to develop appealing children's clothing with self-help and growth features. The girl who wear tested Boettke's dresses could button the center front styles at two years, six months and the front surplice styles at two years, eight months of age. But even the three and four year old nursery school girls who tried on the garments had difficulty with the neckline hammer-on snap of the one dress. Boettke concluded that long thread shanks on buttons facilitated early buttoning skill and that stiff hammer-on snaps complicated fastening.

Bernhardt (5, 1958) designed and evaluated five garments in an attempt to develop attractive clothing designs for preschool children which incorporated self-help, growth, freedom of movement, and ease of care features. Her results indicated (1) that front openings made garment fasteners easy for children to reach and fasten themselves, (2) that 5/8 or 3/4 inch buttons with thread shanks facilitated grasping, (3) that conventional zipper tabs may be too small for some children to grasp, and (4) that center front zippers in overalls permitted children to dress and undress without the awkward maneuver of fastening and unfastening shoulder straps. Bernhardt recommended the use of either large zippers or an attachment on conventional zipper tabs.

Clothing Preference Studies

Studies of parental preferences in preschool children's clothing have shown a preference for zippers and buttons, depending on the respective garment. Zippers were generally preferred for snowsuits and buttons were preferred for girls blouses and dresses. Zippers were usually rated as the easiest for children to manipulate. Most parents were unaware of self-help features, such as front openings and fastenings, and predominantly considered aesthetics when selecting their child's clothing.

Kennally (46, 1950) found that while parents of preschool children preferred zippers, buttons, and hammer-on snaps, the children preferred zippers and medium sized buttons. Approximately half the children surveyed could manipulate both zippers and buttons. Parents cited a preference for zippers in snowsuits. They also mentioned experiencing problems with buttons that were either too large for the respective buttonholes or were too numerous and required excessive fastening time. Hammer-on snaps were the least preferred because they were not easily manipulated by the children and tended to tear clothing.

Brasie and Ryan's data (10, 1951) substantiated Kennally's results by indicating that seventy-six percent of preschool children's mothers preferred front zipper closings in their child's snowsuits and sixty-six percent of the children's snowsuits had zippered closings. The mothers reported that zippers were the easiest fastener for children to manage, and the data indicated that children with zippering snowsuits required less assistance both in donning and doffing their snowsuits. Some mothers considered zippers better looking and warmer

than buttons or other fasteners.

McDonald (54, 1970) found that both mothers of preschool children and day care directors agreed that most children could manipulate common fasteners but had trouble with complicated ones. Zippers and buttons were the preferred closures and those most commonly worn: Hooks and eyes, and buttons with fabric loops were the least preferred and the least commonly worn. The findings also indicated that many mothers and some store buyers were not aware of self-help features and that self-help garments were often not available in stores. McDonald concluded that educational efforts were needed to increase awareness of (1) self-help features, (2) the time saved by teaching self-dressing, and (3) the importance of dressing independence to the child.

Chapter III

STATEMENT OF THE PROBLEM

The age at which a child should be able to manipulate different clothing fasteners is an important question particularly because fasteners range in their manipulative difficulty. Caregivers, educators, clothing designers, and clothing manufacturers need to know when a child's development is, or should be, sufficient to enable fastener mastery.

No empirical data presently exist which relate chronological age with the ability to manipulate fasteners. The limited information available are either from normative studies conducted when buttons and ties were the common fasteners on children's clothing (Ryan, 64; Wagoner & Armstrong, 71), involve only a specific age or disability (Blair, 6; Bynum, 14; Coolidge, 17), or are the secondary result of caregiver's, educator's, or designer's experience (Brasie & Ryan, 10; McDonald, 54; Lamb, 49). The current data contain contradictions or assumptions about sex differences, optimum fastener size, and preferred vertical position of center front fasteners. The basic question of the age at which a normal child can adequately manipulate specific clothing fasteners still remains unanswered.

Empirical data relating chronological age with the ability to manipulate clothing fasteners would establish the basis for developmental testing, clothing design, and clothing selection. Normative data are necessary for the evaluation and assistance of both normal and abnormal children. Explicit information on when developing chil-

dren manipulate specific clothing fasteners would aid caregivers, educators, clothing designers, and clothing manufacturers.

Purpose

Thus, the purpose of this study is (1) to determine the clothing fasteners preschool children can manipulate at six month age intervals from 24 to 54 months, (2) to determine if sex, fastener size, and vertical position of the fastener influence the fastening ability of children, and (3) to recommend clothing fasteners which would facilitate independent dressing.

Hypotheses

To accomplish this purpose, the following statistical hypotheses have been formulated:

1. There is no significant relationship between age and ability to manipulate clothing fasteners among preschool children at six month age intervals from 24 to 54 months.
2. There is no significant difference between the fastener manipulative abilities of preschool boys and girls of the same age level.
3. There is no significant difference in the ability of preschool children of the same age level to manipulate two sizes of the same fastener.
4. There is no significant difference in the ability of preschool children of the same age level to manipulate fasteners positioned at the center front waistline or the center front neckline.

The specific fasteners which will be used to test the first two

hypotheses are 1 cm buttons, 2 cm buttons, hammer-on snaps, hook and loop fasteners, conventional zippers, large zippers, and separating zippers. The third hypothesis will be tested with 1 cm and 2 cm buttons, and with conventional and large zippers. Finally, the fourth hypothesis will be tested with 1 cm buttons, 2 cm buttons, hammer-on snaps, and hook and loop fasteners.

Assumptions

This study assumes that a method of random sample selection yields a representative sample of a population, and that defining an age class in terms of that age, plus or minus a month, will yield normative data for that age. The study also assumes that a child cannot manipulate a fastener (1) if the child indicates that he or she cannot, (2) if the child is not able to close or open the fastener within 300 seconds, or (3) if the child cannot manipulate at least 3 of the 4 fasteners on the 1 cm button, 2 cm button, hammer-on snap, or hook and loop fastener vests. The assumption is also made that non-alignment of the fasteners during manipulative tests will limit the number of fasteners that the children can manipulate on the respective vests. As this would bias the testing of the fourth hypothesis, the children will be assisted in correctly aligning the fasteners.

Chapter IV

METHOD

The research problem stipulated the study's independent and dependent variables. The independent variables were the age and sex of subjects and the type, size, and position of the fasteners. The children's ability to manipulate fasteners was the dependent variable. These variables, as defined in the hypotheses, were the criteria for designing the sample, test instruments, procedures, and data analysis.

Sample

Selection

The population was defined as all children attending licensed day care centers within the city of Winnipeg, Manitoba. Within this population, the study was limited to children without physical or mental handicaps and of the appropriate ages. The age classes or levels were defined in six month intervals from 24 to 54 months of age, plus or minus one month, respectively.

Day care centers were selected by Probability Proportional to Size (PPS) methods. The children in each center were subsequently divided into classes and subclasses by age and sex, respectively. Two subjects were randomly selected from each subclass. If a center did not have children in a specific subclass, substitutions were made from another randomly selected center in an attempt to have at least 10 subjects in each subclass.

Description

Eighteen licensed Winnipeg day care centers were contacted, and all participated in the study. These centers constituted 14% of the day care centers and represented a geographical cross section of Winnipeg (See Appendix E).

One hundred, thirty-two children were subsequently tested to determine their ability to manipulate clothing fasteners. However, some of the subjects initially selected for the study were unable to participate: Several were sick on the testing dates, others had moved or were on vacation, and still others' parents had failed to return the consent form. Two children were not tested because they were unduly shy.

The distribution of the 132 subjects by age and sex is shown in Table 1. Generally there were at least 10 subjects in each age/sex

Table 1

Distribution of Subjects by Age and Sex

Age in Months	Boys	Girls	Both Sexes
24	5	7	12
30	11	12	23
36	13	10	23
42	13	12	25
48	10	16	26
54	12	11	23
Total	64	68	132

subclass. However, difficulties were experienced in finding subjects 24 months old, plus or minus one month. This problem arose because 15 of the 18 day care centers did not admit children until after their second birthday. Also, the day care centers' enrollments were reduced due to summer vacations. (The testing was conducted from May through August, 1983.)

Because the subjects were not selected to represent clothing sizes, the number and ages of the children in each size/sex subclass varied greatly. As shown in Table 2, the number of boys or girls who

Table 2

Distribution of Subjects by Clothing Size

Size	Sex	Age in Months						Total
		24	30	36	42	48	54	
2	Boys	1	1	2	--	--	--	4
	Girls	2	1	2	--	--	--	5
3	Boys	3	3	2	2	--	--	10
	Girls	5	7	1	1	--	--	14
3X	Boys	1	3	1	1	1	1	8
	Girls	--	1	1	--	--	--	2
4	Boys	--	1	4	3	4	4	16
	Girls	--	3	3	8	9	2	25
5	Boys	--	2	2	3	2	3	12
	Girls	--	--	3	2	6	2	13
6	Boys	--	1	2	4	3	2	12
	Girls	--	--	--	--	1	4	5
6X	Boys	--	--	--	--	--	2	2
	Girls	--	--	--	1	--	3	4

Note. Largest clothing size child wore as reported by parent.

wore each size ranged from 2 to 25. The ages of the children in each size class ranged as follows: size 2 from 24 to 36 months, size 3 from 24 to 42 months, size 3X from 24 to 54 months, sizes 4, 5, and 6 from 30 to 54 months, and size 6X from 42 to 54 months. Generally the clothing sizes worn increased with the children's ages.

Instruments

Testing Vests

In order to evaluate the fastener manipulative ability of the preschool children in the sample, two sets of ten vests were constructed so each vest closing would incorporate one of the fasteners to be tested. The two sets of vests were identical in appearance, but different in size. The small vests were designed to fit children size 2 through 4 and the large vests were designed to fit children size 5 through 6X. Canadian standard size measurements and commercial patterns were used to determine the sizing. The vertical length was kept constant in each vest set, but horizontal adjustment was provided for by hook and loop fastener tabs at the two sides of each vest (See Appendix C).

The fasteners were located at the center front of the vests. As one objective was to evaluate how fastener position affected manipulative ability, the fasteners were positioned from the waistline to the interclavicular notch. This resulted in approximately 20.5 cm and 23 cm front fastening lengths in the small and large vests, respectively.

The selection of fasteners to be tested was based on a market survey of children's common clothing fasteners, interviews with

educators and caregivers, and findings or recommendations found in related literature. Each set included vests with these fasteners:

1. four 1 cm buttons,
2. four 2 cm buttons,
3. four hammer-on snaps,
4. four hook and loop fasteners (Velcro (R)),
5. a conventional zipper, and
6. a large separating zipper.

Two vests were constructed in each size for the 1 cm buttons, 2 cm buttons, hammer-on snaps, and hook and loop fasteners. This was done so male children could manipulate these fasteners on left overlapping closures as customary in male clothing and female children could manipulate these fasteners on right overlapping closures as is customary in female clothing.

Facing, but no interfacing, was used along the front openings. This decision was made because (1) some of the fasteners, such as zippers, do not customarily use interfacing, (2) the fabric itself had sufficient firmness, and (3) additional firmness would have made the vests stiffer than most conventional garments.

White, round sew-through buttons with raised rims and thread shanks were used for the button test vests. As buttons are still manufactured according to "Line" sizes and as identical buttons were not available in the two desired sizes, compromises had to be made. Two-holed, 1.1 cm (Line 16 or 3/8 inch) buttons were used as 1 cm buttons. Four-holed, 1.9 cm (Line 30 or 3/4 inch) buttons were used as 2 cm buttons. However only two of the four holes were used in attaching the large buttons to the vests.

White thread and a Singer Buttonholer attachment were used to stitch vertical buttonholes onto the button test vests. The small buttonholes were 1.5 cm long: 0.4 cm longer than the small buttons. The large buttonholes are 2.4 cm long: 0.5 cm longer than the large buttons. The buttonhole size selection was limited by the available buttonhole cams. However, the selected buttonhole sizes were within the "1/8 to 1/4 inch larger than button" range which is usually recommended.

Pearlized white domed 1.2 cm hammer-on snaps were used for the hammer-on snap test vests. Ideally, a flat white dome should have been used, but these were not available on the local retail market.

Medium duty 2.0 cm Velcro (R) dots were used for the hook and loop fastener test vests. The hook component was sewn to the underlap and the loop component was sewn to the overlapping front facing. A 2 cm white felt dot was glued on the outside garment surface, directly over the loop component. This visual identification of the fastener location provided visual consistency with the other fasteners.

White 100% polyester woven, 0.15 cm wide coil, conventional zippers in 20 cm and 23 cm lengths were used for the small and large conventional zipper test vests, respectively. An exposed zipper method was used to insert the zippers at the center front, with the bottom starting at the waistline and the top ending at the neckline (See Appendix C, Figure 5).

Large white 100% polyester woven, 0.4 cm wide teethed, separating zippers in 22.5 cm and 25 cm lengths were used for the small and large separating zipper test vests, respectively. An exposed zipper method

was used to insert the zippers at the center front, with the bottom ends starting at the vest hems (approximately 2.5 cm below the waistline) and the top ends terminating at the necklines. The longer zipper lengths were selected to duplicate customary garment conditions where separating zippers start at garment hems. White lines were embroidered on both sides of each zipper to mark the regular waistlines. Thus the children could be requested to close and open the zipper twice: the first time from the white line as a test of large zipper manipulation and the second time from the zipper bottom, joining and separating the bar pin and pocket, as a test of their ability to manipulate the separating mechanism.

The vests were constructed using red 65% polyester/35% cotton poplin fabric and white fasteners. The fabric was selected for its stable weave, medium weight and red color. The fabric had a balanced plain weave with 55 warp threads and 56 weft threads per square inch. It was 0.006 inches thick under 0.1 pounds per square inch pressure.

Red was deemed the most appropriate fabric color because it is not usually associated with either sex and research has indicated that red is preschool children's favorite color (Hurlock, 39, p. 315; Munn, 57, pp. 266-267; Ryan, 64, p. 213). White was chosen as the fastener color (1) to provide a fabric/fastener color contrast which would aid the children's identification of the fasteners, (2) to minimize differences in contrast between various fasteners and the red fabric, and (3) to facilitate the acquisition of the fasteners desired.

To assess the contrast between the red fabric and the white fasteners, the color-differences between the red fabric and several representative white fabrics and white smooth surfaces were calculated

with the L, a_L, and b_L values obtained from a Hunterlab Color-Difference Meter (Model D25M). Calculated by the modified Judd-Hunter equation, the color differences were from 77.5 to 81.5 standard NBS-CIE units. Calculated by the 1964 CIE U* V* W* equation, which accounts for the wavelength composition of the light source, the color differences were from 72.5 to 85.5 standard NBS-CIE units. These figures indicate both a high level of contrast between the red fabric and the white surfaces and a moderate variation in contrast between the various white surfaces. These findings would seem to indicate (1) that the red/white contrast was sufficient to enable easy identification of the fasteners, and (2) that the contrast variation between the fabric surface and the various fasteners was minimal compared to the fabric/fastener contrast.

Subject Data Sheet

A data sheet was devised to record the necessary personal and test data for each child. The upper portion of the sheet was designed to document the child's age, sex, and clothing size. The bottom portion was designed to register the fastener manipulative skill the child displayed in handling the test garments. Additional space was provided to record the size of vest worn during testing. (See Appendix D.)

For each specific fastener, the following information was recorded:

1. the sequence in which the vest was tested,
2. the time required to fasten,
3. the fastening order, where applicable, or the ability to fasten,

4. the time required to unfasten, and
5. the unfastening order, where applicable, or the ability to unfasten.

The sequence in which the vests were tested was recorded as consecutive numbers from "1" to "6." This record was made to enable the researcher to check whether factors such as fatigue or learning affected the children's manipulative abilities.

The time required to fasten and unfasten each vest was recorded to the tenth of a second. Because previous research had indicated that children have difficulty in manipulating neckline fasteners, only the bottom three of the four fasteners on the button, snap, or hook and loop fastener vests were timed. Thus a child could receive a time, or "pass," if the child could only manipulate three fasteners on each vest. The time measurements were taken as an indication of manipulative proficiency. (No time was recorded if the child manipulated two or less fasteners, and such a child was not considered capable of manipulating the respective fastener when the data analysis was computed.)

The individual fastener manipulation orders were recorded for the button, snap, and hook and loop fastener tests in consecutive numbers from "1" to "4," indicating first to last fastener manipulated successfully. If a fastener was not successfully manipulated, it was recorded as "5." The manipulation sequences were recorded as an indication of position preference.

The ability to fasten and unfasten the zipper vests was recorded as either "1" meaning the fastener was successfully manipulated or "5" meaning the fastener was not successfully manipulated.

Procedure

Prior to starting individual interviews, the researcher introduced the study to the whole day care class. She explained what would take place in a testing session and displayed the fastener vests. She solicited the children's cooperation in doing the fastening tasks and in not interrupting another child's testing session. This group introduction helped to relax subjects and helped to satisfy the other children's curiosity.

The individual testing sessions were conducted at a quiet spot in the child's customary day care room. Where possible, the furniture was arranged to prevent distractions and yet maintain a familiar environment.

The data sheet and vests were prepared before each interview. The personal data for each child was transferred to the upper segment of the data sheet from the consent form. The testing age was calculated, the appropriate vest size was assigned, and a random testing order for the vests was selected from a table of random permutations. The specific testing vests needed were then sequenced for the interview, and the proper horizontal fitting adjustments were made.

At the beginning of each individual session, the researcher talked to the child and attempted to put the child at ease. The researcher displayed the vests and explained what would be asked of the child. Before testing each vest, the researcher positioned the vest on a flat surface in front of the child. She demonstrated the fastener's operation and answered the child's questions. The child was subsequently asked to don the vest, to close the fastener(s), and to open

the fastener(s). Verbal encouragement was given by statements such as:

"That's good."

"You did it!"

"You're doing real well..."

"Can you do the _____ one?"

The child's fastening time, and fastening order or fastening ability were concurrently recorded on the data sheet.

The child was allowed 300 seconds (5 minutes) to manipulate each vest. If the child could not close the fastener(s), the researcher closed them and asked the child to open them. If the child was not able to open the fastener(s), the researcher proceeded directly to the next vest rather than wait the full five minutes. This procedure helped maintain the child's interest and self-respect.

As previously stated, the child was first asked to close the zipper from the white line at the waistline, and then open the zipper that distance. This exercise tested the child's ability to manipulate large sized zippers. If the child was successful in the above task, he/she was requested to assemble the zipper segments, close the zipper, and completely open the zipper. This process tested the child's ability to manipulate the separating mechanism.

Pretest

A pretest was conducted to check the adequacy of the testing vests, data sheets, and testing procedures. Ten children, aged 2 to 5 years, participated.

Based on the information obtained, several changes were made in

data recording and testing procedure. First, the researcher decided to arbitrarily record the largest size when parents identified two clothing sizes for their children, as these children might display the minimum fastening skills of children wearing the larger size. Second, the researcher decided to prompt the children to start with the bottom fastener, helping them correctly align the two sides. Non-alignment would limit the children to manipulating three fasteners on the respective vests, and would complicate the testing of the affect of fastener position on fastener manipulative ability. Third, the researcher decided to test children with limited attention spans in several short sessions. The pretest had indicated that some children, particularly in the 24 and 30 month classes, could not concentrate for longer than two vest fastening attempts. This decision concurs with many child development tests that permit young children to be tested in small segments. This testing procedure appeared to be the best method of determining the child's actual manipulative ability.

Data Analysis and Hypotheses Testing

The data obtained from testing the subjects was entered into the University of Manitoba's Amdahl 5850 computer. Programs prepared by the SAS Institute (Ray, 59; Reinhardt, 63) were used to obtain descriptive statistics and test the hypotheses.

First, contingency table analysis was used to evaluate whether task sequence affected the children's manipulative performance. Second, the UNIVARIATE procedure (Ray, 59, pp. 575-583) was conducted on the timed data for age/sex subclasses and size/sex subclasses to determine the frequencies, means, and standard deviations of the means.

The mean times were plotted. Third, the frequency that the children used particular orders to unfasten the 1 cm buttons, 2 cm buttons, hammer-on snaps, and hook and loop fasteners were tabulated to determine ordering preferences or patterns.

Then, the manipulative data was converted to binary data, either "did manipulate" or "did not manipulate." The LOGIST procedure (Reinhardt, 63, pp. 83-102) at the .05 significance level was used to fit the logistic multiple regression model to the binary manipulative data (the dependent variable). This tested the null hypotheses that there were no significant relationships between age, sex, and the children's ability to manipulate fasteners. The confidence intervals for the predicted probabilities were compared and plotted to assess the relative difficulty of the fasteners, and to test the null hypothesis that there was no significant difference in the children's ability to manipulate two sizes of the same fastener. (Statistical differences were implied if the confidence intervals did not overlap.)

The logistic tests and confidence interval comparisons were then conducted for the waistline and neckline 1 cm buttons, 2 cm buttons, hammer-on snaps, and hook and loop fasteners. This tested the null hypothesis that there was no significant difference in the children's ability to manipulate fasteners at the respective positions.

The logistic multiple regression model was selected because the manipulative data was binary, and thus could not be evaluated by methods which assume normal distribution. The logistic multiple regression model was theoretically appropriate because the predicted probabilities were restricted to values between 0 and 1, and the maximum effect of any variable occurred when the predicted probability

was one-half. This method of estimating probability suited the manipulative data being evaluated.

The logistic multiple regression model also allowed age to be tested as a continuous variable. This permitted inferences to be made at any point within the age span tested.

Chapter V

RESULTS

The results indicate that under certain conditions, age, sex, fastener size, and fastener position affect preschool children's ability to manipulate fasteners. However, the effects are not significant for all age, sex, and fastener combinations so generalized statements must be made with caution.

The results are presented in three sections. The first section reports on task sequences, the second on manipulative data, and the third on the hypotheses testing.

Task Manipulation Sequences

Success Rates

The success rates on the first two and the last two tasks that the children performed were tabulated as shown in Table 3. Then, the two sets of data were tested for independence. This testing yielded a χ^2 value of 0.5731 which is not significant at the .01 significance level.

Unfastening Orders

The orders which the children selected to open the four fasteners on the 1 cm button, 2 cm button, hammer-on snap, and hook and loop fastener vests are shown in Table 4. These tabulations show that younger children are more likely to first manipulate the center fasteners. Older children generally proceed from the garment top to the bottom or the garment bottom to the top. This difference is most

Table 3

Rate of Success on the First Two and Last Two Tasks Performed

Success Rate	First Two Fastening Tasks	Last Two Fastening Tasks
None Successfully Closed and Opened	37 (28%)	33 (25%)
One Successfully Closed and Opened	35 (26.5%)	33 (25%)
Two Successfully Closed and Opened	60 (45.5%)	66 (50%)

Note. $\chi^2 = 0.5731$ (2 d.f.)

Table 4

Fastener Opening Orders in Percentages by Age and Sex

Age in Months	Sex	Not Open Any Fastener on a Vest	Order Opened		
			Bottom to Top	Top to Bottom	Middle to Edges
24	Boys	55%	5%	5%	35%
	Girls	57%	14%	7%	22%
30	Boys	34%	25%	7%	34%
	Girls	33%	36%	6%	25%
36	Boys	29%	23%	15%	33%
	Girls	8%	30%	20%	42%
42	Boys	17%	21%	27%	35%
	Girls	--	58%	40%	2%
48	Boys	--	33%	50%	17%
	Girls	--	45%	47%	8%
54	Boys	--	38%	58%	4%
	Girls	--	50%	48%	2%

noticeable between 24 and 54 month old boys: 78% of the 24 month old boys who were able to open the fasteners and 4% of the 54 month old boys unfastened the middle fasteners first. Conversely, 22% of the 24 month old boys who were able to unfasten the fasteners and 96% of the 54 month old boys unfastened from one garment edge to the other.

Manipulative Data

The children's manipulative abilities are summarized in Table 5. This table indicates the fasteners which at least 50% of the children in each age or size class could successfully close and open. The frequencies, means, and standard deviations of the means for each age/sex and size/sex subclass, and the plotted mean fastening times are located in Appendixes F, G, and H.

1 cm Buttons

Although some boys started opening 1 cm buttons at 36 months, at least 50% did not open and close 1 cm buttons until 48 months of age. At this age, their mean closing and opening times for three buttons were 45.64 and 23.96 seconds, respectively. The boys' mean closing and opening times decreased with age.

Some girls started opening and closing 1 cm buttons at 30 months, but at least 50% did not perform the task until 42 months of age. Their mean closing and opening times for three buttons were 64.41 and 27.85 seconds, respectively, at this age. The girls' mean fastening and unfastening times decreased with age, with leveling effects occurring between 36 and 42 months of age.

The boys wearing size 3 clothes were beginning to open and close the 1 cm buttons, and the percentage who could manipulate the buttons

Table 5

Fasteners Closed and Opened by at Least 50% of the Children By Chronological Age and Clothing Size

Age in Months	Type of Fastener						
	1 cm Buttons	2 cm Buttons	Hammer-on Snaps	Hook and Loop Fasteners	Conventional Zipper	Large Zipper	Separating Zipper
24				X	X	X	
30				X	X	X	
36		(Girls)	X	X	X	X	
42	(Girls)	X	X	X	X	X	
48	X	X	X	X	X	X	X
54	X	X	X	X	X	X	X
Clothing Size							
2				X	X	X	
3				X	X	X	
3X		(Boys)		X	X	X	
4	(Girls)	X	X	X	X	X	
5	(Girls)	X	X	X	X	X	X
6	(Girls)	X	X	X	X	X	X
6X	X	X	X	X	X	X	X

Note. An "X" means that both sexes were able to close and open the fastener. Either "(Boys)" or "(Girls)" means that only that sex was able to close and open the fastener.

tended to increase with size. However, size 6X was the only size where over 50% of the boys could close 1 cm buttons.

The girls' results were diverse. Although one girl wearing size 2 could open 1 cm buttons, the girls wearing size 3X could neither open nor close the buttons. However, most of the girls wearing size 4 and all of the girls wearing sizes 5, 6, and 6X could manipulate 1 cm buttons.

2 cm Buttons

One boy started opening and closing 2 cm buttons at 30 months, but at least 50% of the boys did not begin until 42 months of age. At this age, their mean closing time for three buttons was 46.18 seconds and their mean opening time was 40.34 seconds. If an exception is made for the unique performance of the 30 month old boy, the mean closing times decreased with age. The mean opening times showed slight variations, but generally decreased with age.

Girls started opening and closing 2 cm buttons at 30 months, and at least 50% could do so by 36 months of age. Their mean closing and opening times for three buttons were 94.74 and 52.13 seconds, respectively, at this age. The girls' mean closing times showed a slight peak at 36 months. Otherwise, the mean closing and opening times decreased with age.

Some boys within each size class could manipulate 2 cm buttons. However, only 50% of those wearing size 3X could manipulate the buttons, and the majority could not until they wore the larger sizes. Most of the girls wearing sizes 2-3X could not manipulate 2 cm buttons, but most of the girls wearing sizes 4-6X could.

Hammer-on Snaps

The children started opening hammer-on snaps at 24 months of age. Although some started closing the snaps at 30 months, 50% did not until 42 months of age. Their mean closing and opening times for three hammer-on snaps, at this age, were 55.15 and 5.13 seconds. The mean closing times decreased with age. The mean opening times were similar at 24 and 30 months, but had decreased sharply by 36 months. Thereafter, the opening times gradually decreased with age.

Children wearing all the clothing sizes were able to open hammer-on snaps, but 50% could not close them until size 4.

Hook and Loop Fasteners

The children closed and opened hook and loop fasteners from 24 months of age. At this age, their mean closing and opening times for three fasteners were 20.10 and 13.33 seconds, respectively. The mean closing times peaked sharply at 30 months, and then decreased with age. The mean opening times decreased rapidly from 24 to 30 months and more gradually to 42 months. Then the mean opening times increased slightly at 48 and 54 months of age.

Children wearing all the clothing sizes were able to manipulate hook and loop fasteners.

Conventional Zipper

The children were able to close and open the conventional zipper at 24 months of age. Their mean closing and opening times were 21.87 and 17.70 seconds, respectively, at this age. The mean closing and opening times decreased most rapidly before 42 months. After that, the times remained relatively constant.

The children in all the size classes were able to close and open the conventional zipper.

Large Zipper

Most children were able to close and open the large zipper. The mean closing and opening times at 24 months of age were 12.00 and 4.18 seconds, respectively. The children's mean closing and opening times decreased rapidly between 24 and 36 months, and leveled off after 42 months of age.

Children wearing all the clothing sizes were able to manipulate the large zipper.

Separating Zipper

Although children started opening separating zippers at 24 months, most could not close them before 48 months. At this age, their mean closing time was 10.61 seconds and their mean opening time was 3.48 seconds. The mean closing times decreased through a series of steps, with the drops occurring from 24 to 30 months and 42 to 48 months of age. The mean opening times showed a steady decrease with increasing age, with the exception of a peak at 48 months.

Fifty percent of the children were not able to assemble the separating zipper until they wore size 5 clothing.

Hypotheses Testing

Hypothesis 1

In testing the first hypothesis, the logistic multiple regression model was fitted to (1) the closing data, (2) the opening data, and (3) the closing and opening data for each fastener. Caution must be

taken, however, in evaluating the results for the hook and loop fasteners, conventional zippers, and large zippers. As over 90% of the children were able to manipulate these fasteners, the variability in the dependent variable was not large enough to obtain reliable coefficients for the logistic equation. The confidence intervals obtained in such cases are often too large to have meaningful value. (See Appendix J for logistic equation values.)

The tests of the logistic coefficients, at the .05 significance level, indicated that older children close and open all of the fasteners better than younger children. When closing ability was tested separately, age was again significant for all of the fasteners. But when opening ability was tested separately, age was only significant for the 1 cm buttons, 2 cm buttons, and separating zipper.

The tests for the first hypothesis also calculated the predicted probabilities and confidence intervals for the children's ability to manipulate each fastener (See Appendix K). The predicted probabilities of closing and opening the fasteners are presented in Table 6. These predicted probabilities were plotted as continuous functions between 0 and 1 for the age range tested (See Appendix L). By using the "logistic transformation of the probability p" equation (Appendix I), the predicted percentages shown in Table 7 were obtained.

These percentages indicate the age spans in which most normal children will learn to manipulate specific fasteners. Eighty percent of boys and girls learn to manipulate 1 cm buttons between 39.6 and 53.6 months, and 32.1 and 46.1 months of age, respectively. Eighty percent of boys and girls learn to manipulate 2 cm buttons between 33.5 and 47.5 months, and 27.8 and 41.8 months of age, respectively.

Table 6

Predicted Probabilities of Closing and Opening Fasteners by Fastener, Sex, and Age

Fastener	Sex	Age in Months					
		24	30	36	42	48	54
1 cm Buttons	Boys	0.0008	0.0054	0.0346	0.1907	0.6079	0.9107
	Girls	0.0087	0.0544	0.2746	0.7135	0.9425	0.9908
2 cm Buttons	Boys	0.0057	0.0361	0.1975	0.6181	0.9141	0.9859
	Girls	0.0330	0.1834	0.5962	0.9066	0.9846	0.9976
Hammer-on Snaps		0.0110	0.0611	0.2760	0.6905	0.9289	0.9463
Hook and Loop Fasteners		0.5739	0.8691	0.9703	0.9938	0.9673	0.9997
Conventional Zipper		0.5659	0.9303	0.9927	0.9993	0.9999	1.0000
Large Zipper		0.5785	0.9614	0.9978	0.9999	1.0000	1.0000
Separating Zipper		0.0142	0.0477	0.1485	0.3775	0.6784	0.8801

Note. Values derived from LOGIST procedure.

Table 7

Predicted Age (in Months) of Closing and Opening Fasteners By 10 to 90% of Children

Fastener	Sex	Percent				
		10	25	50	75	90
1 cm Buttons	Boys	39.5	43.1	46.6	50.1	53.6
	Girls	32.1	35.6	39.1	42.6	46.1
2 cm Buttons	Boys	33.5	37.0	40.5	44.0	47.5
	Girls	27.8	31.3	34.8	38.3	41.8
Hammer-on Snaps		31.8	35.5	39.3	43.0	46.7
Hook & Loop Fasteners		--	--	(22.9)	27.0	31.1
Conventional Zipper		--	--	(23.3)	26.2	29.0
Large Zipper		--	--	(23.3)	25.6	27.9
Separating Zipper		33.8	39.1	44.4	49.7	(55.0)

Note. Values calculated by using the "logistic transformation of the probability p" equation and solving for age (See Appendix I).

( ) Extrapolated values.

Eighty percent learn to manipulate hammer-on snaps between 31.8 and 46.7 months and separating zippers between 33.8 and 55.0 months of age. Finally, ninety percent can manipulate hook and loop fasteners by 31.1 months, conventional zippers by 29.0 months, and large zippers by 27.9 months of age.

Hypothesis 2

The tests of regression coefficients applied to the manipulative data to test Hypothesis 1 also tested Hypothesis 2. These results indicated that, at the .05 significance level, girls are better than boys at (1) closing, (2) opening, and (3) closing and opening 1 cm and 2 cm buttons. There were no significant differences between boys' and girls' abilities to manipulate the other fasteners.

Figures 2 and 3 show the children's predicted probability of closing and opening 1 cm and 2 cm buttons. Figure 2 indicates that 24 month old boys and girls cannot manipulate 1 cm buttons. Girls start manipulating 1 cm buttons first and, by 54 months, boys' and girls' abilities to manipulate 1 cm buttons start to converge. The discrepancies are not as great for 2 cm buttons. As Figure 3 indicates, 24 month old girls have already started to manipulate 2 cm buttons. However, the boys' ability to manipulate 2 cm buttons remains nearer to the girls' ability and, by 54 months, both abilities are approximately the same.

Hypothesis 3

The confidence intervals for the predicted probabilities, obtained from the logistic tests for Hypothesis 1, were compared and plotted to test Hypothesis 3. The results indicated that there are

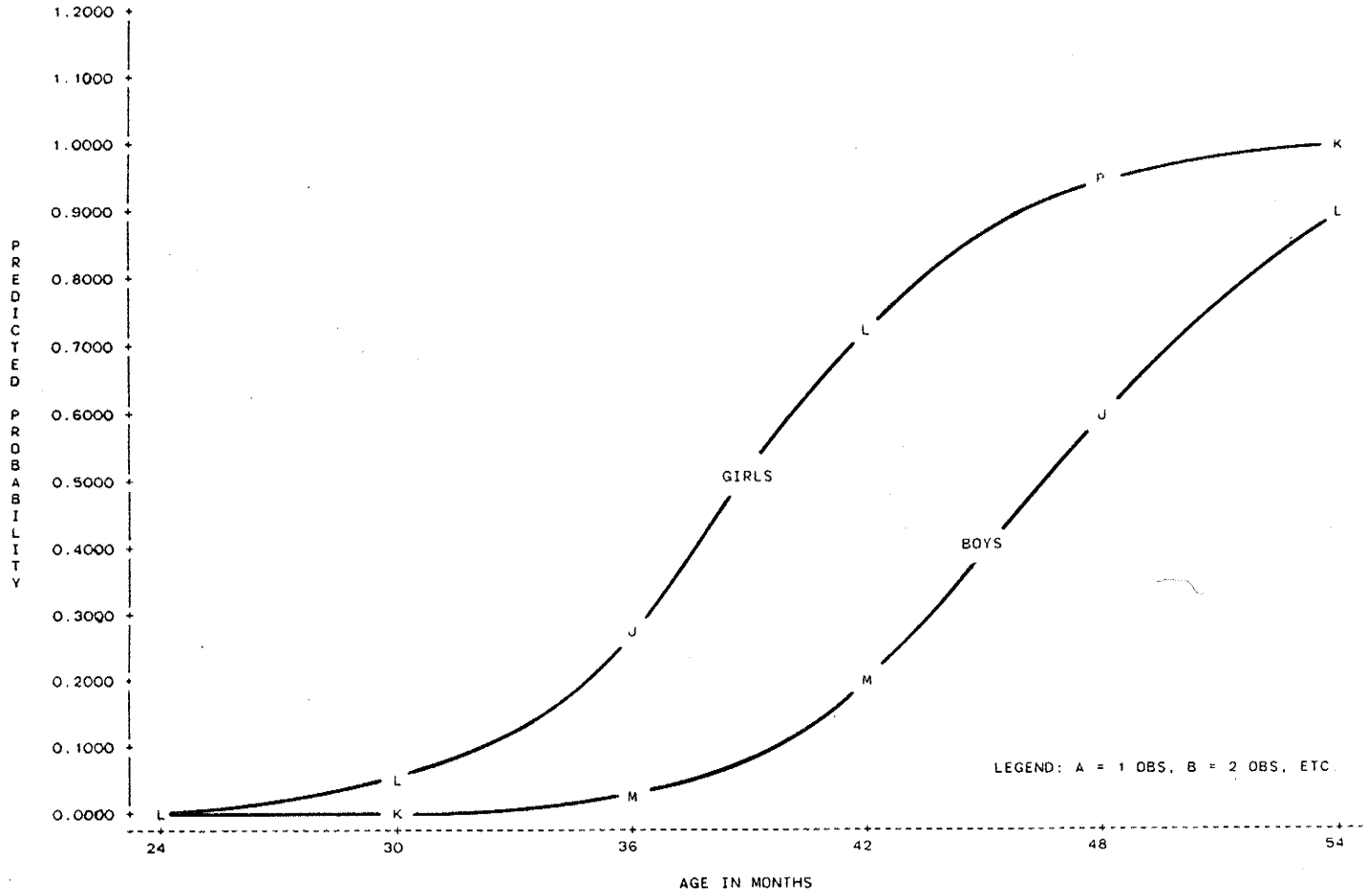

Figure 2

Predicted Probability of Closing and Opening 1 cm Buttons

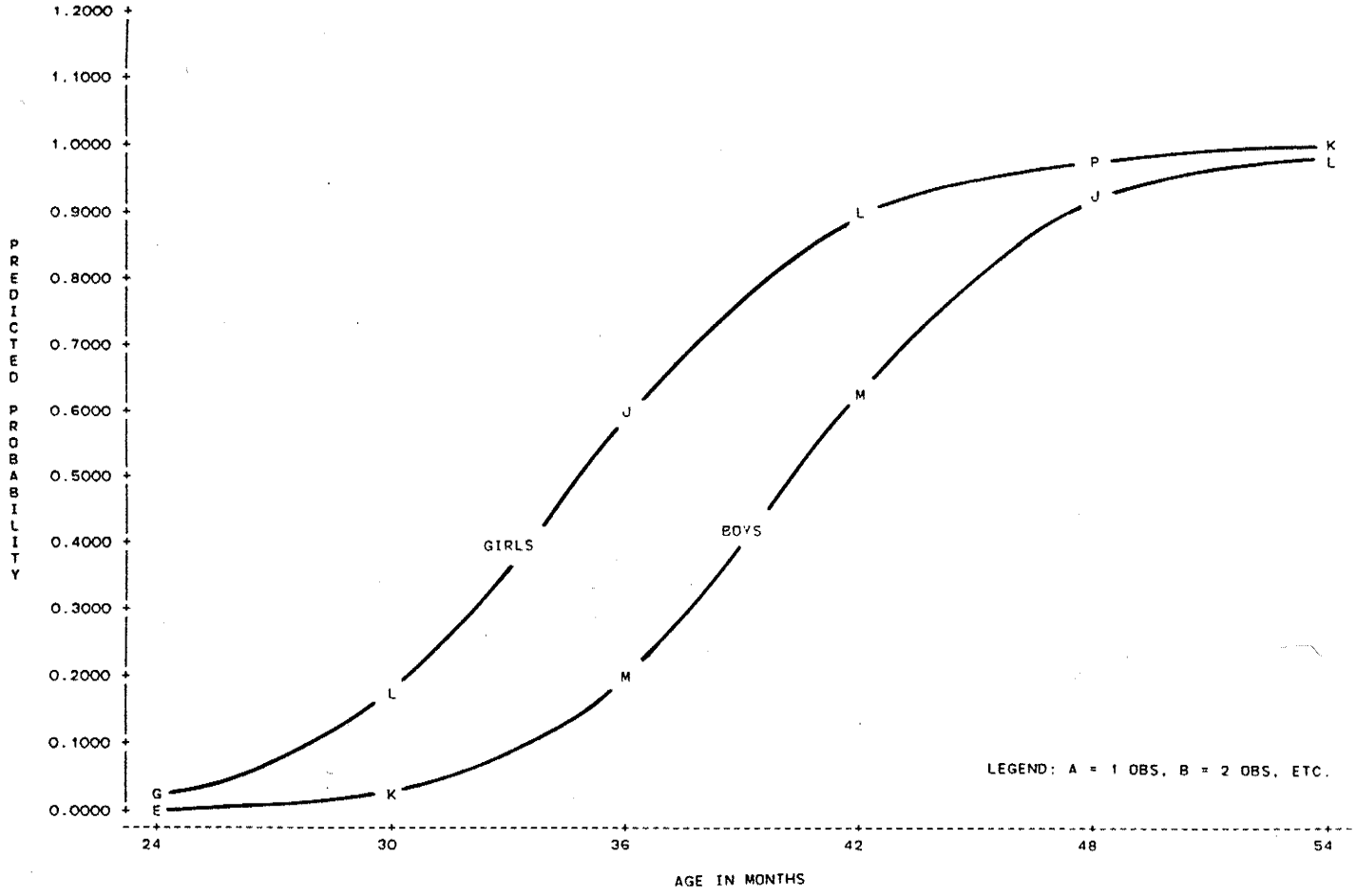

Figure 3

Predicted Probability of Closing and Opening 2 cm Buttons

generally no differences, at the .05 significance level, between preschool children's abilities to manipulate two sizes of buttons or zippers. However, exception must be made for boys between the ages of 36 and 54 months. These boys found 2 cm buttons easier to open than 1 cm buttons. The differences were large enough that, when closing and opening abilities were evaluated together, 42 month old boys still displayed a difference in their ability to manipulate the two button sizes. (See Appendix N.)

The graphs of the confidence intervals for predicted probability also display the relative difficulty of the fasteners for the children in each age group. For instance, Figure 4 shows that 1 cm buttons, 2 cm buttons, hammer-on snaps, and separating zippers pose similar difficulties to 24 month old children. Likewise, hook and loop fasteners, conventional zippers, and large zippers are equally easy for 24 month old children. The graphs change as the children's ages and abilities increase (See Appendix M). Thus, Figure 5 illustrates how buttons, snaps, and separating zippers have become relatively easier for 54 month old children to manipulate.

Hypothesis 4

To test the fourth hypothesis, the logistic multiple regression model was fitted to the closing and opening data for the waistline and neckline fasteners, and the confidence intervals obtained were compared and plotted. However, caution must be used in interpreting the analysis for the waistline hook and loop fastener. As over 90% of the children were able to manipulate this fastener, the variance in the dependent variable was not sufficiently large to obtain

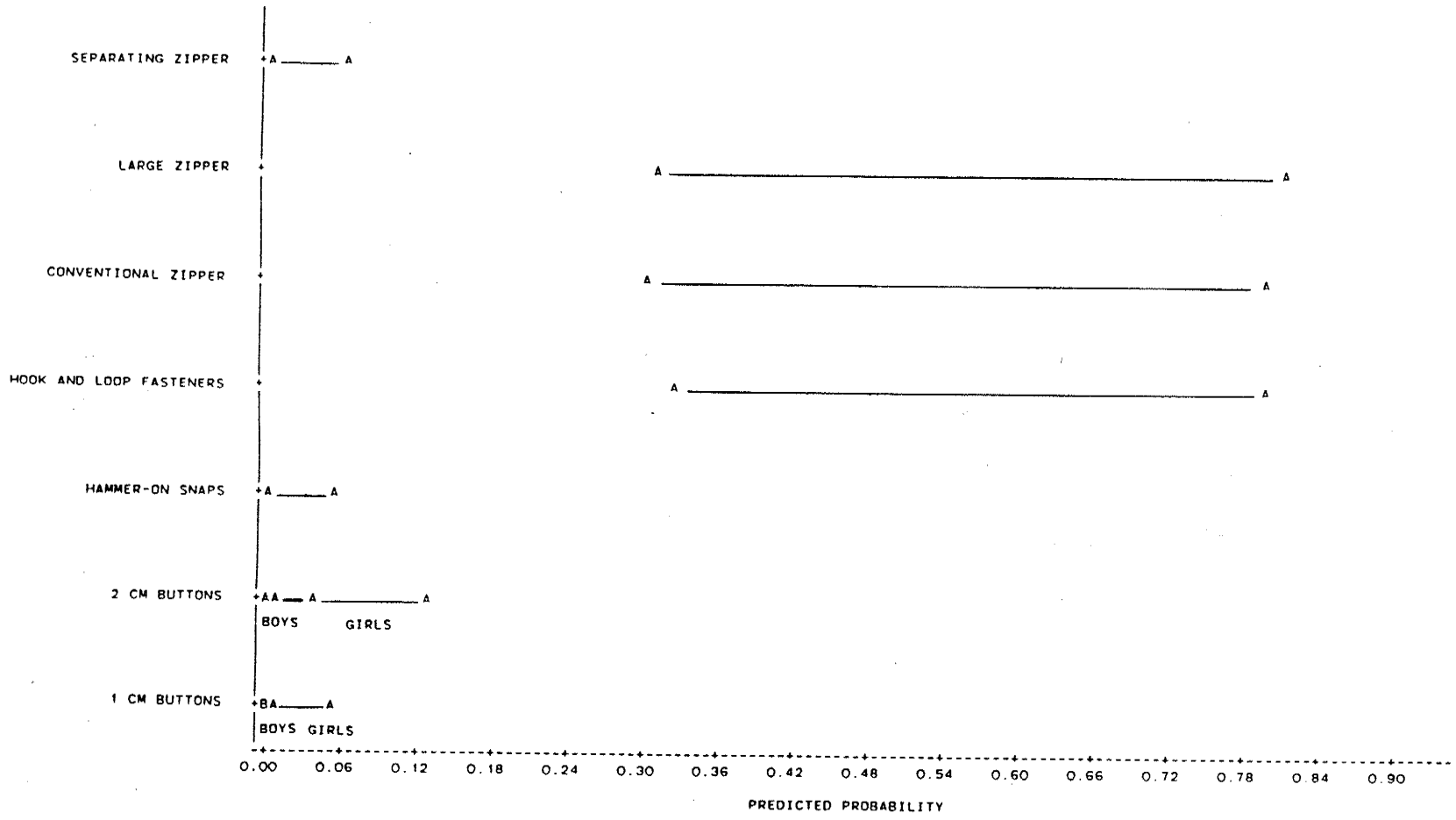

Figure 4

Confidence Intervals for Predicted Probabilities of 24 Month Old Children Closing and Opening Fasteners

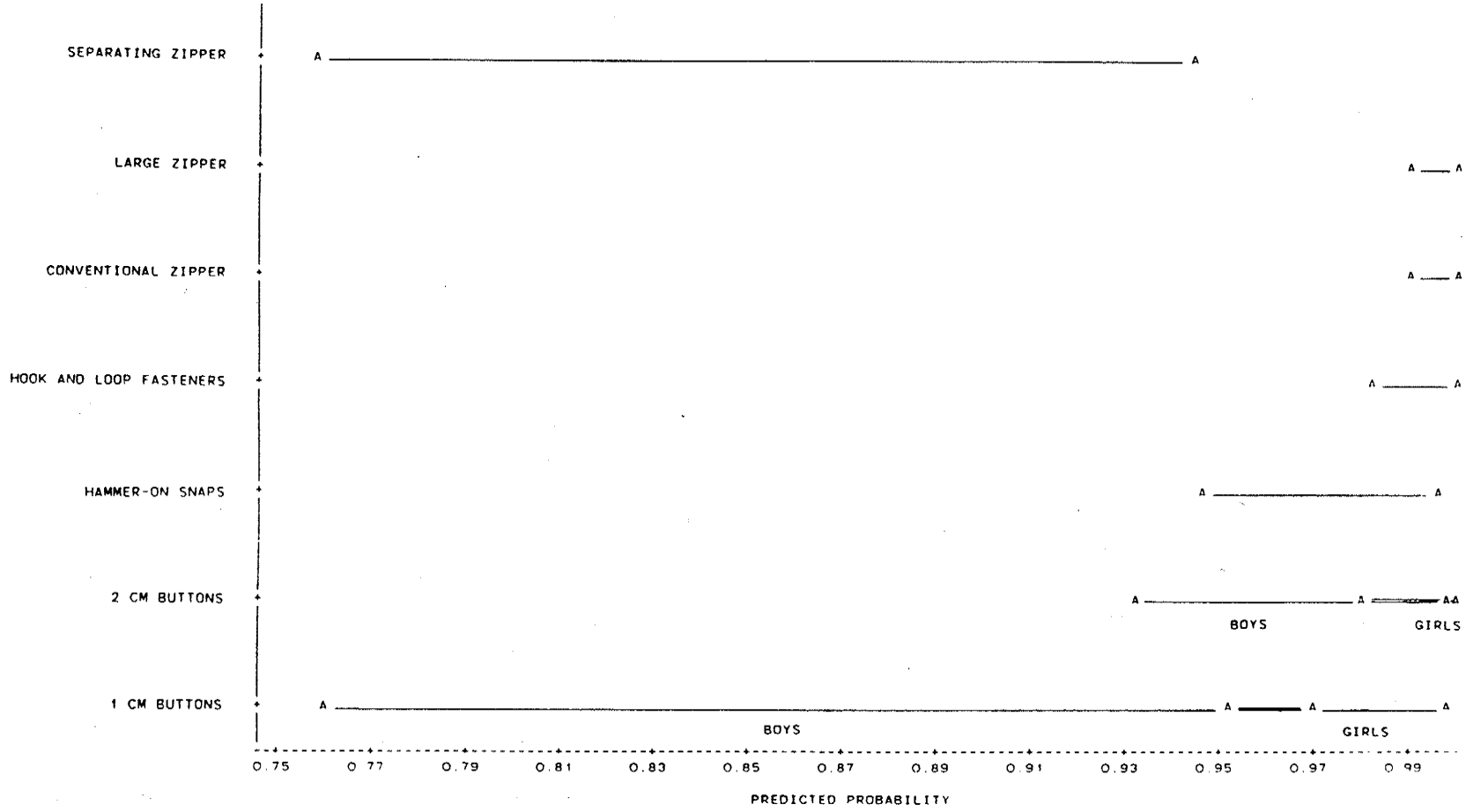

Figure 5

Confidence Intervals for Predicted Probabilities of 54 Month Old Children Closing and Opening Fasteners

reliable coefficients for the logistic equation (See Appendix O).

The overall results indicate that fastener position sometimes effects preschool children's manipulative ability. There is no difference at the .05 significance level in (1) the children's ability to manipulate waistline and neckline 1 cm buttons, (2) the girls' ability and the 24 to 36, and 54 month old boys' ability to manipulate 2 cm buttons, (3) 24 to 30 month old children's ability to manipulate hammer-on snaps, and (4) the children's ability to manipulate hook and loop fasteners. Thus, the neckline position is only significantly more difficult than the waistline position for 42 to 48 month old boys manipulating 2 cm buttons and for 36 to 54 month old children manipulating hammer-on snaps (See Appendix S).

Chapter VI

DISCUSSION AND IMPLICATIONS

The data obtained in this study reiterate that different clothing fasteners present varying degrees of manipulative difficulty and that various factors may influence a child's manipulative abilities. The data also indicate which fasteners a child should be able to manipulate at each age, and provide a basis for self-help fastener recommendations. This information can help caregivers, educators, clothing designers, and clothing manufacturers in teaching fastener manipulation, evaluating children's development, and providing self-help clothing.

The discussion and interpretation of the results will follow the same outline as the results chapter.

Task Manipulation Sequences

Success Rates

The task sequences were recorded to test whether factors such as fatigue or learning affected the children's manipulative abilities. The independence of the success rates on the first two and last two tasks performed seems to indicate that the task sequences did not affect the children's manipulative ability. This implies that the random sequencing of the fastening tasks eliminated test bias.

Unfastening Orders

The orders the children selected to open the four fasteners on the 1 cm button, 2 cm button, hammer-on snap, and hook and loop fastener vests were recorded as an indication of position preference.

The tabulations coincide with the researcher's observation that younger, less proficient children automatically reached for the middle fasteners. These children often had protruding abdomens which made the middle fasteners more visible than the waistline or neckline fasteners. However, as the children's manipulative proficiency increased with their age, they would save motions by systematically moving from one fastener to another.

Wagoner and Armstrong (71), Zaccagnini (77), and Bynum (14) have indicated that the vertical position of a fastener determines its visibility, manipulative ease, and manipulative preference. Wagoner and Armstrong, in particular, reported that lower positioned fasteners were easier to manipulate than higher positioned fasteners. However, this research's findings would imply that body shape and manipulative development also contribute to visibility, manipulative ease, and manipulative preference.

Manipulative Data

Several general observations were made while conducting the fastening tests. First, many 24 and 30 month old children were not familiar with fastening activities and needed the demonstrations of the fasteners' operations. The researcher felt that these children's manipulative abilities were often greater than those displayed in their "first" fastening attempts. Second, children about 48 or 54 months old often analysed the fastening tasks, breaking them into component parts and performing these as separate operations. Third, a child could sometimes perform one element of a task but not another. For instance, one child might correctly align the hammer-on snaps, but might not have the strength to engage them. Another child might

display the strength, but might not be able to align the snap segments. These observations imply that familiarity, perception, and development of component skills influence children's manipulative performance.

1 cm Buttons

Generally, the buttons presented problems of task comprehension, alignment, and dexterity. The youngest children often did not understand the buttons' operation. As this problem eased, the children seemed to have difficulty with alignment and, finally, with dexterity. Their fingers could not isolate the buttons and buttonholes from the surrounding fabric.

The decrease with age in the boys' mean fastening times indicates an increased skill in performing the task.

Overall, the girls' mean fastening times also indicate that girls' buttoning skills improve as they grow older. The leveling effect between 36 and 42 months in the opening times occurred as more girls learned how to perform the task. The drops in mean opening times occurred as the girls gained fastening proficiency.

The boys' fastening abilities according to clothing size imply that 1 cm buttons are not suitable for boys' clothing, sizes 2-6X. The girls' results imply that 1 cm buttons may be used on girls' clothes, sizes 4-6X, but should be avoided on clothes, sizes 2-3X.

2 cm Buttons

The decreases with age in the boys' and girls' mean fastening times indicate that their fastening skills were increasing as they grew older. Their manipulative results by clothing sizes imply that

2 cm buttons should be avoided on toddlers' clothes, sizes 2-3X, and may be cautionsly used on children's clothes, sizes 4-6X.

Hammer-on Snaps

The researcher observed that many children had difficulty in either aligning the snap segments or in pushing them together. The alignment difficulties were caused by a lack of eye-hand coordination and the engagement difficulties were caused by a lack of hand strength. These problems imply that component fastening skills may require differing degrees of maturation or development, and that children may differ in their mastery of component skills.

The decrease with age in the children's mean closing times indicates increasing fastening ability. The sharp drop in mean opening time between 30 and 36 months of age may be attributed to an increased comprehension of the task. Otherwise, the mean opening times also indicate that fastening skills increase with age.

The fact that 50% of the children could not close hammer-on snaps until they wore size 4 clothing implies that hammer-on snaps should not be used on toddlers' clothes, sizes 2-3X, but may be used on children's clothes, sizes 4-6X.

Hook and Loop Fasteners

The researcher observed that many children were not familiar with hook and loop fasteners and took a while to understand their operation. At 24 months, the children simply mimicked the researcher's motions, and incidentally manipulated the fasteners without comprehending their actions. At 30 months, the children thought through the task and attempted to correctly align the fastener segments.

This task analysis at 30 months of age caused a long mean closing time. Otherwise, the mean closing times indicated increased skill with increased age. The mean opening times decreased rapidly between 24 and 30 months as the children learned to understand the directions they were given. The mean opening times increased slightly as the 48 and 54 month old children broke the opening procedure into four separate tasks rather than one pulling motion.

Because children wearing all the clothing sizes were able to manipulate hook and loop fasteners, this fastener would be appropriate for self-help clothing.

Conventional Zipper

The children had some difficulty in holding the small zipper tab securely enough to pull it. Their fingers would slip off, and they would have to regrasp the tab. This happened more often in opening than in closing the zipper. As the children grew older, their finger strength increased and this problem diminished.

The stabilization in mean fastening times after 42 months of age indicates that the children had gained proficiency in manipulating the conventional zipper. The children's ability to manipulate this zipper, regardless of their clothing size, implies that conventional zippers can be recommended for toddlers' and children's self-help clothing.

Large Zipper

The larger zipper tab on the large zipper made grasping easier than the tab on the conventional zipper. The leveling of the mean fastening times after 42 months of age indicated that the children

had perfected the task. The ability of the children in each size class to manipulate the large zipper implies that it can be recommended for toddler's and children's clothes.

Separating Zipper

The opening of the separating zipper was usually performed as a continuous downward pull which automatically separated the zipper segments. However, closing required the sequential or concurrent operation of several tasks. Difficulty was usually experienced in either inserting the pin into the slide and pocket or in starting the zippering operation. The children often failed to hold the inserted garment side down while pulling on the zipper tab, with the result that the zipper disengaged itself.

The drops in mean closing times from 24 to 30 months and 42 to 48 months may be attributed to some children perfecting their skills. The steps occurred as more children learned how to manipulate the separating mechanism. The 48 month peak in mean opening time may be attributed to the tendency of 48 month old children to analyse the task, breaking it into unzipping and disassembling activities rather then performing it as one pulling motion.

The inability of children wearing sizes 2-4 to assemble the separating zipper implies that this fastener may not be appropriate for toddlers' clothing, but can be cautiously used on children's clothes.

Overall, the manipulative results for each clothing size seem to indicate (1) that hook and loop fasteners, conventional zippers, and large zippers are suitable for toddlers' self-help clothes, sizes 2-3X, (2) that 2 cm buttons, hammer-on snaps, and separating zippers

can be used on children's clothes, sizes 4-6X, and (3) that 1 cm buttons should only be used on girls' garments in the children's size range. However, the manipulative findings for each clothing size must be carefully evaluated because the subjects studied were not selected to represent clothing sizes. Thus, these manipulative findings cannot dictate the recommended fasteners for specific clothing sizes, but can only imply manipulative trends which clothing manufacturers may consider in producing toddlers' and children's fashions. The final responsibility for selecting self-help clothing will still rest on each child's caregivers: They must select clothing with fasteners suitable for the child's age and manipulative ability.

Hypothesis Testing

Hypothesis 1

> There is no significant relationship between age and ability to manipulate clothing fasteners among preschool children, at six month age intervals from 24 to 54 months.

The hypothesis testing indicated that age affected the children's ability to (1) close and open all of the fasteners, (2) close all of the fasteners, and (3) open 1 cm buttons, 2 cm buttons, and separating zippers. Thus Hypothesis 1 can be rejected for these fasteners and fastening situations. However, Hypothesis 1 cannot be rejected for the opening of hammer-on snaps, hook and loop fasteners, conventional zippers, and large zippers. These opening tasks were so easy that any child who understood the task was able to perform it.

These findings generally agree with the Gesell (& Ilg, 29) and the Wagoner and Armstrong (71) results which indicated that children's ability to perform fastening tasks increase with their age. This

study does qualify, though, that age is not significant for opening hammer-on snaps, hook and loop fasteners, conventional zippers, and large zippers.

The predicted ages at which most normal children learn to manipulate specific fasteners may be used as guidelines for fastener introduction and for detection of abnormal development. Individual children may be successfully introduced to specific fasteners at any time within the predicted age span for learning the fastener's manipulation. Conversely, if a child repeatedly cannot master the fasteners within the predicted age spans, the child may have developmental problems. Developmental testing by qualified specialists may identify the cause of the deviant behavior and may enable assistance to be supplied.

The predicted ages for fastener manipulation also indicate which fasteners are better for each age level's clothing: Fasteners which are manipulated by at least 75% of the children at an age level can be recommended for their self-help clothing as most children will be able to manipulate the fasteners independently and as the others may need exposure in order to learn the fastener's manipulation. Using this criteria, no fasteners would be recommended for 24 month old children. Hook and loop fasteners, conventional zippers, and large zippers would be recommended for 30, 36, and 42 month old children. As well, girls 42 and 48 months old could have 2 cm and 1 cm buttons, respectively, on their garments. At 48 months of age, the children would be able to manipulate 2 cm buttons and hammer-on snaps. Finally, at 54 months, 1 cm buttons and separating zippers could be recommended for all the children's self-help clothing. These recommendations are presented in Table 8.

Table 8

Fasteners Recommended for Self-Help Clothing By Age

Age in Months	Fasteners						
	1 cm Buttons	2 cm Buttons	Hammer-on Snaps	Hook and Loop Fasteners	Conventional Zipper	Large Zipper	Separating Zipper
24							
30				X	X	X	
36				X	X	X	
42		(Girls)		X	X	X	
48	(Girls)	X	X	X	X	X	
54	X	X	X	X	X	X	X

Note. The criteria used was that 75% of the children at an age level should be able to manipulate the fastener. An "X" means that both sexes were able to close and open the fastener, while "(Girls)" means that only girls met the manipulative criteria.

Hypothesis 2

> There is no significant difference between the fastener manipulative abilities of preschool boys and girls of the same age level.

The results of the hypothesis testing indicated that Hypothesis 2 should be rejected for buttons, but should not be rejected for the other fasteners. The qualification that sex differences are only significant for buttoning tasks implies that boys and girls have similar abilities in manipulating hammer-on snaps, hook and loop fasteners, and zippers. This may contradict the commonly held assumption that girls are better at fine motor tasks than boys, or it may suggest that other types of skills are as important as fine motor skills in manipulating clothing fasteners.

The study's findings agree with Gesell, Wagoner and Armstrong, and Bynum's findings on sex differences in buttoning abilities. Gesell (& Ilg, 29) and Wagoner and Armstrong (71) reported that girls begin to manipulate buttons earlier than boys. However, Bynum (14) did not find any sex differences in the abilities of her subjects whose ages were between 4 years, 8 months and 5 years. This study would substantiate that girls begin buttoning and unbuttoning earlier than boys, and that this sex difference becomes minimal after 54 months of age (4 years, 6 months).

Hypothesis 3

> There is no significant difference in the ability of preschool children of the same age level to manipulate two sizes of the same fastener.

The hypothesis testing indicated that there are generally no significant differences in preschool children's abilities to manipulate

two sizes of buttons or zippers. Thus, Hypothesis 3 cannot be rejected for most buttoning and zippering situations. However, the hypothesis should be rejected for 36 to 54 month old boys' abilities to open different sized buttons, as they found 2 cm buttons easier to open than 1 cm buttons.

The simplest explanation for this difference in manipulative abilities is that the boys may have found the large buttons easier to grasp. Another explanation might be that opening the 2 cm buttons required less wrist rotation that opening the 1 cm buttons. However, neither of these explanations indicates why the manipulative difference is not evident in the boys' closing abilities.

The manipulative findings for fastener size both support and contradict previous research. Wagoner and Armstrong, Bynum, and Johnson (71, 14, 42) recommend button sizes between 1/2 and 1 inch. Likewise, Bernhardt and Zaccagnini (5, 77) recommend large zippers and large zipper tabs. This study agrees that button size may influence 36 to 54 month old boys' ability to open buttons, but states that in other situations button size has no effect on preschool children's fastening abilities. This research also contradicts the previous zipper recommendations by stating that neither zipper size nor zipper tab size has a significant effect on children's ability to close and open zippers.

Hypothesis 4

> There is no significant difference in the ability of preschool children of the same age level to manipulate fasteners positioned at the center front waistline or center front neckline.

The results of the hypothesis testing indicated that Hypothesis 4 should be rejected for (1) 42 to 48 month old boys manipulating waistline and neckline 2 cm buttons, and (2) 36 to 54 month old children manipulating waistline and neckline hammer-on snaps. The results also indicated that Hypothesis 4 should not be rejected for the other fastener, position, or subject combinations.

The lack of difference in the children's ability to manipulate waistline and neckline 1 cm buttons may be caused by the difficulty of manipulating these buttons. By the time the children develop sufficient finger dexterity to manipulate the waistline button, they have the manipulative capacity to also manipulate the neckline button.

The waistline and neckline 2 cm button results were only significantly different for 42 and 48 month old boys. This reflects the boys' developing buttoning skills: As 24 to 36 month old boys were not able to manipulate either button position and 54 month old boys were able to manipulate both, the significant difference occurred while the boys were learning to manipulate 2 cm buttons. This difference reveals that the waistline button position was easier to manipulate before the boys had gained proficient buttoning skills.

The hammer-on snap findings also reflect the children's developing skills. No significant difference was evident in 24 and 30 month old children's ability to manipulate the waistline and neckline snaps because they were not able to manipulate either. However, between 36 and 54 months of age, the children displayed a greater ability to close and open the waistline snap. The manipulative difficulty of the neckline hammer-on snap was caused by a lack of

visibility, displayed in an inability to align the snap segments, and an absence of a firm surface to push the snap against.

Finally, no significant difference was evident between waistline and neckline hook and loop fasteners because of this fastener's manipulative ease: Most of the children were able to manipulate the hook and loop fasteners in both positions.

The findings for the fourth hypothesis are in qualified agreement with other researchers' findings. Zaccagnini (77) reported that neckline fasteners were difficult for children because the fasteners were not visible and lacked a firm background surface. Wagoner and Armstrong (71) indicated that lower buttons were easier to button than higher ones. Bynum (14) simply assumed that children would have difficulty with neckline fasteners, and positioned her top fastener 6 inches below the neck. This research indicates that neckline fasteners create problems for children whose manipulative skills for the fastener are still being developed. But when the children gain fastening proficiency, the vertical position of the fastener does not affect their manipulative performance.

In answer to which fasteners a child should be able to manipulate at each age, this study would indicate that (1) 90% of boys manipulate 1 cm buttons at 53.6 months and 2 cm buttons at 47.5 months of age, (2) 90% of girls manipulate 1 cm buttons at 46.1 months and 2 cm buttons at 41.8 months of age, and (3) 90% of children manipulate large zippers at 27.9 months, conventional zippers at 29.0 months, hook and loop fasteners at 31.1 months, hammer-on snaps at 46.7 months, and separating zippers at 55.0 months of age. This study concludes

that age significantly affects preschool children's ability to manipulate fasteners, that sex only affects children's buttoning abilities, that fastener size only affects boys' unbuttoning abilities, and that fastener position affects children who are developing fastening skills. Table 9 summarizes Gesell, Wagoner and Armstrong, Bynum, and this study's conclusions for the affects of age, sex, fastener size, and fastener position on preschool children's fastening abilities.

Table 9

Research Findings for the Variables of Age, Sex, Fastener Size, and Vertical Position

Variable	Research Study			
	Gesell (1920f)	Wagoner & Armstrong (1926-27)	Bynum (1975)	Becker (1983)
Age	Ability increases with age--for buttons	Ability increases with age--for buttons	--	Ability increases with age--for buttons, hammer-on snaps, & separating zippers
Sex	Girls learn to button earlier than boys	Girls learn to button earlier than boys	No difference at 4 yrs, 10 mos.	Girls learn to button earlier than boys. Ability to do other fasteners the same.
Fastener Size	--	3/4 to 7/8 inch buttons best	1 inch buttons best (largest tested)	Size only affects boys unbuttoning.
Vertical Position	--	Lower side buttons easier than higher	--	Only affects children in process of learning fastener manipulation

Chapter VII

SUMMARY

This research study considered the question of the age at which a child should be able to manipulate different types of clothing fasteners. The study attempted (1) to establish the normal fastener manipulative ability of preschool children at six month age intervals from 24 to 54 months, (2) to assess the affects of sex, fastener size, and vertical location of fastener on manipulative ability, and (3) to recommend fasteners for self-help clothing. This research used age and sex of subjects and the type, size, and position of fasteners as independent variables. The dependent variable was the children's ability to manipulate clothing fasteners. The children's clothing sizes were also recorded to aid clothing designers and manufacturers in translating the children's ability to manipulate fasteners into self-help clothing.

One hundred, thirty-two children, 64 boys and 68 girls, from 18 licensed Winnipeg day care centers participated in the study. Of these, 12 were 24 months, 23 were 30 months, 23 were 36 months, 25 were 42 months, 26 were 48 months, and 23 were 54 months of age, plus or minus one month, respectively.

To test the children's fastening ability, two sets of vests in small and large sizes were constructed with 1 cm buttons, 2 cm buttons, hook and loop fasteners, conventional zippers, and large, separating zippers. The fasteners were located on center front openings between the waist and the interclavicular notch. Extra vests were made so

boys and girls could manipulate the fasteners on left or right overlapping closures as is customary.

Testing was conducted in each child's classroom at his/her day care center. Before asking the child to don and fasten each vest, the researcher demonstrated the fastener's operation. The child's fastening time, order, and ability were then recorded as the child performed the task.

The data obtained from the tests were evaluated by descriptive statistics. The hypotheses were tested by fitting the logistic multiple regression model, at the .05 significance level, to the manipulative data, and comparing the resulting confidence intervals.

Contingency table analysis indicated that the sequence in which the children performed the fastening tasks did not appear to affect their manipulative performance. The descriptive results indicated that at least 50% of the 24 and 30 month old children tested were able to manipulate hook and loop fasteners, conventional zippers, and large zippers. At least 50% of the 36 month old children could manipulate hammer-on snaps and the girls could manipulate 2 cm buttons. At 42 months, at least 50% of the boys could manipulate 2 cm buttons and the same percentage of girls were able to manipulate 1 cm buttons. By 48 months, at least 50% of the boys were also able to manipulate 1 cm buttons, and at least 50% of the children were able to manipulate separating zippers. Thus, at least 50% of the children were able to manipulate all the fasteners by 48 months of age.

The older children's ability to close and 'close and open' all of the fasteners was significantly better than the younger children's ability. However, age was not significant for opening hammer-on snaps,

hook and loop fasteners, conventional zippers, and large zippers.

The girls performed significantly better than the boys in (1) closing, (2) opening, and (3) closing and opening 1 cm and 2 cm buttons. Sex did not affect the children's ability to manipulate the other fasteners.

There was generally no significant difference in the preschool children's ability to manipulate two sizes of buttons and two sizes of zippers. The only differences which occurred were for 36 to 54 month old boys, who found 2 cm buttons easier to manipulate than 1 cm buttons.

Fastener position had some affect on the preschool children's manipulative ability. The neckline fastener position was significantly more difficult than the waistline position for boys who were learning to manipulate 2 cm buttons and for children learning to manipulate hammer-on snaps. But when the children gained fastening proficiency, the vertical position of the fasteners did not affect their manipulative performance.

The statistical testing indicated the age spans in which normal children learn to manipulate fasteners. Eighty percent of boys learn to manipulate 1 cm buttons between 39.6 and 53.6 months and 2 cm buttons between 33.5 and 47.5 months of age. Eighty percent of girls learn to manipulate 1 cm buttons between 32.1 and 46.1 months and 2 cm buttons between 27.8 months and 41.8 months of age. Eighty percent of children learn to manipulate hammer-on snaps between 31.8 and 46.7 months and separating zippers between 33.8 and 55.0 months of age. Finally, ninety percent will be able to manipulate hook and

loop fasteners at 31.1 months, conventional zippers at 29.0 months, and large zippers at 27.9 months of age. These findings are illustrated in Figure 6.

This study arbitrarily selected the criteria that 75% of the children in an age level should be able to manipulate a fastener before the fastener could be recommended for their self-help clothing. With this criteria, no fasteners would be recommended for 24 month old children. Hook and loop fasteners, conventional zippers, and large zippers would be recommended for 30, 36, and 42 month old children. Two cm buttons and hammer-on snaps could be added for 48 month old children. As well, 2 cm and 1 cm buttons could be used on garments for girls 42 and 48 months old, respectively. Finally, 1 cm buttons and separating zippers would be recommended for 54 month old children's self-help clothing.

As the children tested had not been selected to represent clothing sizes, no definitive statements can be made on manipulative ability per size. The results do imply, however, that hook and loop fasteners, conventional zippers, and large zippers are the preferred fasteners for toddlers' clothing, sizes 2-3X. Two cm buttons, hammer-on snaps, and perhaps 1 cm buttons and separating zippers may be suitable for children's clothing, sizes 4-6X.

Tabulations of the order the children selected to unfasten the button, snap, and hook and loop fasteners revealed that younger children prefer to open middle fasteners and older children prefer to systematically work from one garment edge to another. The researcher observed that the protruding abdomens of many younger children made the middle fasteners more visible and convenient. Likewise, a

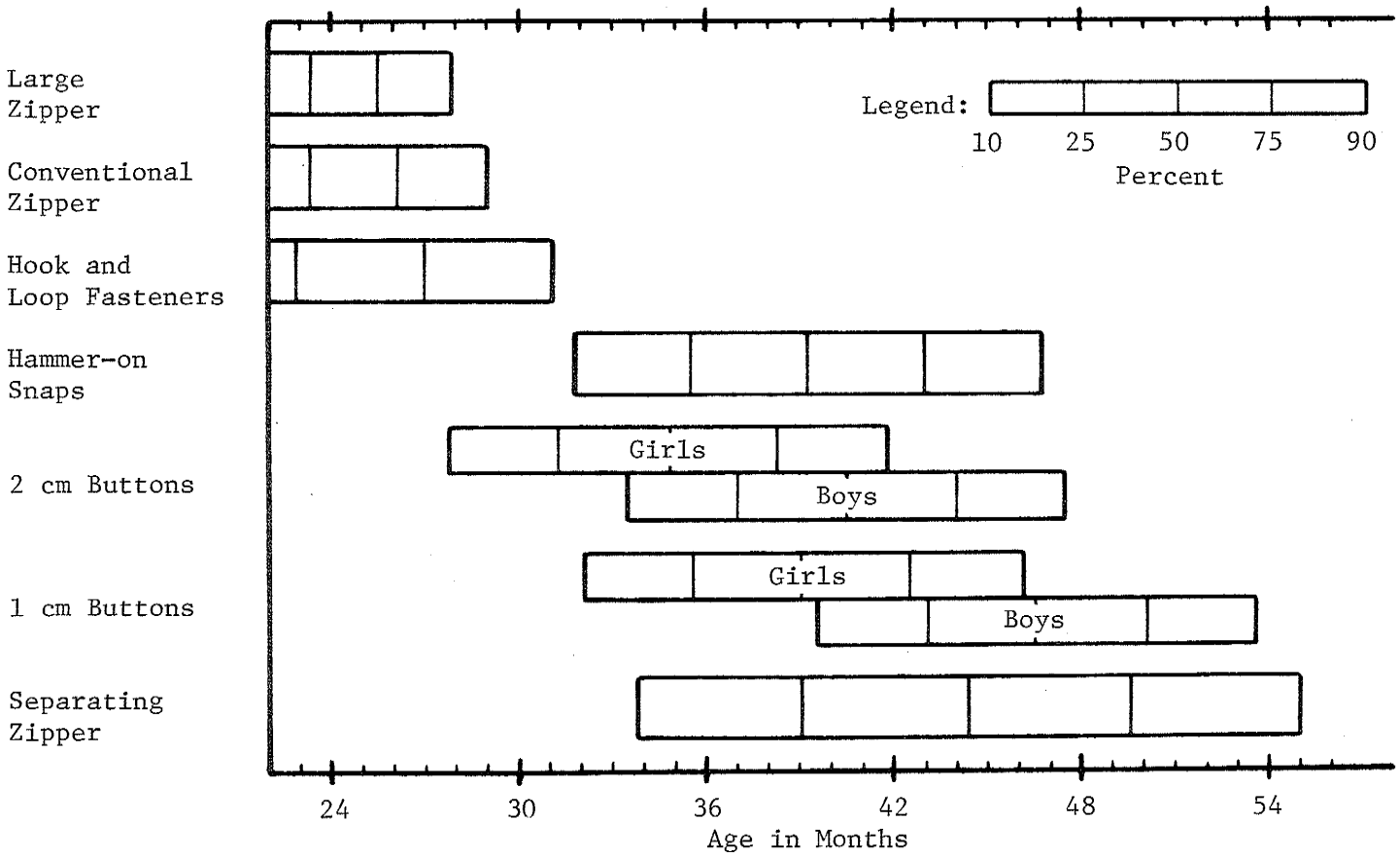

Figure 6

Predicted Age (in Months) of Closing and Opening Fasteners
By 10 to 90% of Children

systematic progression through the fasteners was more efficient for children with fastening proficiency.

The researcher observed that many 24 and 30 month old children were not familiar with fastening activities, and she felt that these children's manipulative capabilities were greater than those displayed. This raises the question of which fastening tasks 24 and 30 month old children could perform if they were shown and encouraged by their caregivers.

Another observation made was that 48 and 54 month old children sometimes analyzed the fastening tasks, breaking them into component elements and performing these as separate operations. This raises the question of how children perceive fastening activities and how their perception affects their manipulative actions.

The researcher also noticed that children often had the ability to perform one element of a fastening task, but could not perform other elements. Perhaps future studies could document component fastening skills, and thus provide insights into children's skill development.

As stated, more information is needed on the effects of familiarity and encouragement on fastening abilities, on children's perception of fastening tasks, and on children's development of component skills. Other research could develop teaching techniques for fastener manipulation or provide reliable data on the manipulative capabilities of children who wear each clothing size. As well, additional research is necessary to verify the manipulative findings and fastener recommendations of this study.

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Appendix A

BUTLER, GOTTS, AND QUISENBERRY'S

FINE MOTOR DEVELOPMENT LEVELS

Butler, Gotts, and Quisenberry's

Fine Motor Development Levels

(Commonly Seen in Children, Aged 3-5 Years)

Level I. At this level, the child pinches with the forefingers and thumb exactly opposing each other, thus permitting exact grasping movements. The child can pick up pins, pills, and other tiny objects, can turn the pages of a book, and begins to cut with safety scissors.

His grasping behavior makes it possible for him to hold a crayon or thick pencil, although he may still grasp it with his fist to control its length. He makes a spontaneous scribble and will imitate a vertical stroke and a horizontal stroke or strokes. This ability also shows his level of hand-eye coordination, as does the picking up of tiny objects.

Hand-eye coordination is further revealed by his skill at taking things apart or putting them back together. For example, he places a wheel back where it belongs on a toy car or properly holds together the parts of a broken doll. He uses a fork and drinks from a glass without assistance. He can rapidly place round pegs into round holes and square pegs into square holes of a pegboard.

The child's visual acuity and form recognition skills are considerably advanced beyond infancy. However, his eye movements are irregular, sweeping, and nonsystematic. He recognizes objects or miniatures of objects and pictures of common objects. He places a square, circle, and triangle in a form board. It is evident from a comparison of these visual perceptual behaviors with his drawing ability that recognition is well ahead of the motor ability to reproduce what is seen. This is

true at all preschool age levels.

The child's manipulative ability is increased by his greater use of wrist motion; he can, for example, turn a door knob. Much of his manipulation is not, however, intended to accomplish some result but is instead an end in itself. That is, he manipulates repetitively in the process of experiencing sensations and is mastering the performance of particular motor actions. Actions of this type include rolling, pounding, pulling, and squeezing clay or other pliable materials; scrubbing paper with a paint brush with no apparent concern for the placement of colors; filling containers with water, sand, or dirt and then emptying them, only to repeat the action; and splashing water and kneading or spreading sand. For these reasons, he prefers action toys like cars and boats.

Although he engages in few constructive activities spontaneously, he may with encouragement or in imitation build a tower of six blocks or an imaginary train of cubes. He will also tightly pack blocks into a box in which they will fit only if they are properly arranged in rows.

His left-right coordination at or across the center or his body has advanced to the point that he can unwrap a small candy or a piece of gum, make an egg beater operate, and imitate the folding of paper.

Level II. At this level, the child uses his pincer much like he did at level I, but he is more likely to use his fingers rather than his whole hand to grip a pencil or crayon. He carries breakable objects without accidents. Control over the fingers permits him to wiggle his thumb while the rest of his hand is fisted.

With pencil or paint brush he experiments with vertical and horizontal lines, dots, and circular motions. Although he may start out by trying to produce a particular form, he quickly shifts into the action of painting or drawing for its own sake. If he is asked to make a more complex figure, such as a cross, he will often make the number of strokes required, thereby showing that he knows visually what is required, but both of his strokes are likely to be horizontal or vertical without any lines crossing. He can copy a vertical line and a horizontal line, which he could only imitate earlier. Copying is more difficult for children than imitating, so it consistently comes later for a comparable form. He can roughly imitate the letters V and H because they involve a combination of strokes which he has mastered or is near to mastering. He can imitate a circle but probably cannot copy one.

Hand-eye coordination is a bit faster and surer than before but no other developments appear. About the same thing can be said for form recognition. He is faster in his performance but is not yet dealing with many new geometric forms. Eye movements are about the same as at level I.

He sometimes gets carried away with the sensory aspects of his play. He may, in fact, paint the table, easel, floor, his own hands, or other children in the excitement of the action. If he paints on paper for a long period of time, little variety will be seen from picture to picture; he will repeatedly complete a very similar drawing. Finger painting interests him more for the manipulation and sensation than for the form of effect produced. Crayons also interest him.

Color discrimination is apparent from his ability to sort objects by color. He makes pies and muffins or cupcakes from sand or dirt, patting and smoothing the contents of the baking utensil.

Considerable advance is evident in the area of construction. His towers may rise to seven or eight blocks in height. When he lines up blocks and pushes them like a train, he will add a block for a smoke stack in imitation. He will place two blocks a small distance apart and put a third block across them to form a bridge, if you demonstrate this. If he fails to accomplish this, he will form a three-block pyramid in the same manner. Some symmetry begins to appear in his spontaneous building with blocks.

He takes apart more complicated things than formerly and tries to reassemble them but may be unable to do so. He unbuttons his clothing in front but cannot yet rebutton it. He is able to dry his own hands. All of these are behaviors which require the hands to meet at or cross the midline of the body.

Level III. At this level, the child is likely to use his fingers to grip a crayon or pencil; however, if he is trying to place a short stick into a hole in an object held in his other hand, he may still use a full fist grip on the stick. By this level, many children can make scissors do what they want them to do--except for following a desired outline. The thumb can be wiggled on a fisted hand on either the left or right side. The thumb can touch at least two of the fingers on the same hand.

Horizontal and vertical strokes are imitated with a greater resemblance of the product to the original model. The child attempts to

make more capital letters, especially those involving horizontal and vertical strokes. Paintings done at the easel are a little more recognizable as pictures. He copies a circle and can draw the head of a person. He is likely to include one other detail on the head--probably the eyes which you may not recognize as such, but he will assure you of what the detail is. He will imitate the horizontal and vertical strokes of a cross with intersection.

Hand-eye coordination is no longer dependent on binocular viewing. With one eye covered, the child can pick up pins and other tiny objects. He can string beads onto a cord or shoestring. He can place tiny pellets into a small-mouthed bottle. The child can discriminate more forms and can visualize which line of a series is longer. His eye movements are only slightly more systematic. He easily sorts black and white objects into piles or containers, and his color discrimination is better for sorting.

Sensory and repetitive aspects of his manipulation are less prominent. He can use a hammer or mallet to drive nails or pegs. Constructive activity is advancing. The child's tower is now nine blocks high. He can build a three-block bridge from a model, so he is less dependent on the imitation of a model's action.

The stringing of beads, which calls for left-right coordination is developing further. Now the child begins to button a coat or dress. The child washes his hands by himself but would not yet be described as being neat at the sink.

Level IV. Further hand control is evident in the child's ability to touch his thumb to each finger on the same hand.

The major fine motor developments at this level occur in hand-eye coordination, particularly in drawing or copying. The child's ability to match or discriminate between more difficult forms increases, and there are further signs of hand-eye coordination. For example, he begins catching a ball in midair. His visual movements over the surface of an unfamiliar object are becoming more rapid and systematic, and they are less likely to drift away from what he is inspecting. When he draws a person, the face is now more complete, probably containing in addition to the head's outline the eyes, mouth, and nose. A little later two or three additional details will be added to the human drawing. When an incomplete man is presented, the child adds three or more completing features. He can copy capital letters involving circular forms. He will print the first letter of his first name and will try to print simple words. The child does free drawings with pencil or crayon. He draws a simple house. He copies a cross, square, star, left diagonal, right diagonal, and puts the two diagonals into an X-shaped cross by copying.

Sensory aspects of fine motor activity are much less prominent and have virtually disappeared in some children. Finger exploration is likely to be used in conjunction with visual searching to examine something new--so touch is being used to gain information rather than in a repetitive sensory action. The child will attempt more challenging forms of constructive play with Lego blocks or other available materials. A tower of ordinary finger blocks is now ten or more blocks high. He will build a six-block pyramid in three steps following a demonstration. He will imitate a door or gateway so that a car or other object can pass through.

Left-right coordination progress can be observed in the child's tendency to hold his paper steady with one hand while writing or drawing with the other. He can fold a paper three times following a demonstration.

Level V. The child's hand control is further developed. He can now spread butter on bread. He picks up and drops small pellets into a container very rapidly.

The child copies a triangle, a rectangle with center diagonals, a square and circle which touch at the lower right corner of the square (lower left may be better if the child is using his left hand), three intersecting lines resembling an asterisk(*), and a cross with arrow points at the ends of each arm of the cross. He can trace around a diamond shape. He prints his first name in large and irregular letters. He frequently reverses letters, especially S. He prints the numbers one through five. His free drawings are outlines without shading. When he colors outline drawings, he stays within the lines. Later, he colors right up to the lines, but still no shading is present. He draws a house with door, windows, roof, and chimney. When he draws a person, it is now recognizable by head, body, legs, arms, and facial features. Ten or more total details are present at this level. He adds seven parts to an incomplete man. Cutting with scissors becomes, at about this level, a form of tracing, with the child following the outline of a simple figure while cutting.

More complex forms are correctly matched or placed in a form board. Puzzles have become a favorite activity for some children. The child's visual precision allows him to lace his own shoes and to

catch a ball five inches in diameter. His visual searching of new objects is more rapid and systematic. His eyes seem to estimate the distance between the parts of a figure and move as if to trace a figure's outline.

Before he reaches the degree of mastery described above, the child rough cuts (i.e., approximates the outline) with scissors and follows up by pasting. Thus, within this level, cutting shifts from being a type of constructive play to being an aspect of copying realistic shapes by tracing with the scissors along the outline. At this level, the child can make a three-step pyramid of six blocks from a model; he no longer requires actions to be imitated. Tinker Toys, Lincoln Logs, and other commercially available construction sets become interesting to the child.

The child's left-right coordination permits him to fold paper in a complicated manner to match a particular form. For example, the child can fold a square paper into a triangle, and he can then fold the triangle into a smaller triangle in imitation of a model. He buttons more difficult buttons, such as smaller ones. With a shoelace, he ties a simple knot around a pencil in imitation of a model. Toward the end of this level, the child will tie his shoes in a loose bow.

When his fine motor skills have reached this level, he is essentially ready for the first grade within this area.

Taken from:

Butler, Annie L., Edward Earl Gotts, and Nancy L. Quisenberry. Early Childhood Programs: Developmental Objectives and Their Use (Columbus, Ohio: Charles E. Merrill, 1975), pp. 52-56.

Appendix B

LETTER AND CONSENT FORM

THE UNIVERSITY OF MANITOBA

FACULTY OF HUMAN ECOLOGY
Department of Clothing and Textiles

Winnipeg, Manitoba
Canada R3T 2N2
(204) 474-8137

Dear Parent,

As part of my Master of Science program at the University of Manitoba, I am studying the ability of preschool children to manipulate buttons, snaps, Velcro dots, and zippers. The purpose of the research is (1) to determine the clothing fasteners preschool children can manipulate at six month age intervals from 24 to 54 months, (2) to determine if sex, fastener size, and vertical position influence the fastening ability of children, and (3) to recommend clothing fasteners which would facilitate independent dressing. The information collected will help (1) parents and teachers know what fasteners children should be able to manipulate at each age, (2) parents in choosing clothing, and (3) clothing designers and manufacturers in producing clothes that children can put on by themselves.

Testing will be done in each child's regular classroom at the day care center when the child is in attendance. The child will be asked to open and close six vests with various fasteners located on center front openings. The results will be recorded on coded data sheets and will be kept confidential.

I would appreciate having your child participate in the study. If you are willing, would you please sign the attached consent form and return it to your day care center. You may withdraw your child from the project, or your child may refuse to participate, at any time.

The results of the research should be available within the next school year. Summaries will be distributed to all participating day care centers. You may pick up your copy at that time.

If you have any questions, please call me at 474-8137. If I am not there, leave a message and I will return your call.

Sincerely,

Leola Becker

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CLOTHING FASTENER MANIPULATIVE ABILITY OF PRESCHOOL CHILDREN

Clothing Research Project

CONSENT FORM

As a parent, I have been informed that the purpose of this research is (1) to determine the clothing fasteners preschool children can manipulate at six month age intervals from 24 to 54 months, (2) to determine if sex, fastener size, and vertical position influence the fastening ability of children, and (3) to recommend clothing fasteners which would facilitate independent dressing.

I understand that my child will be asked to open and close the clothing fasteners on six vests, and that my child's ability will be recorded on coded data sheets.

I am aware that the information about my child will be kept confidential. I also understand that I can withdraw my child from this project, or my child can refuse to participate, at any time.

I consent to have my child participate in this research:

Child's name: _____

Birthdate: _____ Sex: _____

Size (of most of his/her clothing): _____

Parent's
Signature: _____ Date: _____

Appendix C

TESTING VESTS' DESIGNS

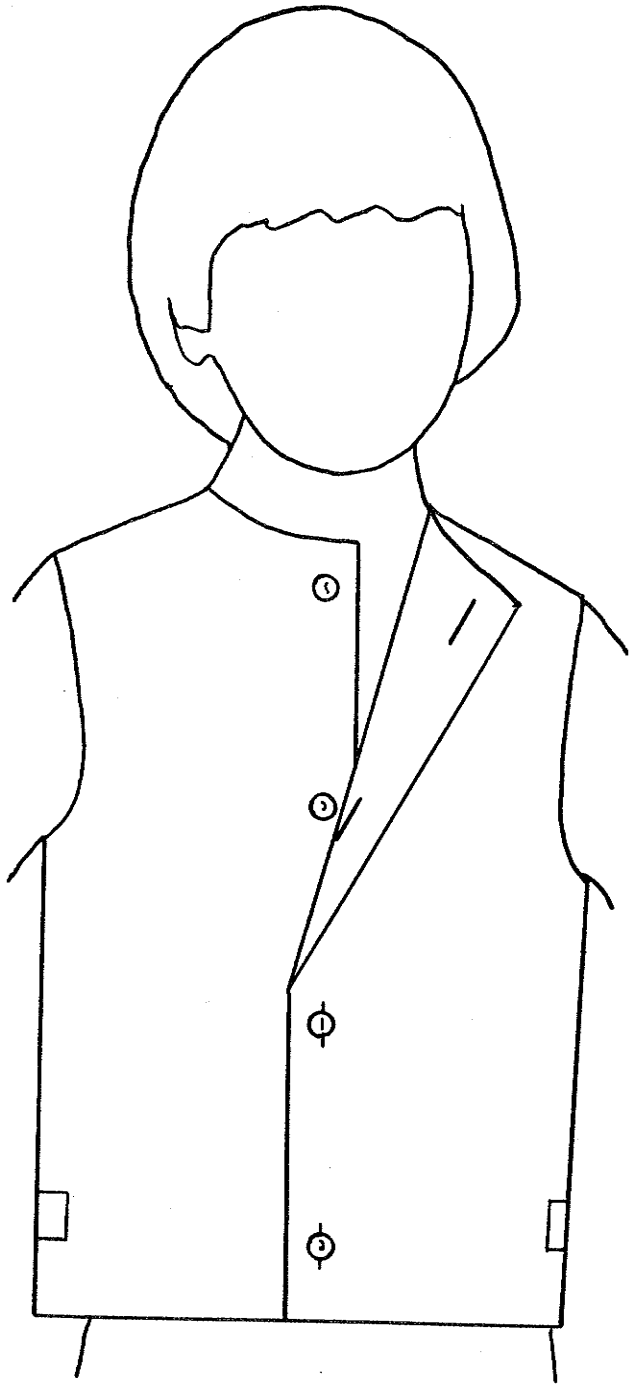

Figure 7

1 cm Button Vest Design

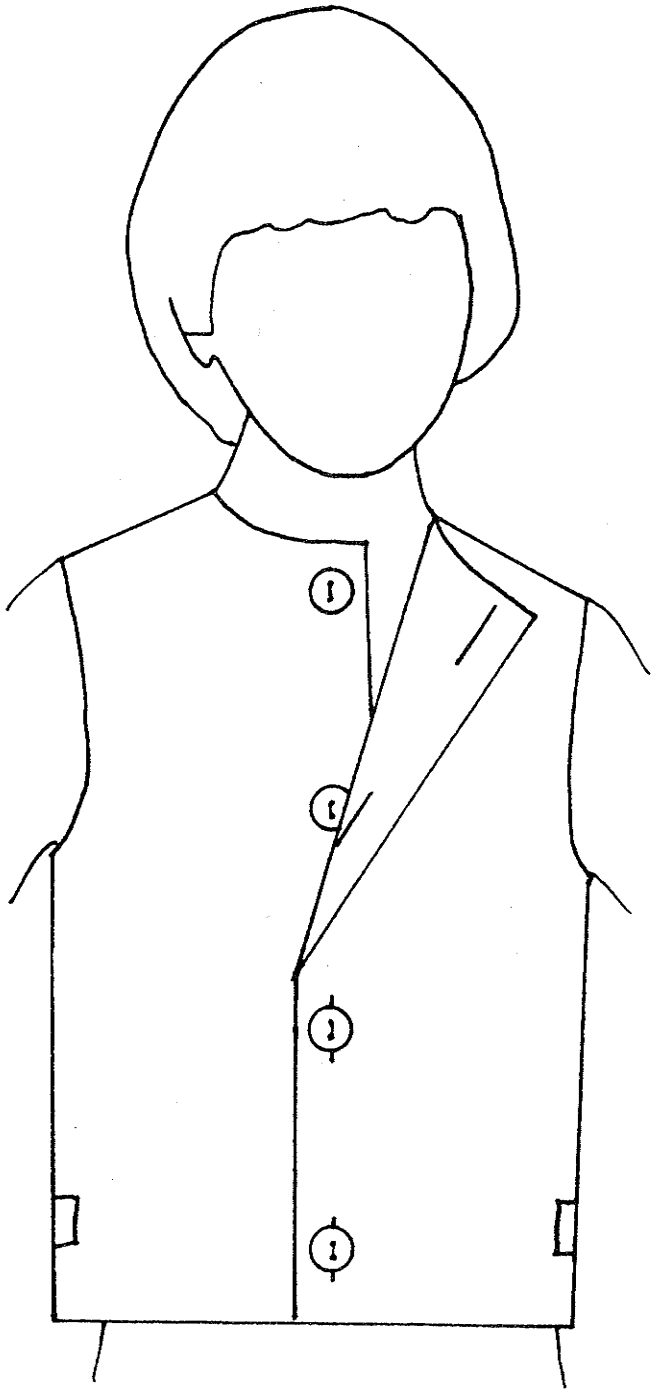

Figure 8

2 cm Button Vest Design

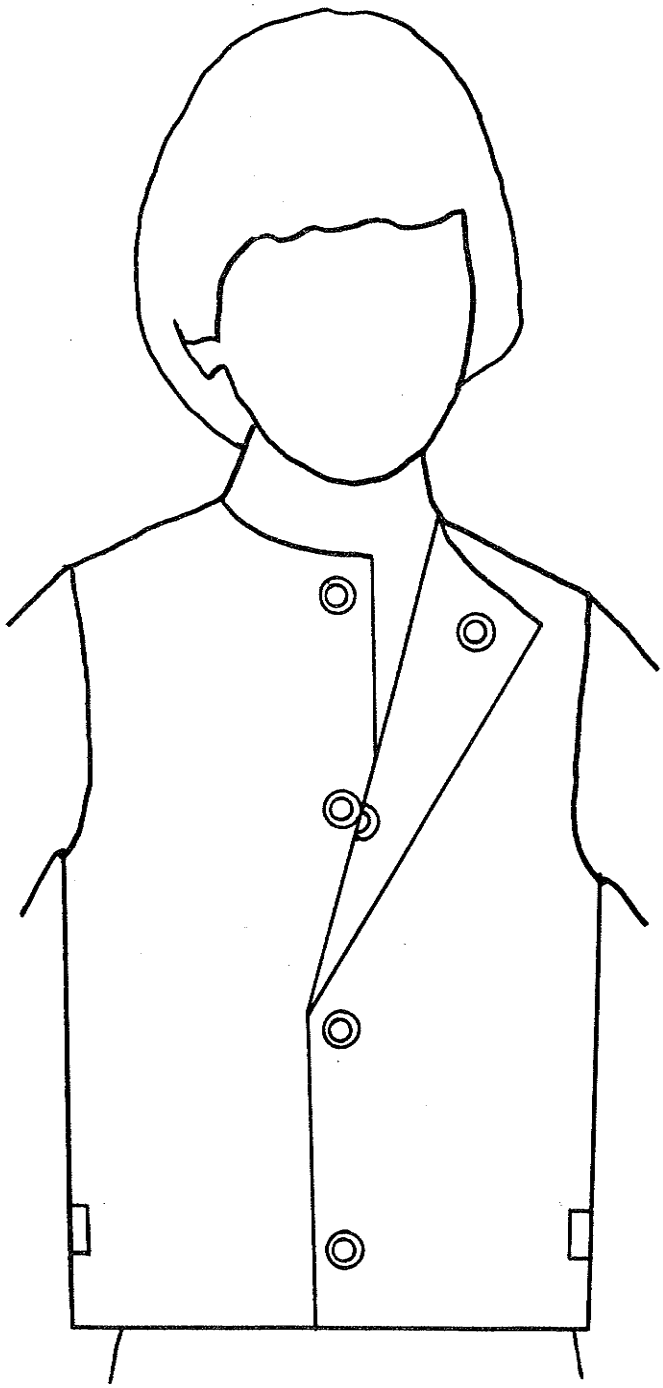

Figure 9

Hammer-on Snap Vest Design

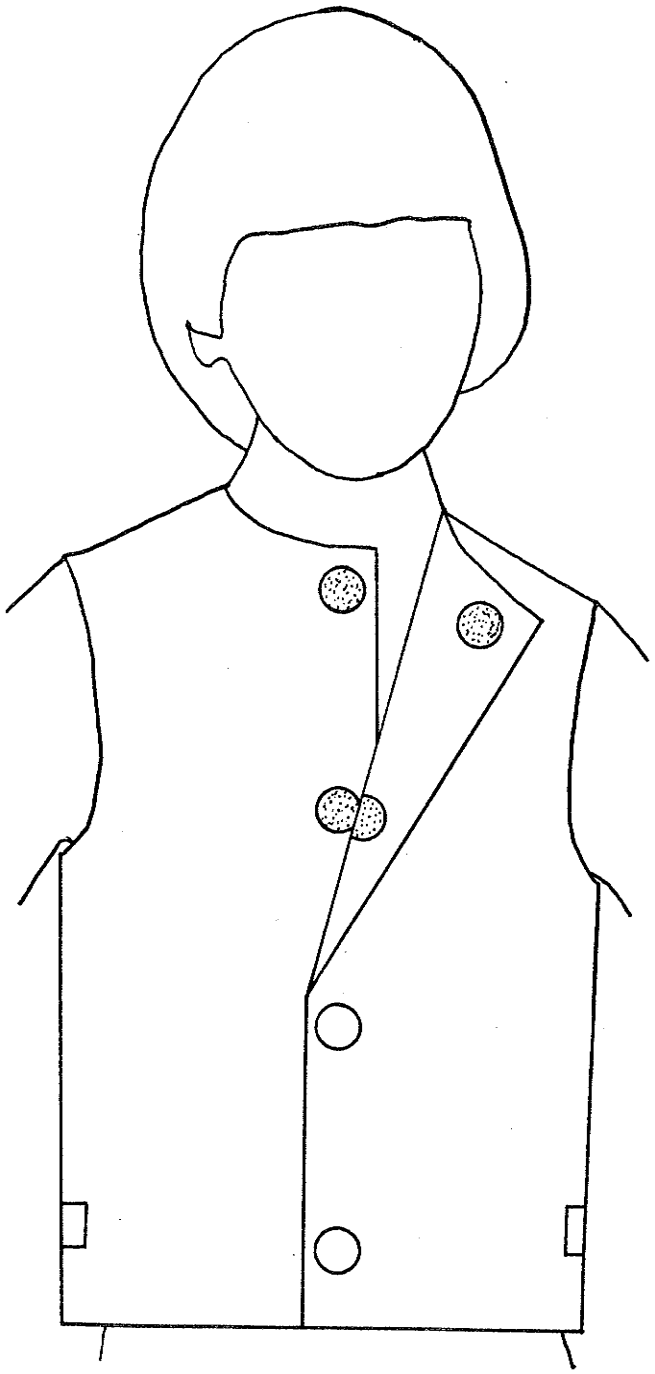

Figure 10

Hook and Loop Fastener Vest Design

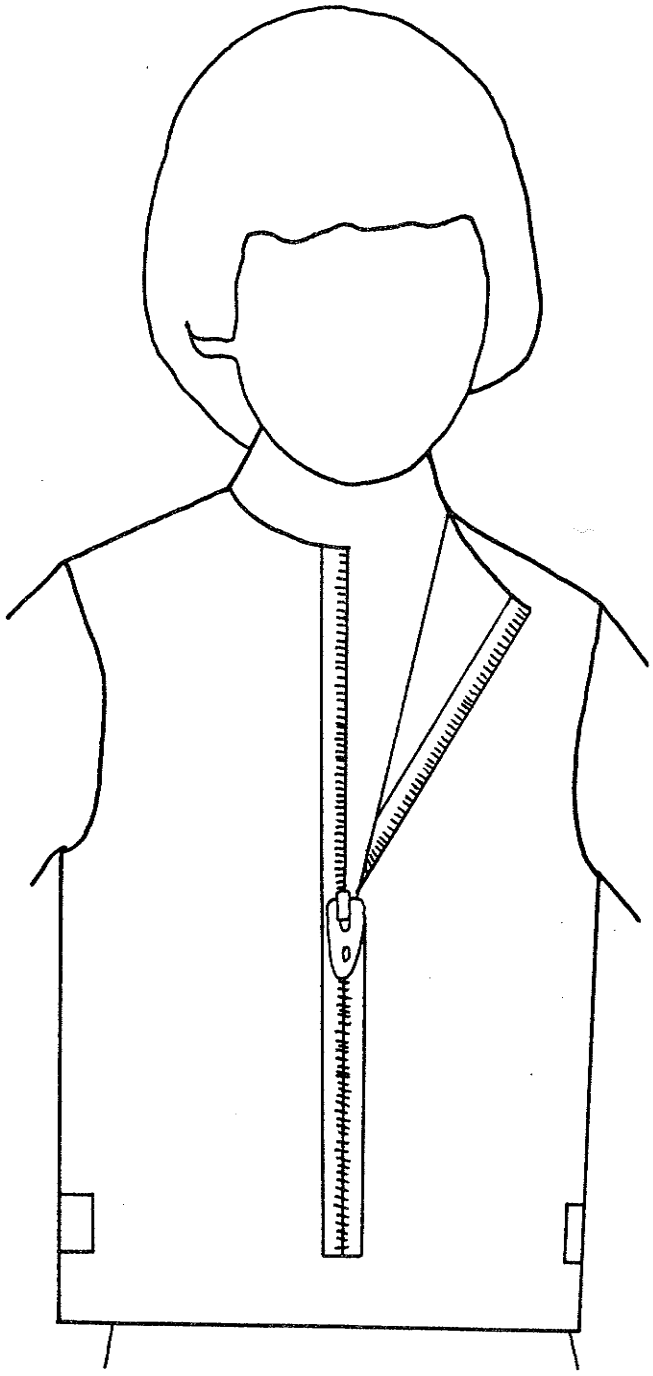

Figure 11

Conventional Zipper Vest Design

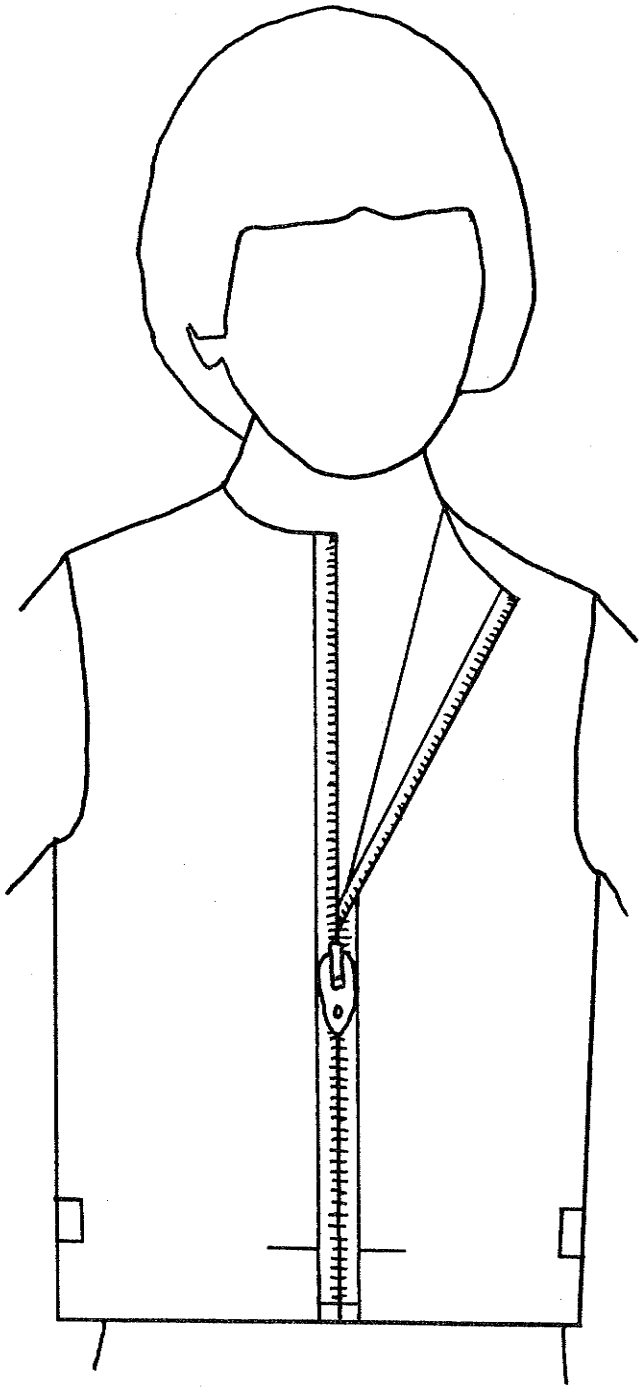

Figure 12

Large Separating Zipper Vest Design

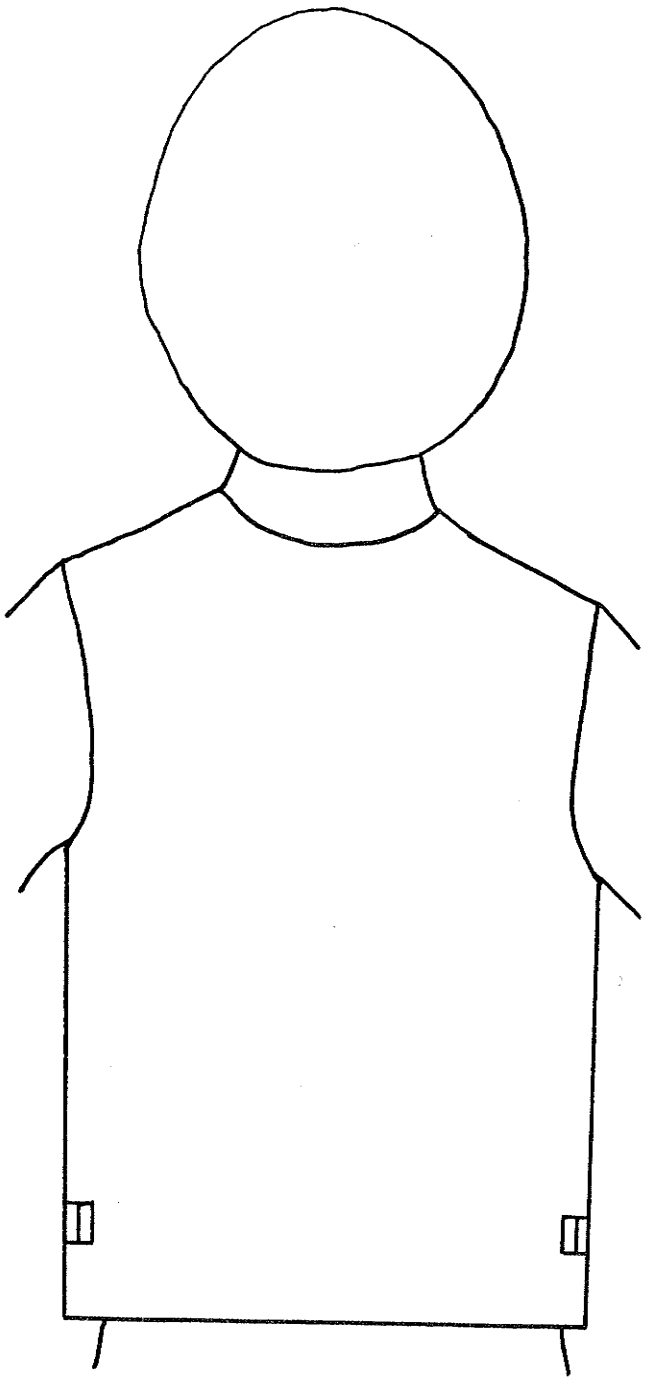

Figure 13

Back Design of All Vests

Appendix D

SUBJECT DATA SHEET

SUBJECT DATA SHEET

Subject no: ____/____/____/ Test Date: ____yr. ____mo. ____day

Age: ____/____mo. Subject birthdate: ____yr. ____mo. ____day

Sex: M, 1 F, 2

Size: 2 3 3X 4 5 6 6X Actual age: ____yr. ____mo. ____day

Testing vests: S, 1 L, 2

Ability to Manipulate Fasteners:

Fastener	Order Tested	Position	Order Closed	Closing Time	Order Opened	Opening Time
1 cm buttons		Waistline				
		2nd bottom				
		3rd bottom				
		Neckline				
2 cm buttons		Waistline				
		2nd bottom				
		3rd bottom				
		Neckline				
Hammer-on snaps		Waistline				
		2nd bottom				
		3rd bottom				
		Neckline				
Hook and loop fasteners		Waistline				
		2nd bottom				
		3rd bottom				
		Neckline				
Conventional zipper						
Large separating zipper		To white line				
		Separating				

Appendix E

GEOGRAPHICAL DISTRIBUTION OF DAY CARE CENTERS

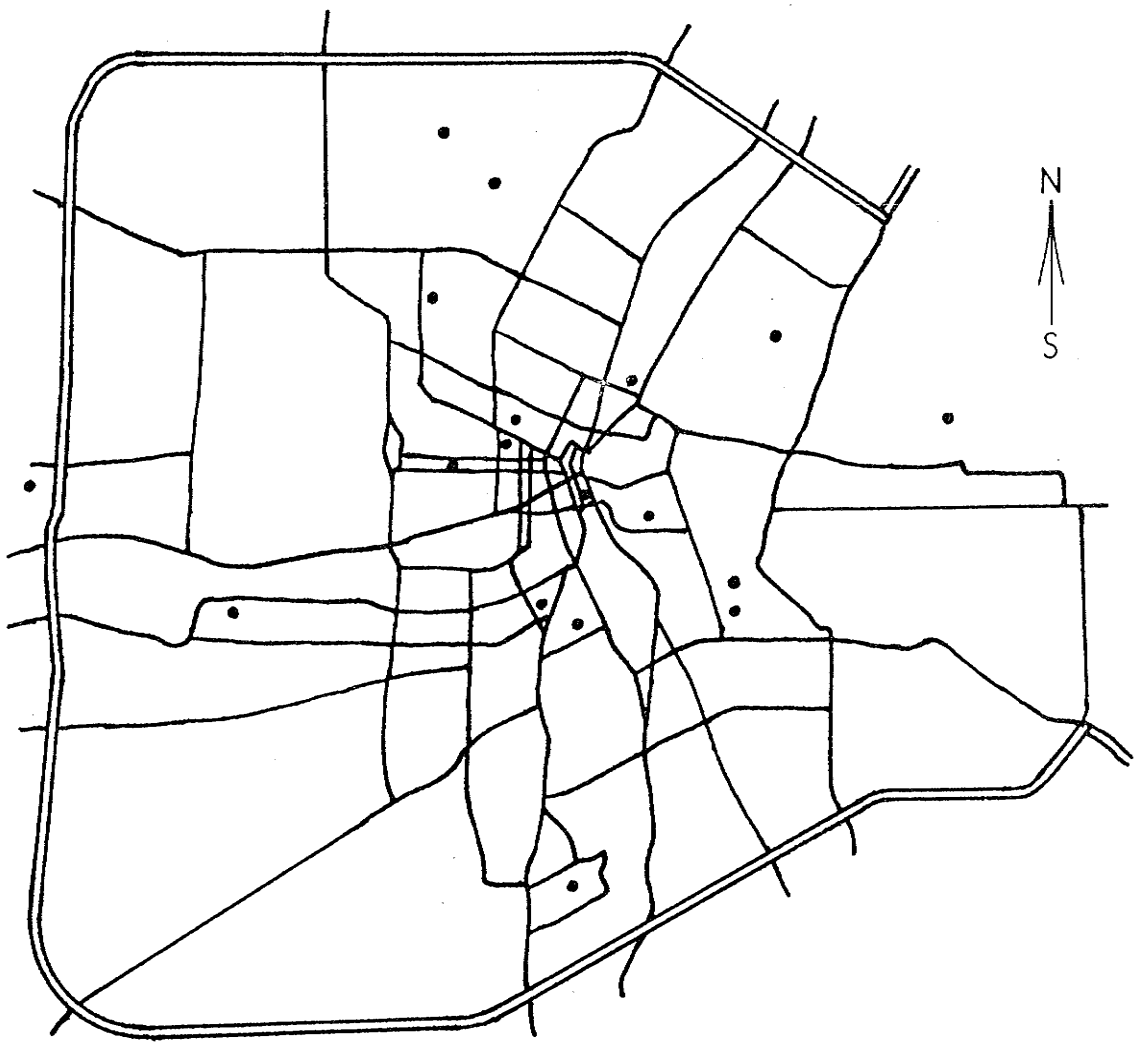

Figure 14

Geographical Distribution of Participating Day Care Centers
Within the City of Winnipeg

Appendix F

MANIPULATIVE DATA BY AGE AND SEX

Table 10

Manipulative Ability of 24 Month Old Boys

Fastener	Number of Subjects	Ability to Close			Ability to Open		
		Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean	Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean
1 cm Buttons	5	0	--	--	0	--	--
2 cm Buttons	5	0	--	--	0	--	--
Hammer-on Snaps	5	0	--	--	4	19.48	8.26
Hook and Loop Fasteners	5	3	16.20	3.37	5	7.78	4.22
Conventional Zipper	5	2	28.85	12.05	5	15.62	7.40
Large Zipper	5	2	6.55	3.75	5	3.16	1.42
Separating Zipper	5	0	--	--	3	1.67	0.27

Table 11

Manipulative Ability of 24 Month Old Girls

Fastener	Number of Subjects	Ability to Close			Ability to Open		
		Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean	Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean
1 cm Buttons	7	0	--	--	0	--	--
2 cm Buttons	7	0	--	--	0	--	--
Hammer-on Snaps	7	0	--	--	5	10.20	3.98
Hook and Loop Fasteners	7	4	23.03	6.63	7	17.29	11.88
Conventional Zipper	7	4	18.38	5.23	6	19.43	7.49
Large Zipper	7	5	14.18	4.81	7	4.91	2.58
Separating Zipper	7	0	--	--	6	8.77	4.69

Table 12

Manipulative Ability of 30 Month Old Boys

Fastener	Number of Subjects	Ability to Close			Ability to Open		
		Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean	Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean
1 cm Buttons	11	0	--	--	0	--	--
2 cm Buttons	11	1	52.70	--	1	91.90	--
Hammer-on Snaps	11	0	--	--	11	17.37	4.77
Hook and Loop Fasteners	11	9	26.34	4.86	10	2.98	0.72
Conventional Zipper	11	11	10.31	1.85	11	5.17	1.11
Large Zipper	11	11	7.28	2.26	11	2.05	0.73
Separating Zipper	11	0	--	--	9	4.41	1.41

Table 13

Manipulative Ability of 30 Month Old Girls

Fastener	Number of Subjects	Ability to Close			Ability to Open		
		Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean	Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean
1 cm Buttons	12	1	145.80	--	3	52.60	6.70
2 cm Buttons	12	2	82.10	26.60	3	90.70	47.18
Hammer-on Snaps	12	1	103.80	--	12	11.92	3.02
Hook and Loop Fasteners	12	11	35.89	3.93	12	4.23	0.87
Conventional Zipper	12	12	8.83	2.65	12	5.87	1.91
Large Zipper	12	11	8.09	2.97	12	1.87	0.62
Separating Zipper	12	2	23.00	18.00	11	2.91	0.56

Table 14

Manipulative Ability of 36 Month Old Boys

Fastener	Number of Subjects	Ability to Close			Ability to Open		
		Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean	Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean
1 cm Buttons	13	0	--	--	2	50.40	17.90
2 cm Buttons	13	3	63.97	15.75	6	37.67	6.69
Hammer-on Snaps	13	3	80.07	4.34	13	6.78	0.72
Hook and Loop Fasteners	13	13	25.53	3.00	13	2.65	0.54
Conventional Zipper	13	12	3.78	1.10	13	5.05	1.09
Large Zipper	13	13	3.71	0.78	13	1.58	0.29
Separating Zipper	13	0	--	--	13	2.98	0.61

Table 15

Manipulative Ability of 36 Month Old Girls

Fastener	Number of Subjects	Ability to Close			Ability to Open		
		Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean	Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean
1 cm Buttons	10	2	84.40	16.60	6	28.81	4.33
2 cm Buttons	10	7	94.74	14.44	9	52.13	6.27
Hammer-on Snaps	10	4	54.03	3.47	10	6.17	1.60
Hook and Loop Fasteners	10	10	22.23	3.70	10	2.40	0.43
Conventional Zipper	10	10	2.05	0.28	10	1.80	0.39
Large Zipper	10	10	1.64	0.17	10	0.93	0.13
Separating Zipper	10	3	17.17	3.41	10	3.03	0.74

Table 16

Manipulative Ability of 42 Month Old Boys

Fastener	Number of Subjects	Ability to Close			Ability to Open		
		Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean	Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean
1 cm Buttons	13	3	56.97	29.92	4	38.58	14.36
2 cm Buttons	13	8	46.18	5.97	11	40.34	8.25
Hammer-on Snaps	13	7	64.82	11.81	13	5.92	1.24
Hook and Loop Fasteners	13	13	20.32	2.24	13	2.01	0.37
Conventional Zipper	13	13	2.05	0.47	13	2.72	0.57
Large Zipper	13	13	1.28	0.20	13	0.91	0.22
Separating Zipper	13	4	8.15	0.86	13	2.28	0.90

Table 17

Manipulative Ability of 42 Month Old Girls

Fastener	Number of Subjects	Ability to Close			Ability to Open		
		Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean	Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean
1 cm Buttons	12	8	64.41	12.35	10	27.85	5.95
2 cm Buttons	12	10	53.42	7.96	12	30.92	6.10
Hammer-on Snaps	12	10	48.38	9.05	12	4.28	0.56
Hook and Loop Fasteners	12	12	21.15	2.54	12	1.76	0.36
Conventional Zipper	12	12	1.78	0.39	12	1.38	0.12
Large Zipper	12	12	1.61	0.29	12	0.89	0.17
Separating Zipper	12	4	25.25	10.40	12	3.25	0.97

Table 18

Manipulative Ability of 48 Month Old Boys

Fastener	Number of Subjects	Ability to Close			Ability to Open		
		Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean	Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean
1 cm Buttons	10	9	45.64	6.43	9	23.97	7.25
2 cm Buttons	10	10	36.17	6.70	10	18.25	3.28
Hammer-on Snaps	10	10	51.57	10.57	10	2.64	0.70
Hook and Loop Fasteners	10	10	24.74	4.57	10	1.62	0.53
Conventional Zipper	10	10	1.45	0.33	10	1.01	0.23
Large Zipper	10	10	0.93	0.18	10	0.39	0.03
Separating Zipper	10	9	10.60	1.86	10	4.97	2.47

Table 19

Manipulative Ability of 48 Month Old Girls

Fastener	Number of Subjects	Ability to Close			Ability to Open		
		Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean	Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean
1 cm Buttons	16	16	40.84	6.14	16	15.07	2.18
2 cm Buttons	16	16	27.82	3.50	16	13.98	1.88
Hammer-on Snaps	16	15	42.24	4.72	16	4.68	0.95
Hook and Loop Fasteners	16	16	16.68	1.64	16	2.66	0.46
Conventional Zipper	16	16	1.76	0.29	16	1.96	0.32
Large Zipper	16	16	1.33	0.23	16	0.79	0.12
Separating Zipper	16	10	10.61	2.37	16	2.54	0.65

Table 20

Manipulative Ability of 54 Month Old Boys

Fastener	Number of Subjects	Ability to Close			Ability to Open		
		Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean	Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean
1 cm Buttons	12	9	42.49	9.16	11	20.43	3.71
2 cm Buttons	12	11	34.01	6.57	12	27.83	5.20
Hammer-on Snaps	12	11	45.53	8.78	12	3.40	0.42
Hook and Loop Fasteners	12	12	19.46	2.40	12	2.80	0.67
Conventional Zipper	12	12	1.32	0.23	12	1.53	0.35
Large Zipper	12	12	0.80	0.13	12	0.65	0.14
Separating Zipper	12	10	9.65	2.19	12	1.93	0.42

Table 21

Manipulative Ability of 54 Month Old Girls

Fastener	Number of Subjects	Ability to Close			Ability to Open		
		Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean	Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean
1 cm Buttons	11	11	27.05	2.20	11	13.62	1.88
2 cm Buttons	11	11	19.87	1.26	11	11.04	1.47
Hammer-on Snaps	11	11	31.20	4.15	11	3.49	0.66
Hook and Loop Fasteners	11	11	14.25	2.43	11	1.87	0.36
Conventional Zipper	11	11	1.12	0.19	11	1.56	0.35
Large Zipper	11	11	1.03	0.24	11	0.86	0.12
Separating Zipper	11	10	9.89	2.54	11	2.37	0.34

Appendix G

GRAPHS OF MEAN FASTENING TIMES

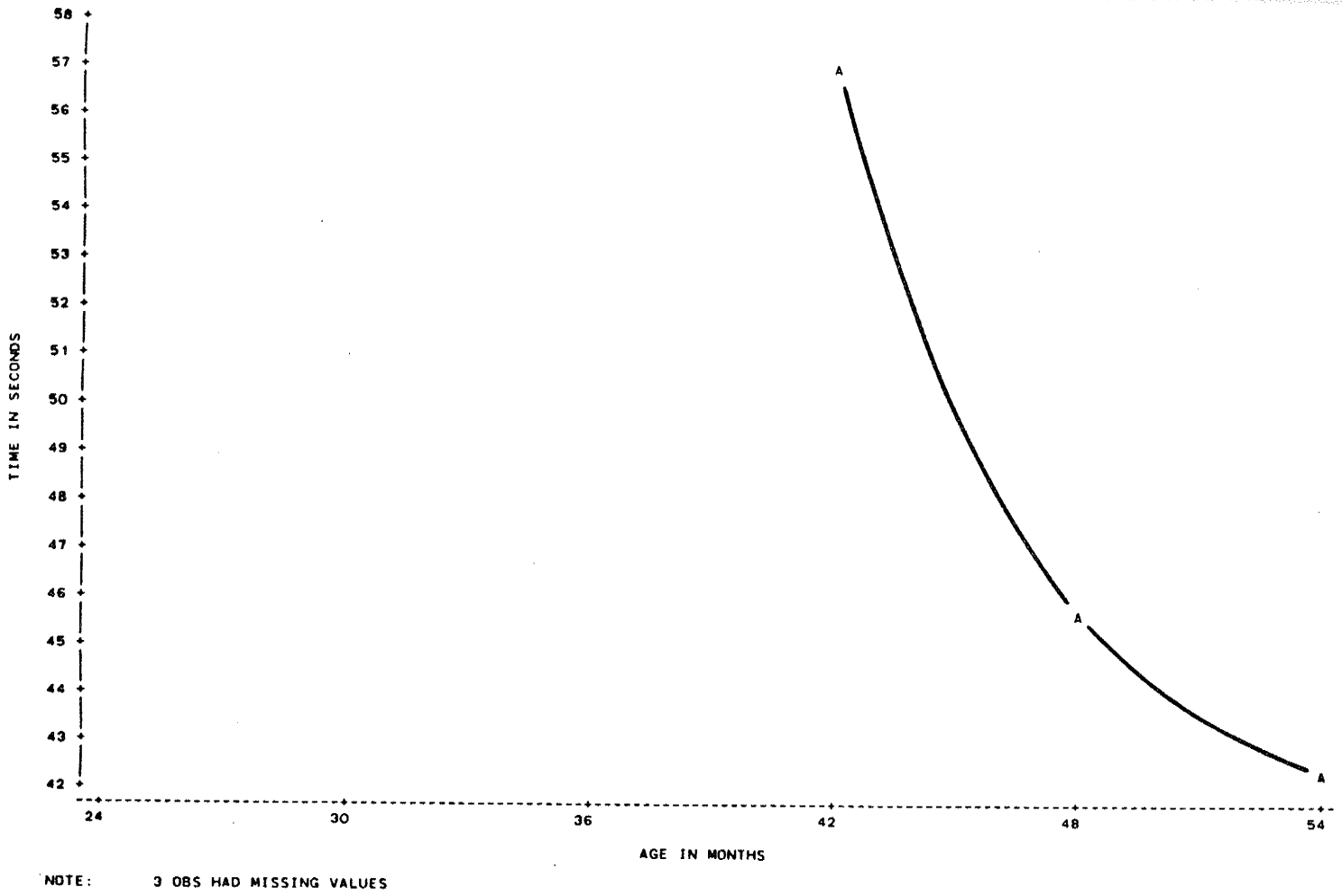

Figure 15

Boys' Mean Times for Closing Three 1 cm Buttons

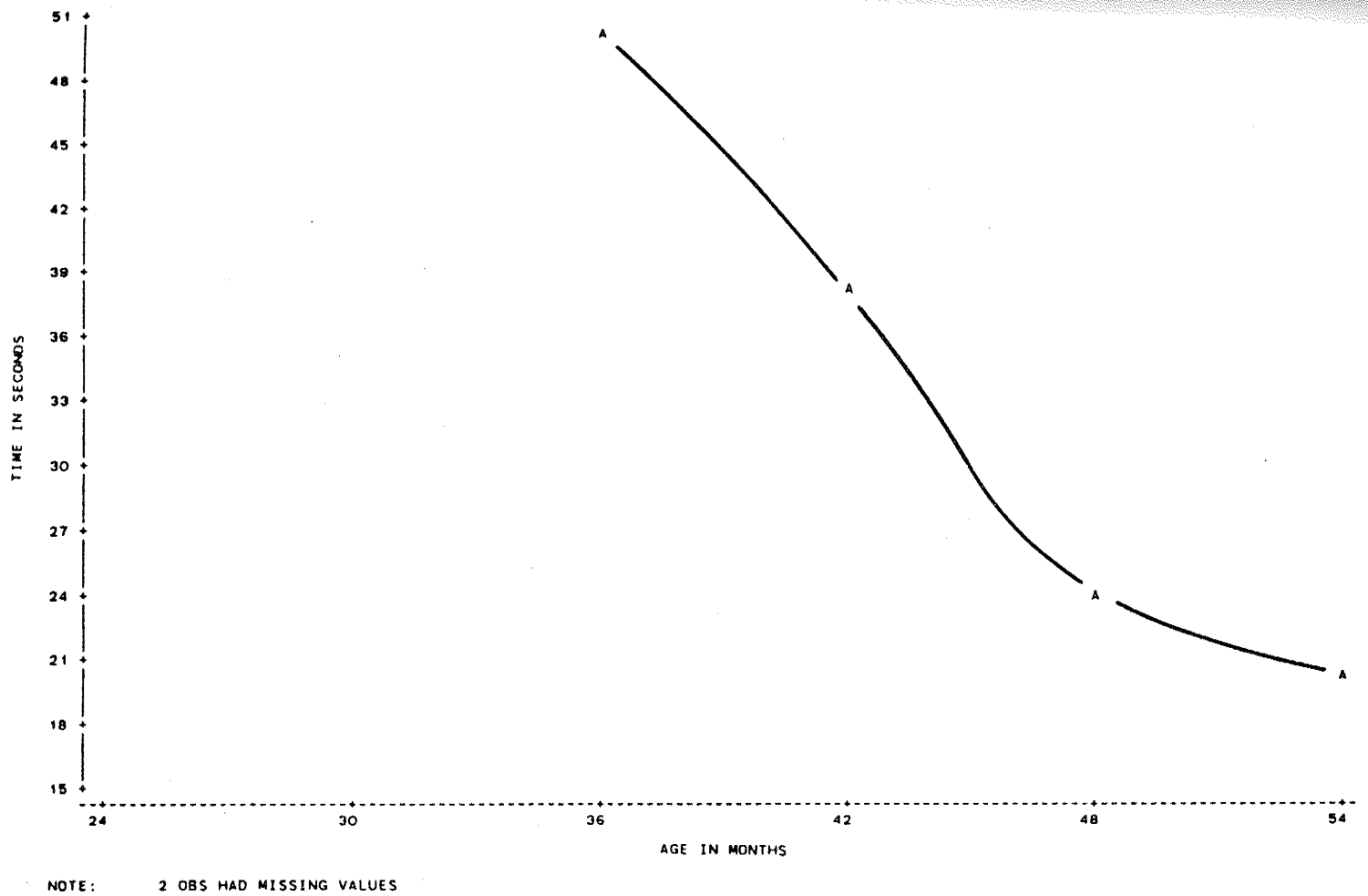

Figure 16

Boys' Mean Times for Opening Three 1 cm Buttons

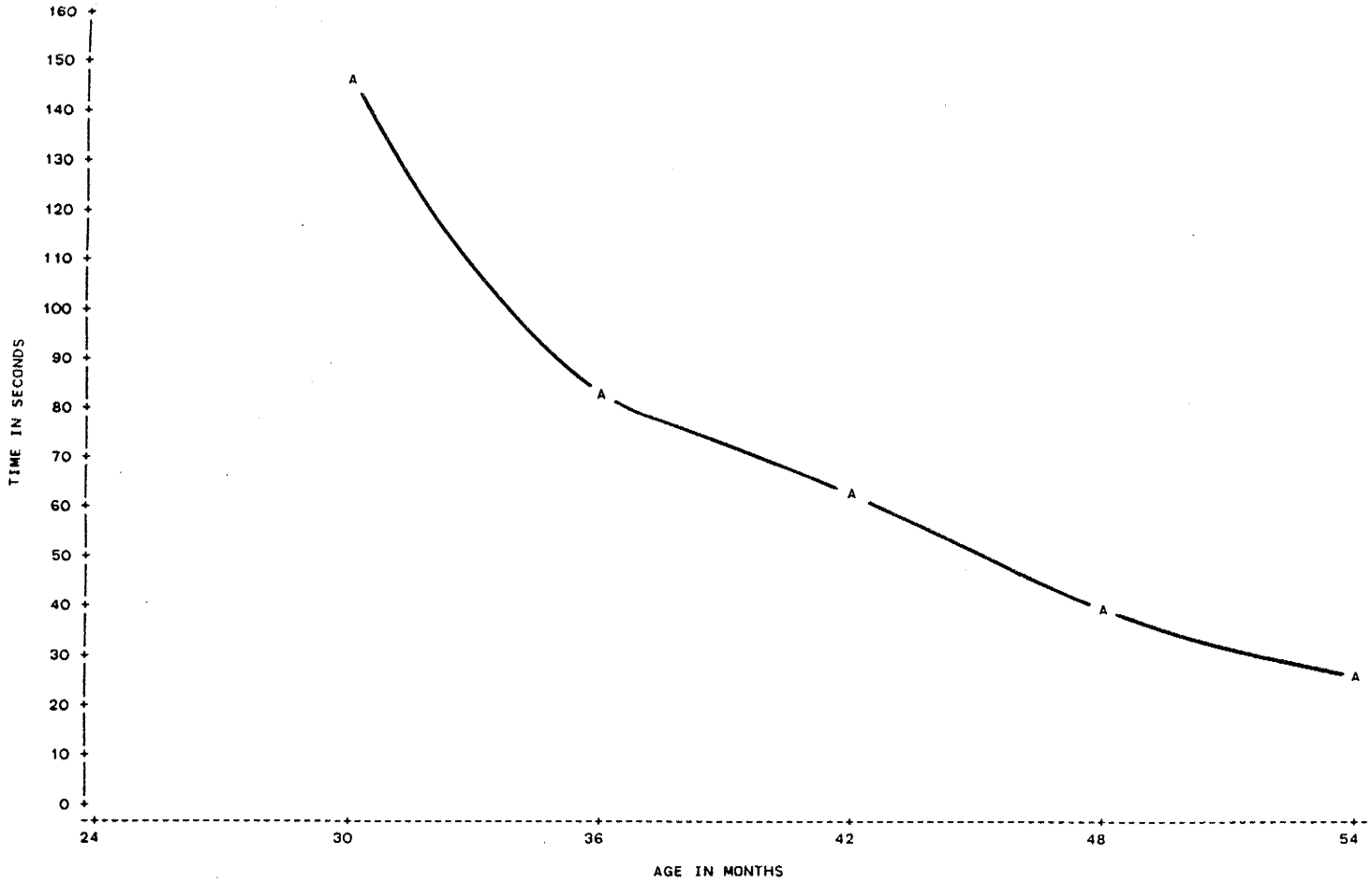

Figure 17

Girls' Mean Times for Closing Three 1 cm Buttons

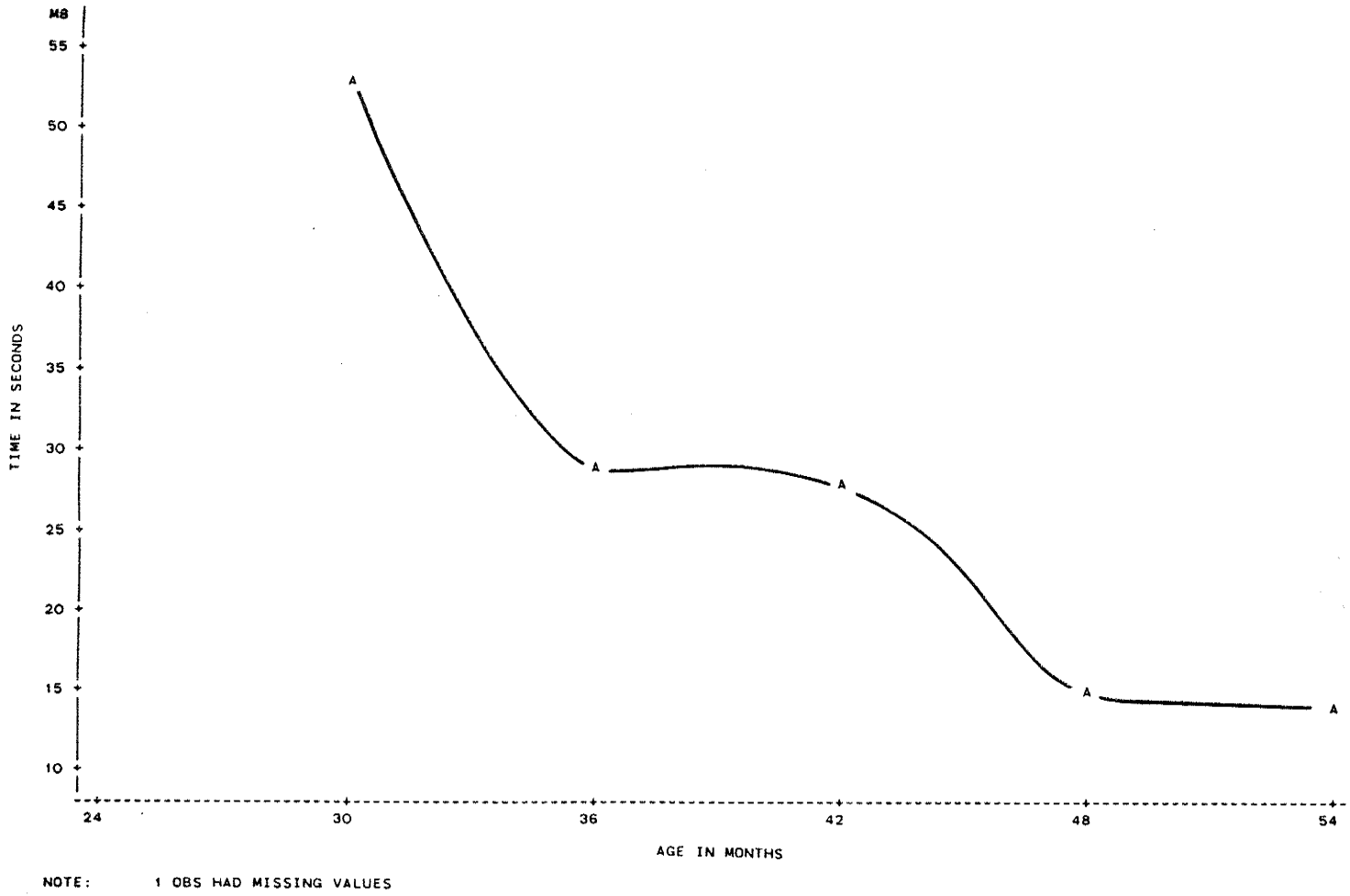

Figure 18

Girls' Mean Times for Opening Three 1 cm Buttons

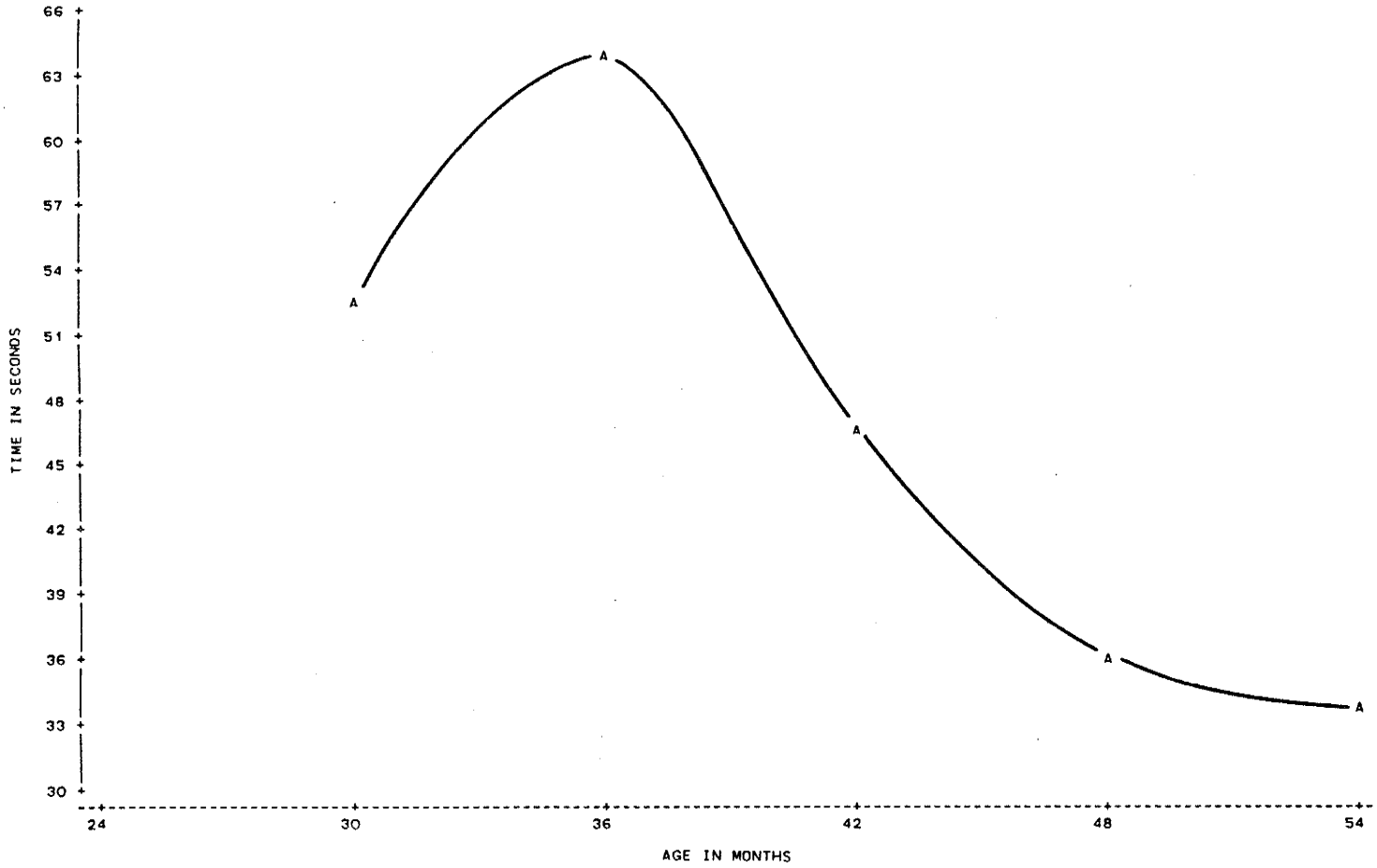

Figure 19

Boys' Mean Times for Closing Three 2 cm Buttons

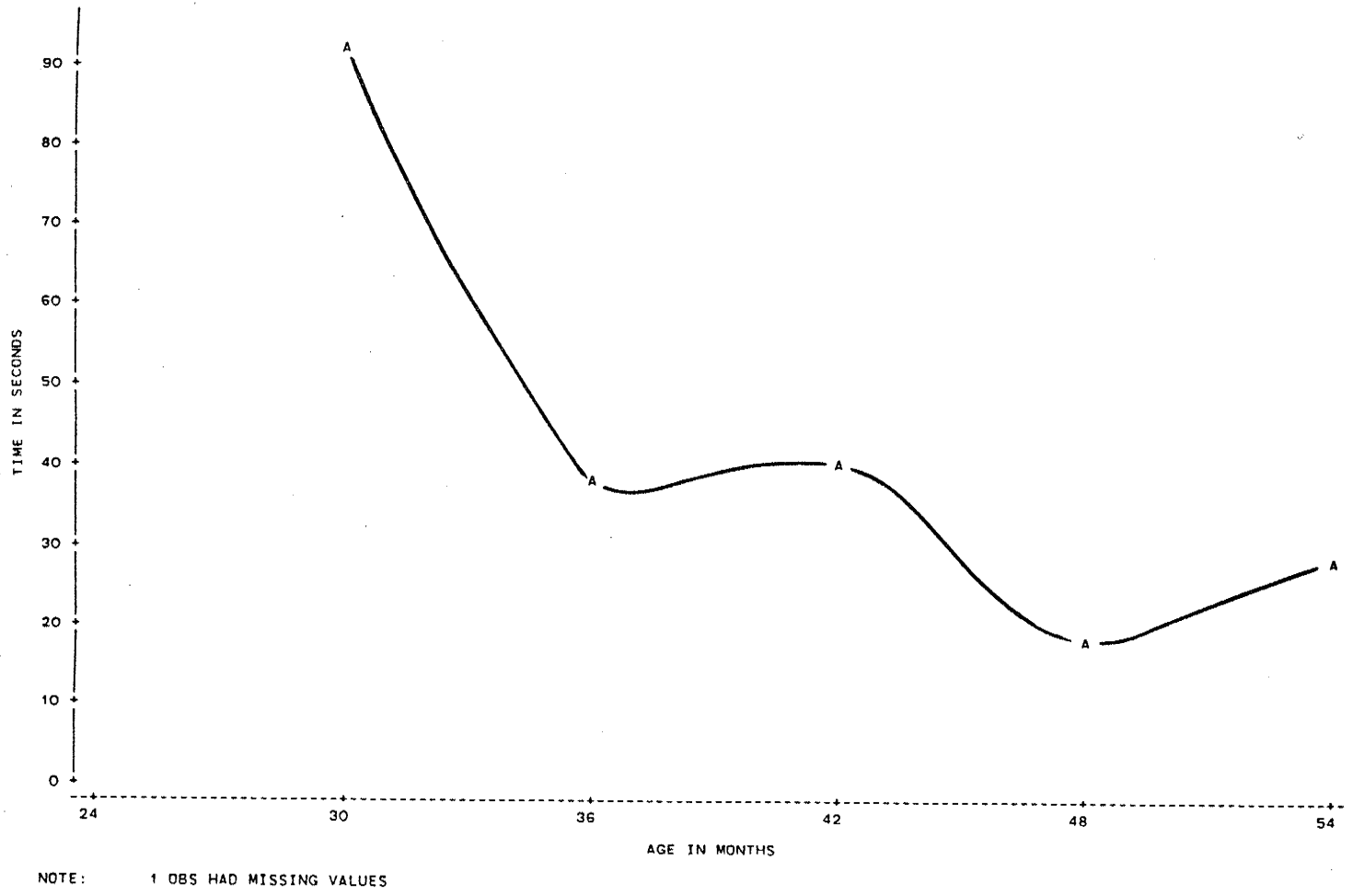

Figure 20

Boys' Mean Times for Opening Three 2 cm Buttons

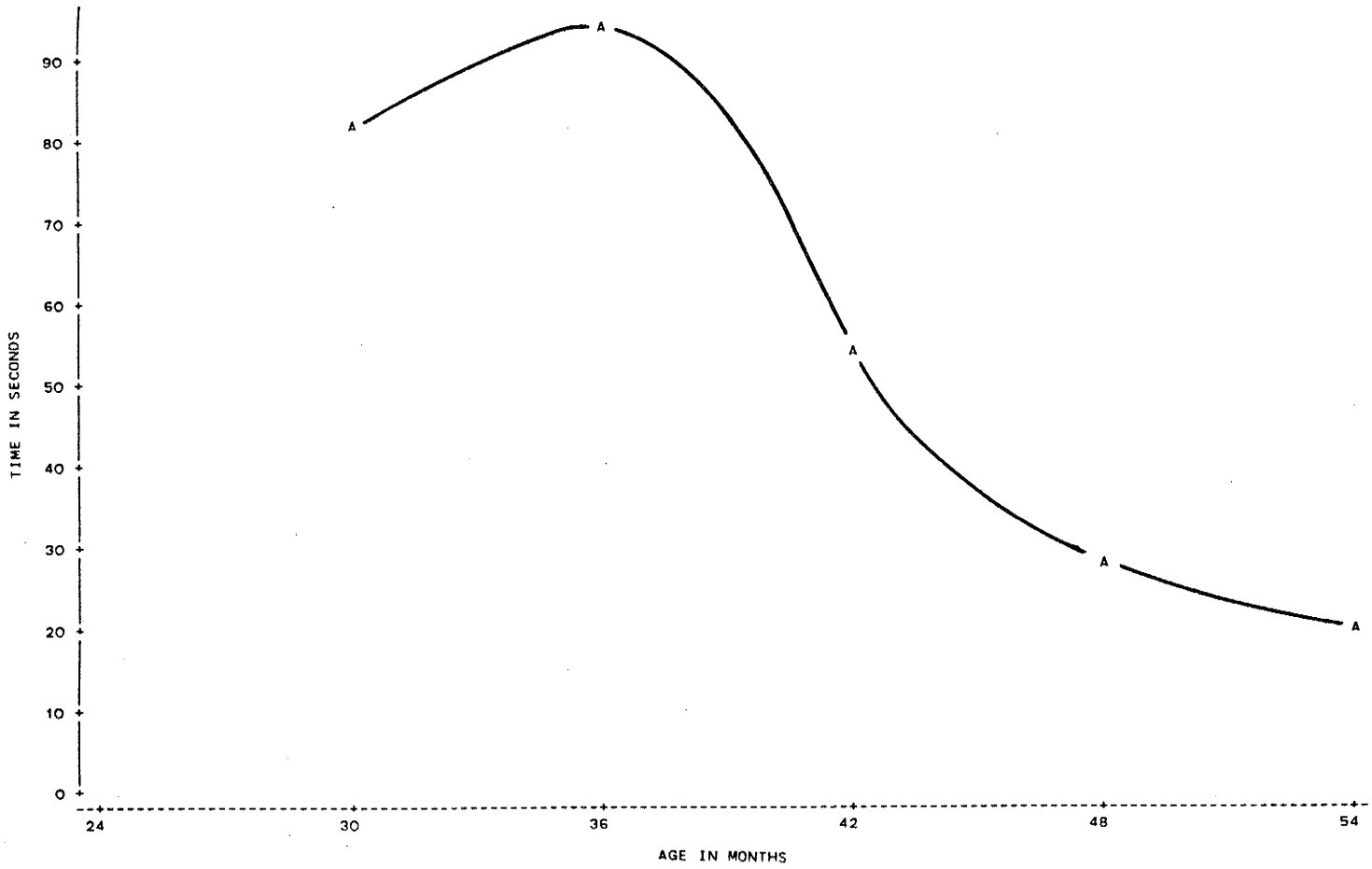

Figure 21

Girls' Mean Times for Closing Three 2 cm Buttons

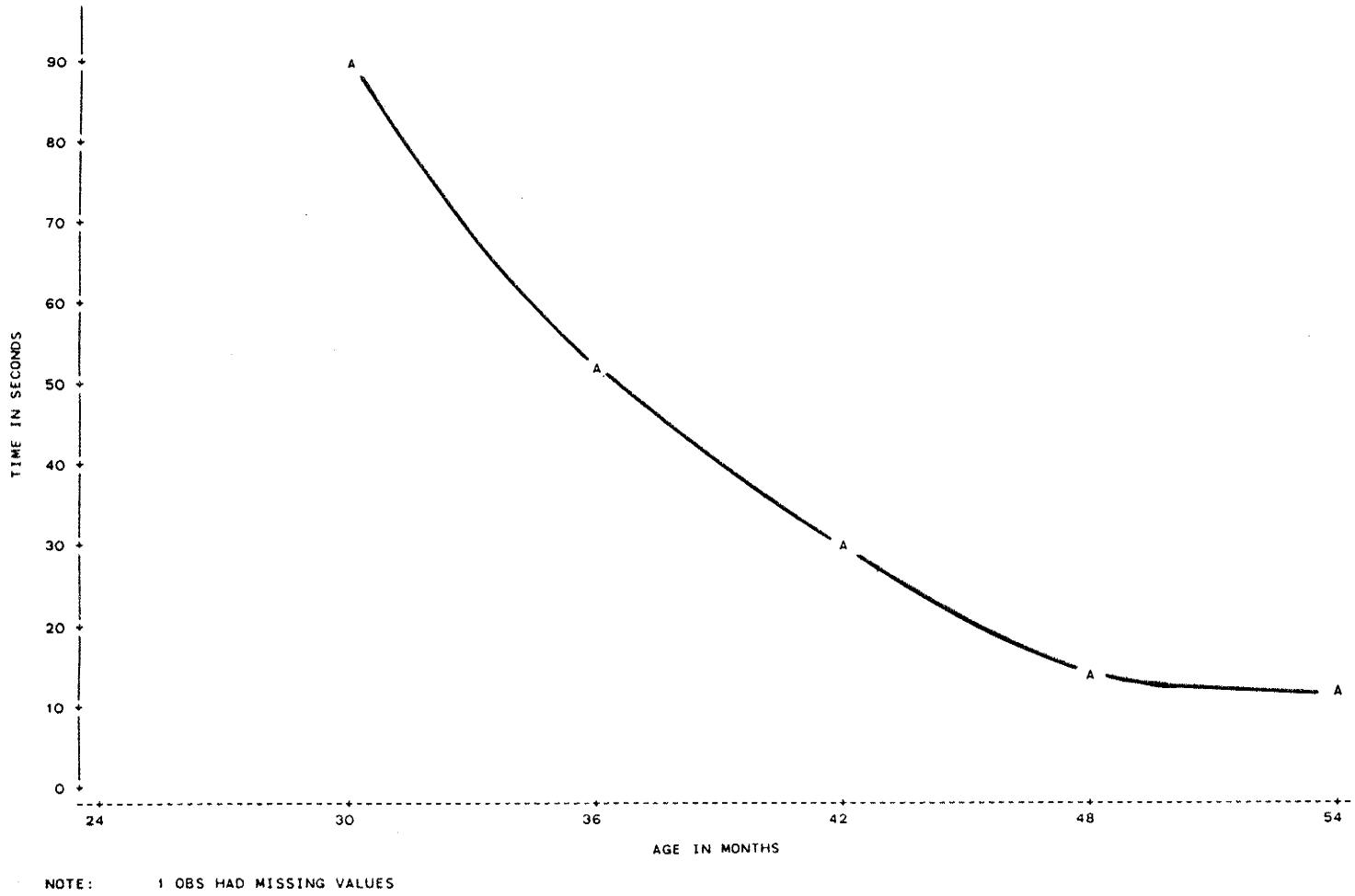

Figure 22

Girls' Mean Times for Opening Three 2 cm Buttons

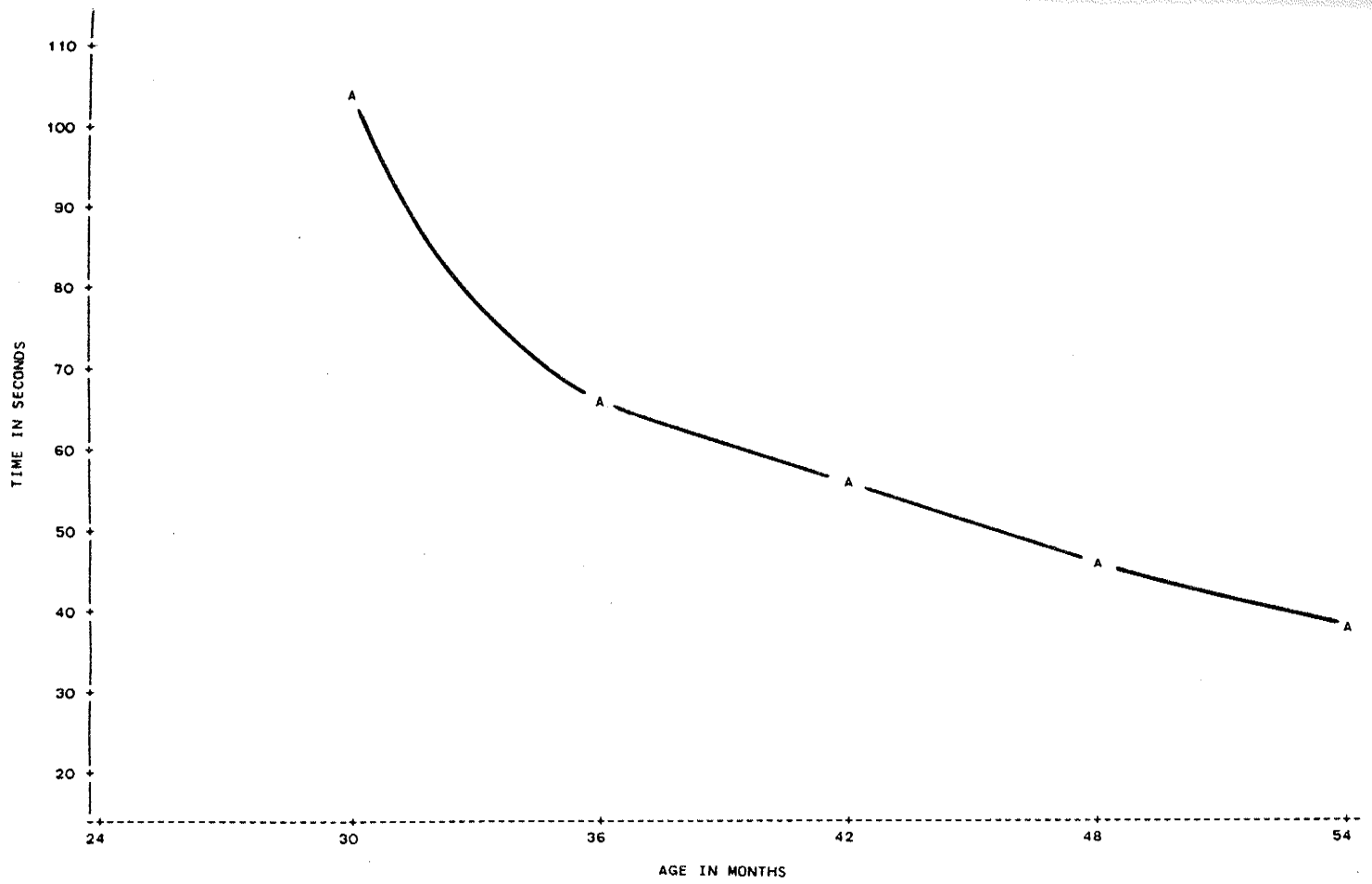

Figure 23

Mean Times for Closing Three Hammer-on Snaps

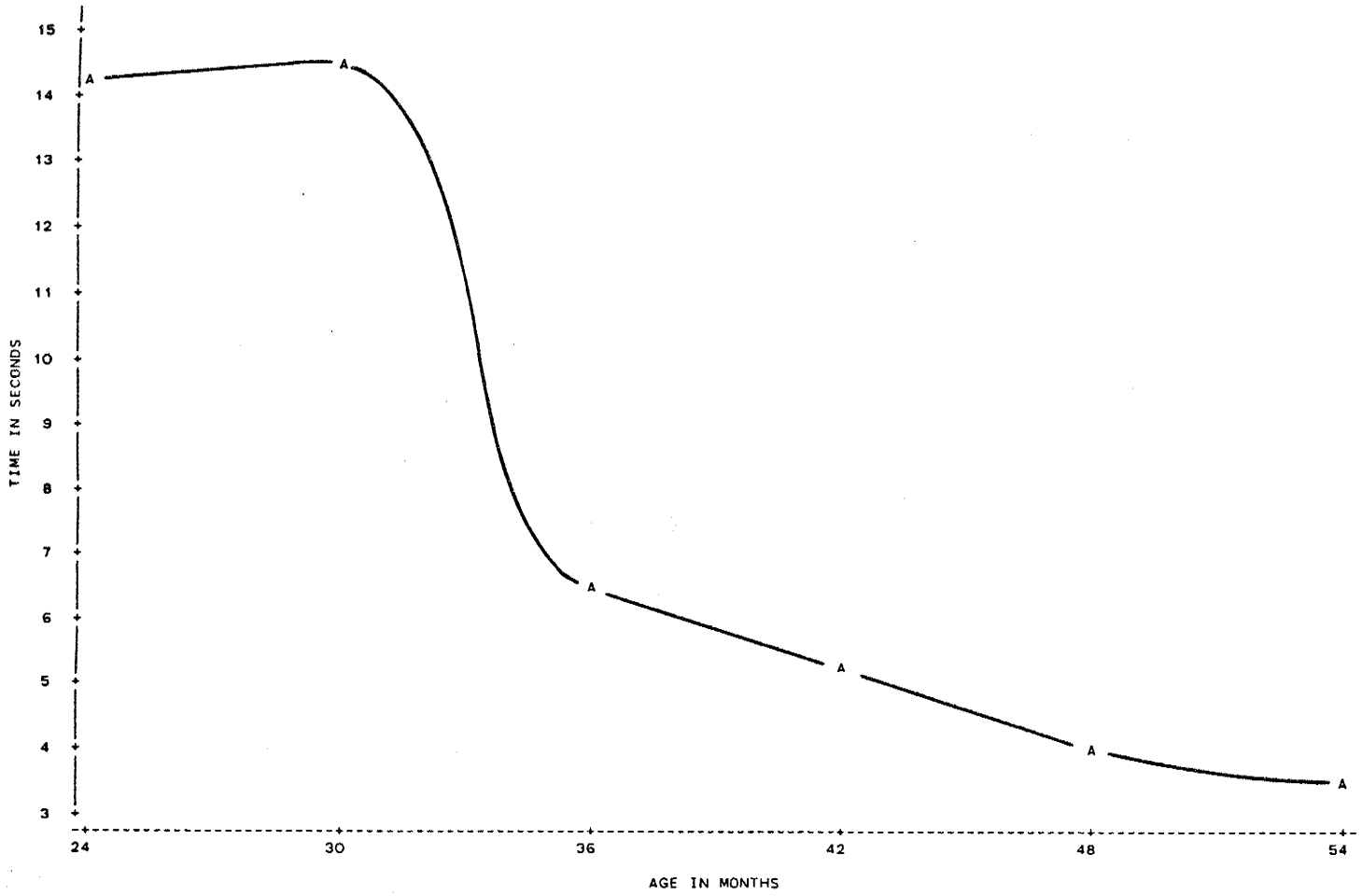

Figure 24

Mean Times for Opening Three Hammer-on Snaps

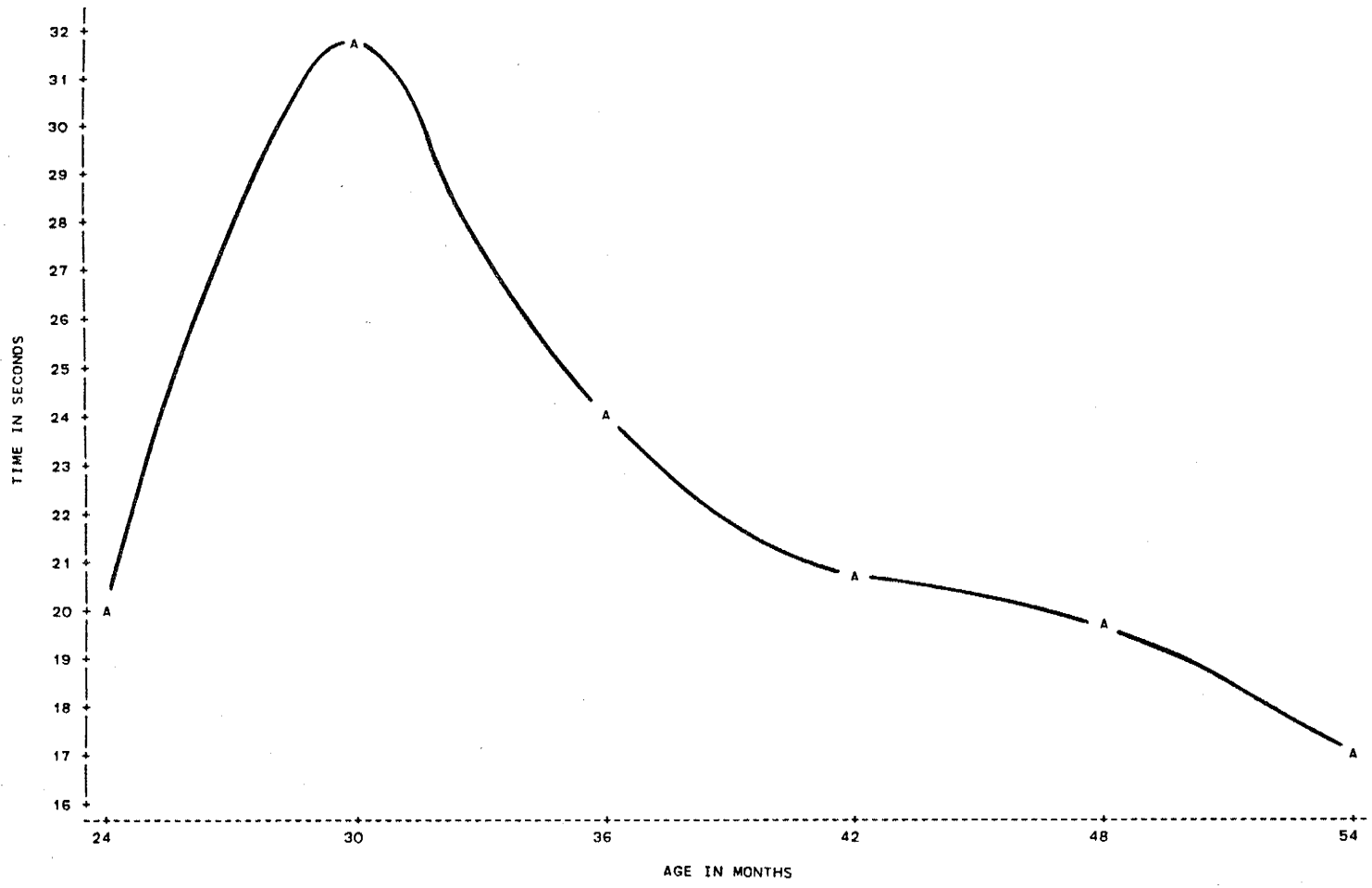

Figure 25

Mean Times for Closing Three Hook and Loop Fasteners

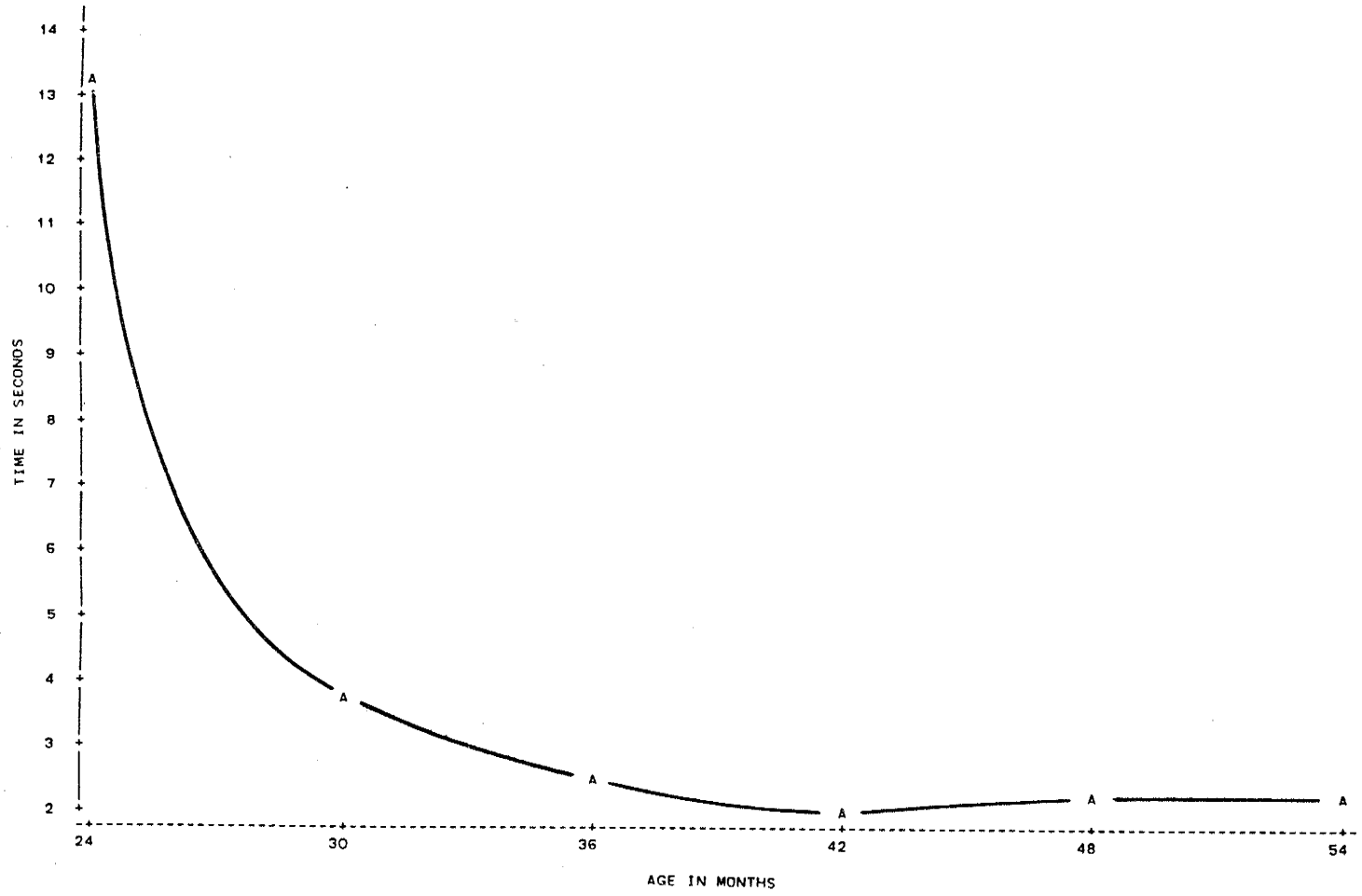

Figure 26

Mean Times for Opening Three Hook and Loop Fasteners

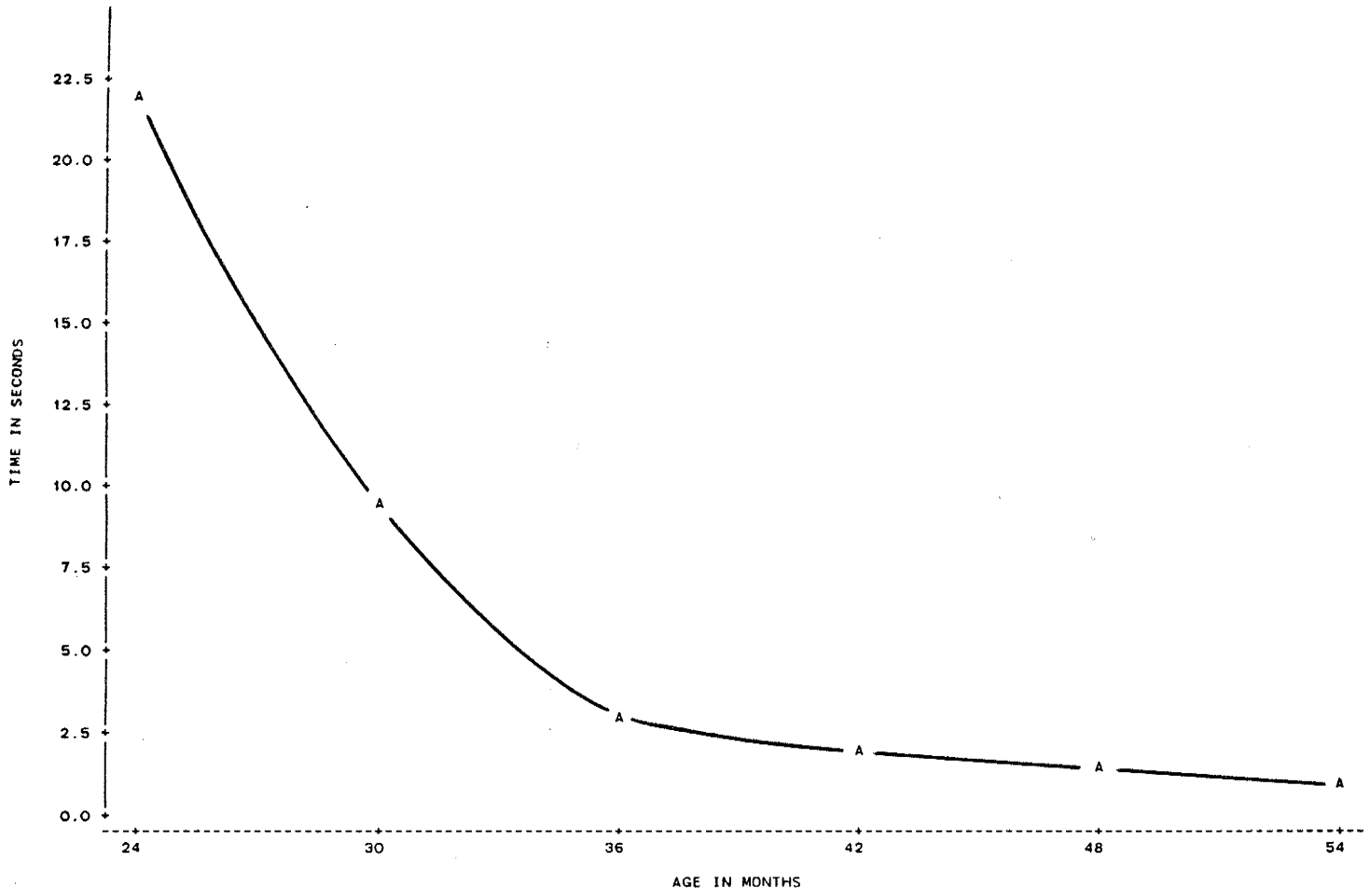

Figure 27

Mean Times for Closing Conventional Zipper

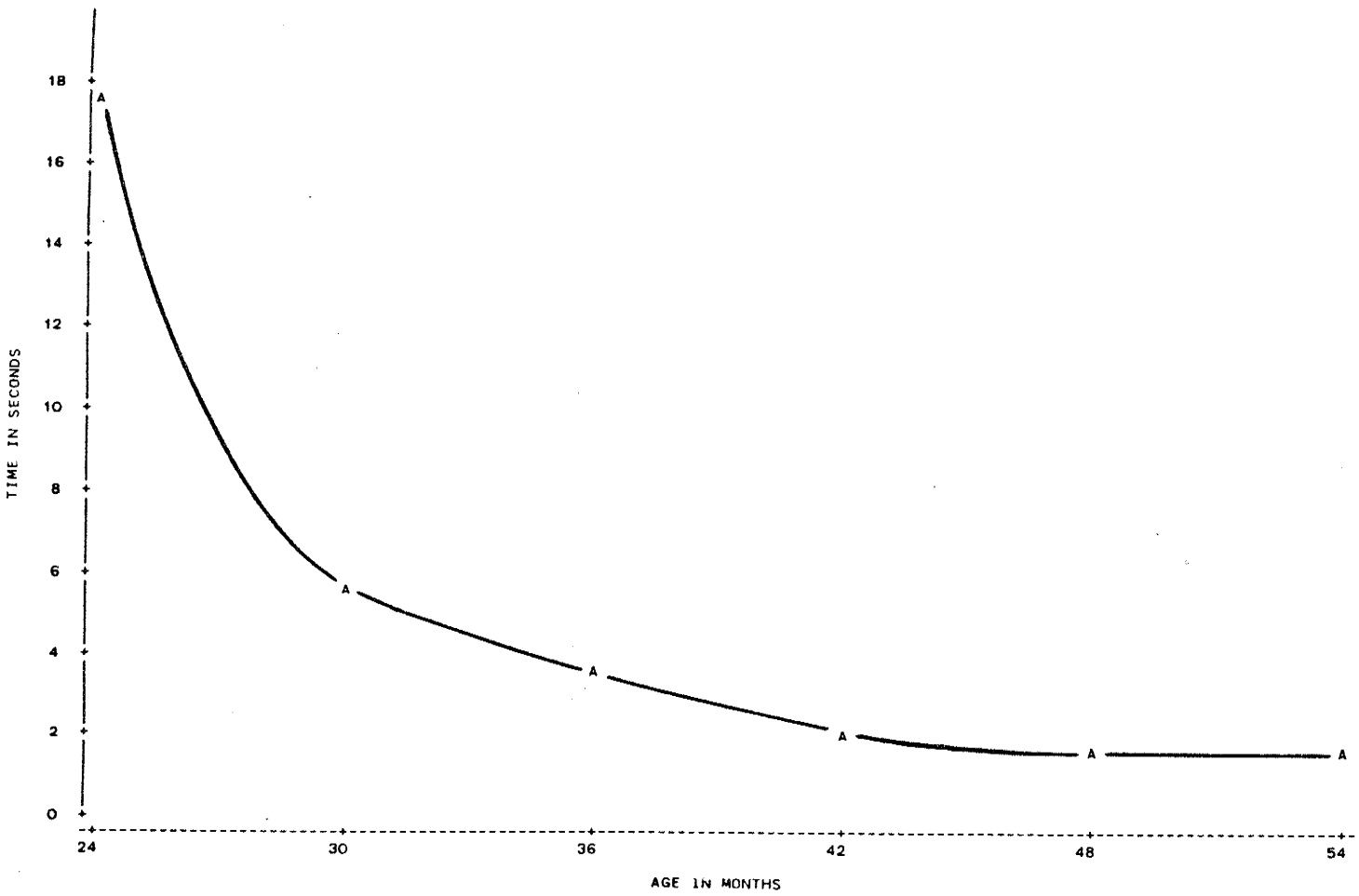

Figure 28

Mean Times for Opening Conventional Zipper

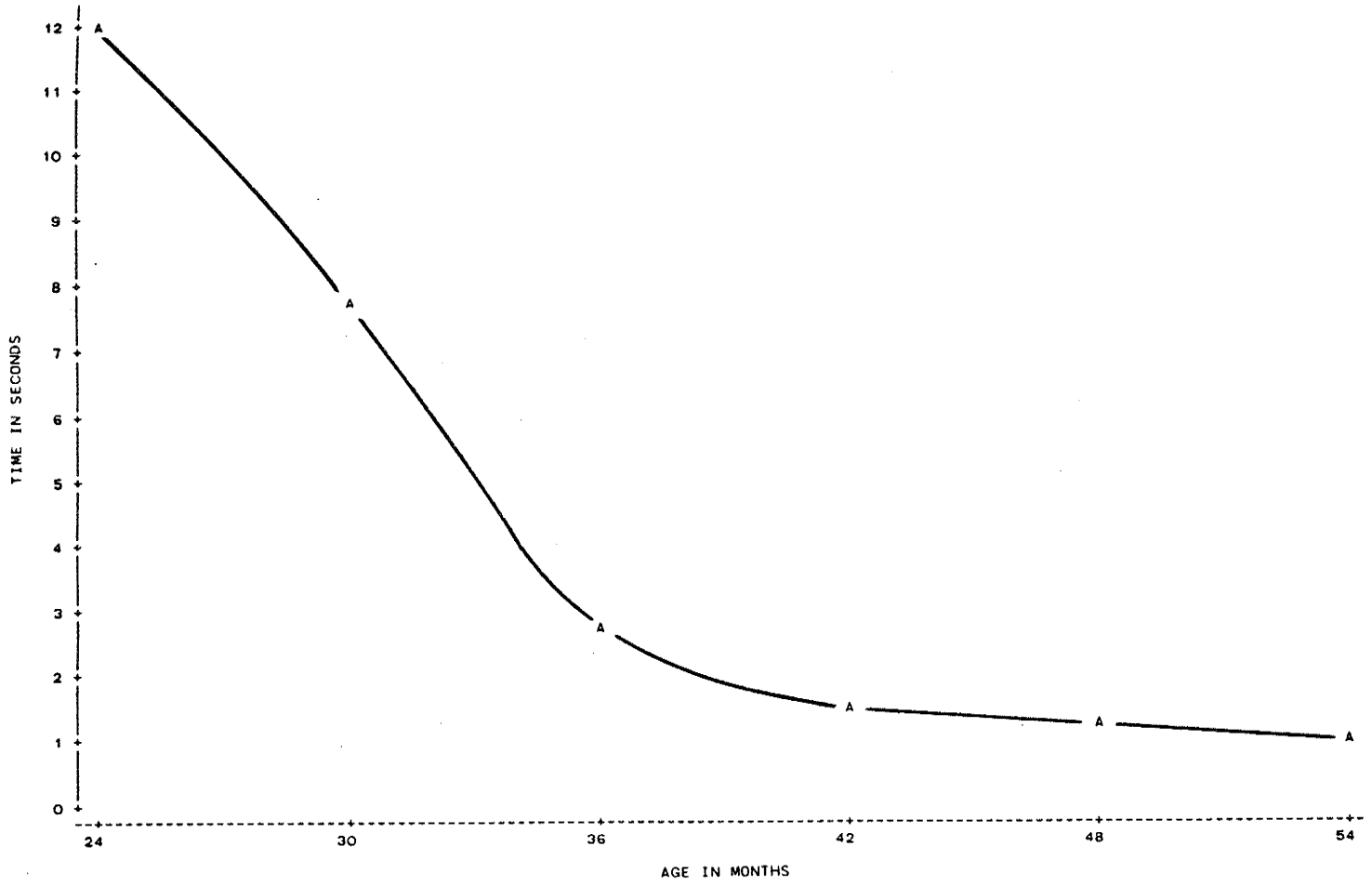

Figure 29

Mean Times for Closing Large Zipper

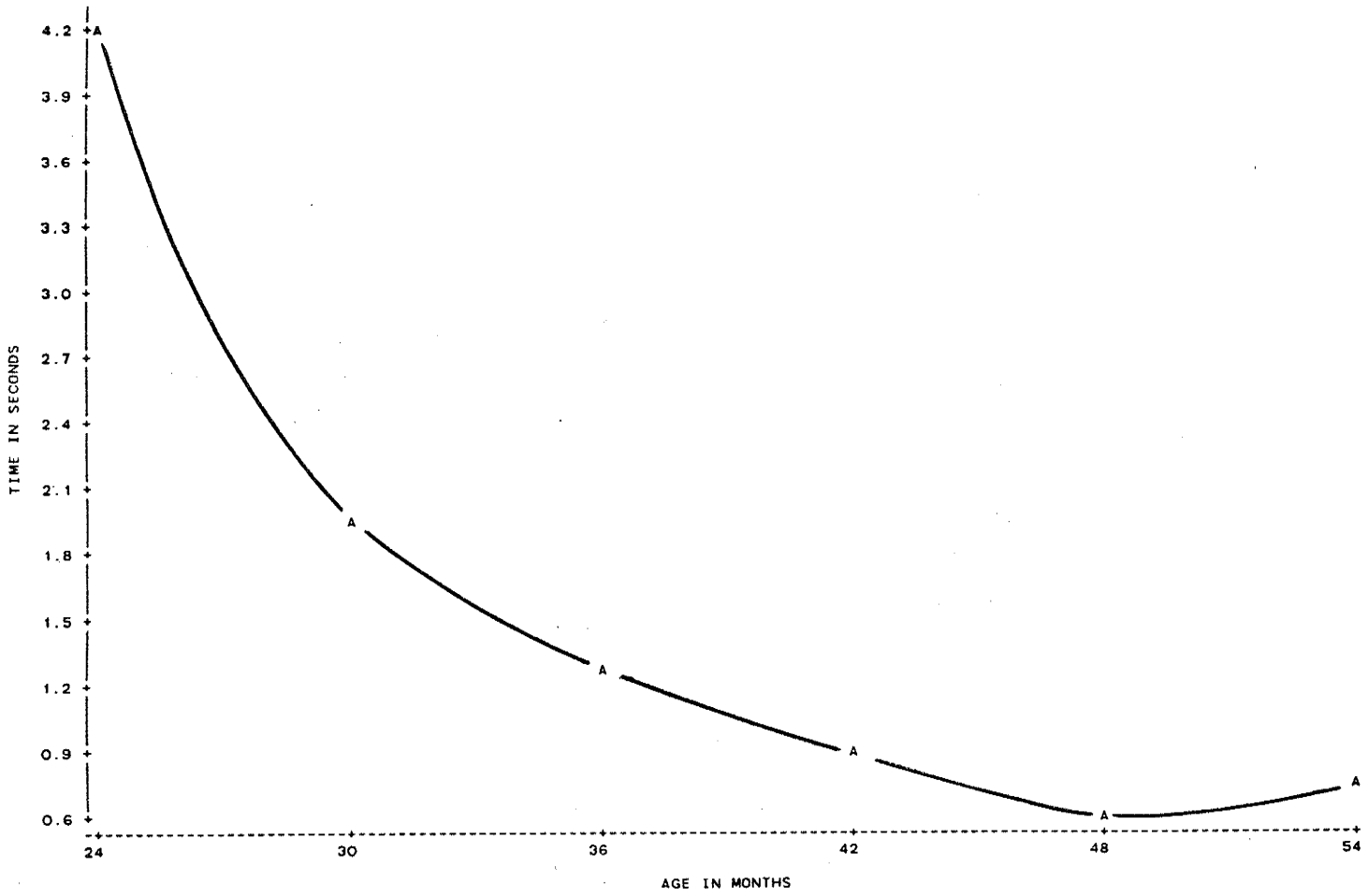

Figure 30

Mean Times for Opening Large Zipper

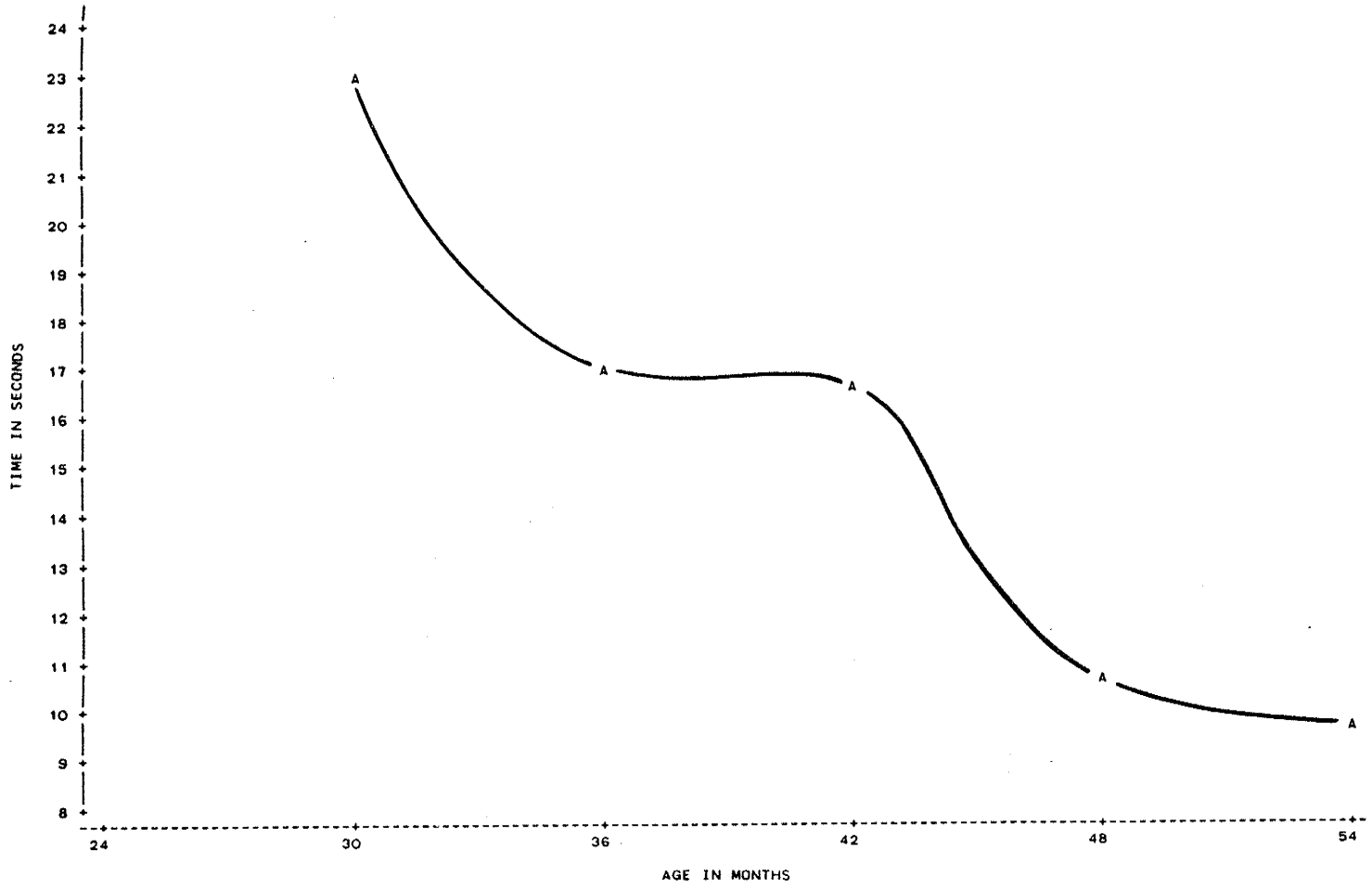

Figure 31

Mean Times for Closing Separating Zipper

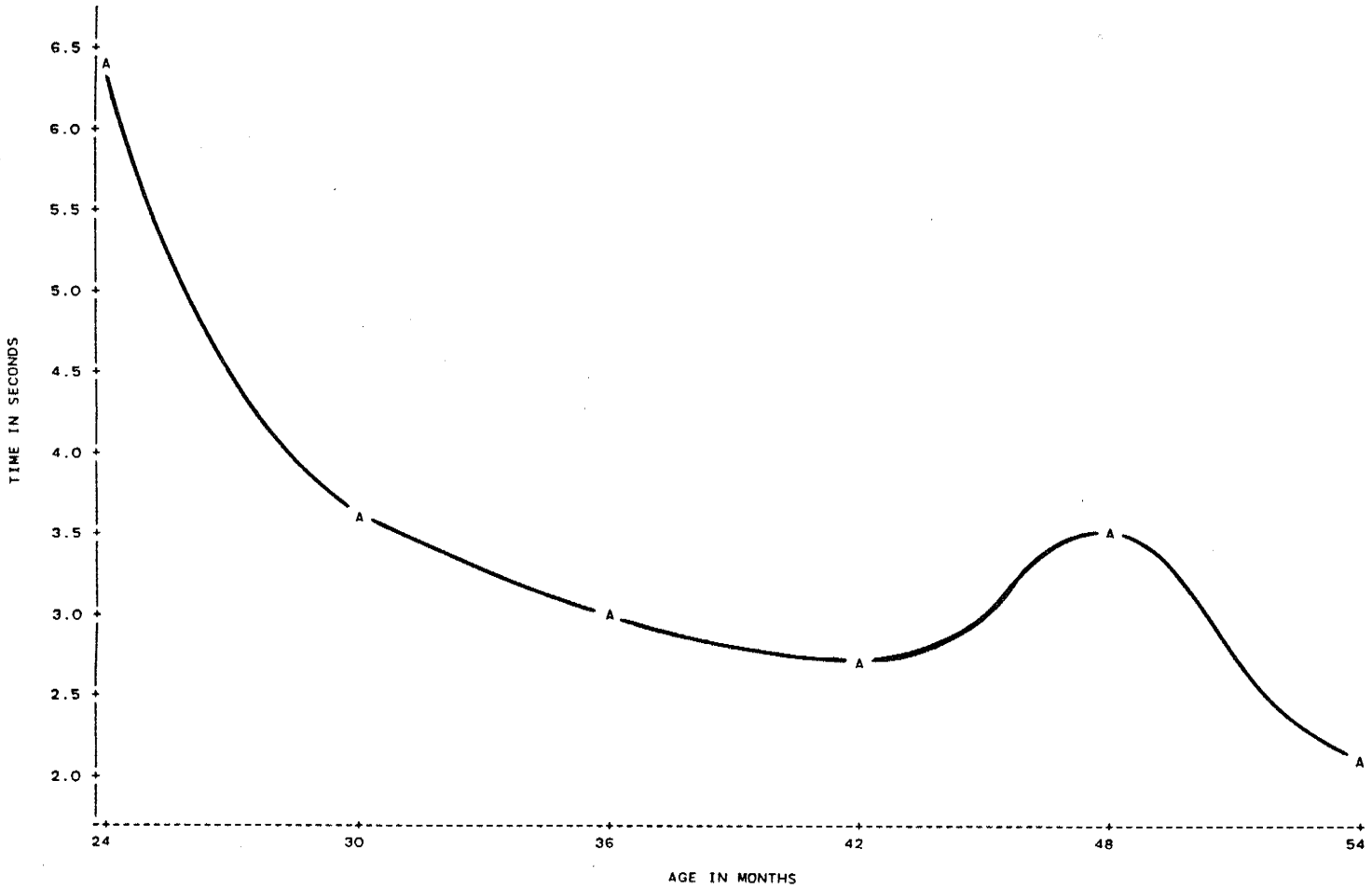

Figure 32

Mean Times for Opening Separating Zipper

Appendix H

MANIPULATIVE DATA BY SIZE AND SEX

Table 22

Manipulative Ability of Size 2 Boys

Fastener	Number of Subjects	Ability to Close			Ability to Open		
		Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean	Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean
1 cm Buttons	4	0	--	--	0	--	--
2 cm Buttons	4	2	44.00	8.70	1	8.90	--
Hammer-on Snaps	4	1	85.60	--	4	26.50	10.98
Hook and Loop Fasteners	4	3	23.83	5.38	4	8.00	5.47
Conventional Zipper	4	3	6.27	3.87	4	7.00	3.23
Large Zipper	4	3	10.27	9.02	4	2.53	2.03
Separating Zipper	4	0	--	--	3	1.87	0.70

Table 23

Manipulative Ability of Size 2 Girls

Fastener	Number on Subjects	Ability to Close			Ability to Open		
		Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean	Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean
1 cm Buttons	5	0	--	--	1	30.30	--
2 cm Buttons	5	1	74.90	--	1	48.10	--
Hammer-on Snaps	5	1	60.50	--	4	9.45	3.44
Hook and Loop Fasteners	5	5	23.80	5.61	5	3.90	0.96
Conventional Zipper	5	4	10.55	5.96	4	12.60	11.40
Large Zipper	5	5	8.84	4.56	5	4.98	3.81
Separating Zipper	5	1	41.00	--	5	8.18	5.81

Table 24

Manipulative Ability of Size 3 Boys

Fastener	Number of Subjects	Ability to Close			Ability to Open		
		Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean	Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean
1 cm Buttons	10	1	116.80	--	2	50.10	18.20
2 cm Buttons	10	1	60.30	--	3	48.70	8.21
Hammer-on Snaps	10	1	41.10	--	9	8.07	1.17
Hook and Loop Fasteners	10	7	22.71	4.06	9	3.51	0.60
Conventional Zipper	10	7	11.11	5.28	10	9.11	4.00
Large Zipper	10	8	4.90	1.42	10	1.50	0.28
Separating Zipper	10	0	--	--	9	3.00	0.97

Table 25

Manipulative Ability of Size 3 Girls

Fastener	Number of Subjects	Ability to Close			Ability to Open		
		Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean	Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean
1 cm Buttons	14	2	110.10	35.70	4	47.63	7.93
2 cm Buttons	14	3	88.77	25.74	4	68.83	37.91
Hammer-on Snaps	14	1	38.80	--	13	7.85	2.09
Hook and Loop Fasteners	14	10	30.73	4.31	14	10.46	6.05
Conventional Zipper	14	12	10.19	3.13	14	8.39	2.86
Large Zipper	14	11	6.36	2.53	14	2.06	0.57
Separating Zipper	14	1	5.00	--	13	3.42	0.75

Table 26

Manipulative Ability of Size 3X Boys

Fastener	Number of Subjects	Ability to Close			Ability to Open		
		Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean	Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean
1 cm Buttons	8	2	41.90	12.50	2	20.45	12.05
2 cm Buttons	8	4	53.25	11.86	4	36.63	5.64
Hammer-on Snaps	8	3	73.53	18.72	8	11.93	5.17
Hook and Loop Fasteners	8	8	22.60	4.58	8	2.24	0.56
Conventional Zipper	8	8	5.91	2.27	8	4.25	1.53
Large Zipper	8	8	2.85	0.94	8	1.18	0.30
Separating Zipper	8	2	6.25	2.35	7	2.97	1.51

Table 27

Manipulative Ability of Size 3X Girls

Fastener	Number of Subjects	Ability to Close			Ability to Open		
		Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean	Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean
1 cm Buttons	2	0	--	--	0	--	--
2 cm Buttons	2	0	--	--	1	46.40	--
Hammer-on Snaps	2	1	55.90	--	2	13.40	8.10
Hook and Loop Fasteners	2	2	40.55	12.45	2	2.35	0.65
Conventional Zipper	2	2	4.95	3.15	2	5.70	3.90
Large Zipper	2	2	16.65	15.05	2	0.75	0.25
Separating Zipper	2	0	--	--	2	3.05	0.15

Table 28

Manipulative Ability of Size 4 Boys

Fastener	Number of Subjects	Ability to Close			Ability to Open		
		Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean	Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean
1 cm Buttons	16	6	37.72	7.50	8	23.49	7.24
2 cm Buttons	16	9	29.52	5.13	11	27.57	3.23
Hammer-on Snaps	16	8	54.56	13.32	16	6.33	1.80
Hook and Loop Fasteners	16	16	21.57	3.22	16	2.14	0.42
Conventional Zipper	16	16	4.23	1.57	16	3.01	0.77
Large Zipper	16	16	2.13	0.61	16	0.79	0.23
Separating Zipper	16	7	10.51	2.03	16	3.38	1.42

Table 29

Manipulative Ability of Size 4 Girls

Fastener	Number of Subjects	Ability to Close			Ability to Open		
		Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean	Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean
1 cm Buttons	25	18	43.95	6.79	21	20.40	3.01
2 cm Buttons	25	21	42.37	5.20	23	24.82	4.23
Hammer-on Snaps	25	19	45.74	5.43	25	5.52	1.35
Hook and Loop Fasteners	25	25	18.43	1.76	25	2.74	0.37
Conventional Zipper	25	25	2.17	0.31	25	2.27	0.37
Large Zipper	25	25	2.09	0.53	25	0.85	0.10
Separating Zipper	25	11	13.91	3.33	24	2.93	0.52

Table 30

Manipulative Ability of Size 5 Boys

Fastener	Number of Subjects	Ability to Close			Ability to Open		
		Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean	Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean
1 cm Buttons	12	5	42.28	10.84	7	32.53	9.26
2 cm Buttons	12	8	41.24	7.27	10	33.16	7.69
Hammer-on Snaps	12	7	36.03	5.48	12	5.25	1.01
Hook and Loop Fasteners	12	12	27.35	3.22	12	2.58	0.87
Conventional Zipper	12	12	2.56	0.78	12	2.83	1.01
Large Zipper	12	12	1.40	0.39	12	0.97	0.21
Separating Zipper	12	6	7.70	1.64	11	2.15	0.40

Table 31

Manipulative Ability of Size 5 Girls

Fastener	Number of Subjects	Ability to Close			Ability to Open		
		Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean	Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean
1 cm Buttons	13	10	47.40	9.20	12	21.22	4.18
2 cm Buttons	13	12	46.46	13.57	13	28.45	7.48
Hammer-on Snaps	13	10	40.52	5.23	13	6.05	1.54
Hook and Loop Fasteners	13	13	20.63	2.78	13	1.82	0.26
Conventional Zipper	13	13	1.34	0.25	13	1.50	0.28
Large Zipper	13	13	1.26	0.19	13	1.10	0.16
Separating Zipper	13	8	14.38	5.23	13	2.92	0.89

Table 32

Manipulative Ability of Size 6 Boys

Fastener	Number of Subjects	Ability to Close			Ability to Open		
		Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean	Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean
1 cm Buttons	12	5	32.04	1.30	5	13.90	4.52
2 cm Buttons	12	7	48.34	11.29	9	34.14	12.13
Hammer-on Snaps	12	9	67.30	10.25	12	4.87	0.65
Hook and Loop Fasteners	12	12	20.59	2.36	12	2.23	0.45
Conventional Zipper	12	12	2.41	0.70	12	2.24	0.47
Large Zipper	12	12	2.68	0.69	12	1.80	0.71
Separating Zipper	12	6	9.15	2.36	12	4.17	1.45

Table 33

Manipulative Ability of Size 6 Girls

Fastener	Number of Subjects	Ability to Close			Ability to Open		
		Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean	Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean
1 cm Buttons	5	5	42.30	15.85	5	12.64	1.58
2 cm Buttons	5	5	19.44	2.64	5	11.20	4.04
Hammer-on Snaps	5	5	27.62	4.36	5	4.04	1.00
Hook and Loop Fasteners	5	5	11.22	2.65	5	2.08	0.77
Conventional Zipper	5	5	1.94	0.73	5	2.08	0.61
Large Zipper	5	5	1.60	0.42	5	0.82	0.18
Separating Zipper	5	5	8.28	2.06	5	2.40	0.51

Table 34

Manipulative Ability of Size 6X Boys

Fastener	Number on Subjects	Ability to Close			Ability to Open		
		Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean	Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean
1 cm Buttons	2	2	82.80	25.20	2	34.65	11.65
2 cm Buttons	2	2	27.25	1.15	2	17.15	2.95
Hammer-on Snaps	2	2	34.45	14.65	2	2.35	0.55
Hook and Loop Fasteners	2	2	15.45	7.25	2	2.80	1.40
Conventional Zipper	2	2	1.15	0.45	2	1.20	0.20
Large Zipper	2	2	0.55	0.05	2	1.05	0.65
Separating Zipper	2	2	18.65	5.35	2	2.45	1.25

Table 35

Manipulative Ability of Size 6X Girls

Fastener	Number of Subjects	Ability to Close			Ability to Open		
		Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean	Number Completed Task	Mean Time in Seconds	Standard Deviation of Mean
1 cm Buttons	4	3	28.03	1.49	3	10.67	1.91
2 cm Buttons	4	4	33.33	10.34	4	22.73	9.53
Hammer-on Snaps	4	4	53.20	20.22	4	4.23	1.39
Hook and Loop Fasteners	4	4	23.50	7.29	4	1.65	0.70
Conventional Zipper	4	4	1.53	0.58	4	1.08	0.27
Large Zipper	4	4	1.03	0.40	4	1.03	0.34
Separating Zipper	4	3	16.03	6.65	4	2.28	0.82

Appendix I

LOGISTIC RESPONSE FUNCTION EQUATIONS

Logistic Response Function Equation

$$E(Y) = \frac{\exp\ (\beta_0 + \beta_1 X)}{1 + \exp\ (\beta_0 + \beta_1 X)}$$

Logistic Trnasformation of the Probability p Equation

$$p' = \beta_0 + \beta_1 X$$

Taken from: Neter, John and William Wasserman. Applied Linear Statistical Models. Homewood, Ill.: Richard D. Irwin, 1974, pp. 329-330.

Appendix J

ESTIMATED PARAMETERS AND STATISTICAL TESTS FROM LOGISTIC REGRESSION EQUATIONS ON MANIPULATING FASTENERS

Table 36

Estimated Parameters and Statistical Tests from Logistic Regression Equation on Closing Fasteners

Fastener	Number Not Able to Manipulate	Number Able to Manipulate	Variable	Beta	Standard Error of Beta	Chi-Square H_o:Beta=0	P Value	Fraction of Concordant Pairs of Predicted Probability & Responses
1 cm Buttons	67	65	Intercept	-14.9432	2.5150	35.30	0.0000	0.917
			Age	0.2805	0.0463	36.70	0.0000	
			Sex	2.2976	0.6303	13.29	0.0003	
2 cm Buttons	53	79	Intercept	-13.0142	2.3152	31.60	0.0000	0.911
			Age	0.2876	0.0484	35.28	0.0000	
			Sex	1.5176	0.5925	6.56	0.0104	
Hammer-on Snap	60	72	Intercept	-11.5658	1.9391	35.58	0.0000	0.891
			Age	0.2945	0.0485	36.93	0.0000	
Hook & Loop Fasteners	8	124	Intercept	-7.9905	3.0131	7.03	0.0080	0.883
			Age	0.3410	0.1099	9.62	0.0019	
Conventional Zipper	7	125	Intercept	-9.0374	3.5359	6.53	0.0106	0.816
			Age	0.3876	0.1325	8.55	0.0035	
Large Zipper	6	126	Intercept	-11.2738	4.6550	5.87	0.0154	0.915
			Age	0.4829	0.1814	7.09	0.0078	
Separating Zipper	80	52	Intercept	-9.2263	1.5492	35.47	0.0000	0.821
			Age	0.2078	0.0351	35.10	0.0000	

Table 37

Estimated Parameters and Statistical Tests from Logistic Regression Equations on Opening Fasteners

Fastener	Number Not Able to Manipulate	Number Able to Manipulate	Variable	Beta	Standard Error of Beta	Chi-Square H_o:Beta=0	P Value	Fraction of Concordant Pairs of Predicted Probability & Responses
1 cm Buttons	60	72	Intercept	-15.2698	2.6354	33.57	0.0000	0.920
			Age	0.2922	0.0493	35.16	0.0000	
			Sex	2.5639	0.6713	14.59	0.0001	
2 cm Buttons	41	91	Intercept	-17.9563	3.7461	22.98	0.0000	0.948
			Age	0.4358	0.0870	25.09	0.0000	
			Sex	1.9947	0.7816	6.51	0.0107	
Hammer-on Snaps	3	129	Intercept	-33.6780	111.6196	0.09	0.7629	0.930
			Age	1.4490	--	--	--	
Hook & Loop Fasteners	2	130	Intercept	4.1744	0.7125	34.32	0.0000	0.500
			Age	--	--	--	--	
Conventional Zipper	1	131	Intercept	4.8752	1.0038	23.59	0.0000	0.500
			Age	--	--	--	--	
Large Zipper	0	132	Intercept	--	--	--	--	--
			Age	--	--	--	--	
Separating Zipper	7	125	Intercept	-6.7913	2.9079	5.45	0.0195	0.867
			Age	0.3039	0.1053	8.33	0.0039	

Table 38

Estimated Parameters and Statistical Tests from Logistic Regression Equations on Closing and Opening Fasteners

Fastener	Number Not Able to Manipulate	Number Able to Manipulate	Variable	Beta	Standard Error of Beta	Chi-Square H_o:Beta=0	P Value	Fraction of Concordant Pairs of Predicted Probability & Responses
1 cm Buttons	74	58	Intercept	-16.9916	2.8997	34.34	0.0000	0.928
			Age	0.3140	0.0529	35.29	0.0000	
			Sex	2.3580	0.6640	12.61	0.0004	
2 cm Buttons	54	78	Intercept	-14.4926	2.5936	31.22	0.0000	0.921
			Age	0.3139	0.0537	34.19	0.0000	
			Sex	1.7914	0.6343	7.98	0.0047	
Hammer-on Snaps	60	72	Intercept	-11.5658	1.9391	35.58	0.0000	0.891
			Age	0.2945	0.0485	36.93	0.0000	
Hook and Loop Fasteners	9	123	Intercept	-6.0807	2.3697	6.58	0.0103	0.851
			Age	0.2658	0.0826	10.34	0.0013	
Conventional Zipper	7	125	Intercept	-9.0374	3.5359	6.53	0.0106	0.816
			Age	0.3876	0.1325	8.55	0.0035	
Large Zipper	6	126	Intercept	-11.2738	4.6550	5.87	0.0154	0.915
			Age	0.4829	0.1814	7.09	0.0078	
Separating Zipper	80	52	Intercept	-9.2263	1.5492	35.47	0.0000	0.821
			Age	0.2078	0.0351	35.10	0.0000	

Appendix K

PREDICTED PROBABILITIES AND CONFIDENCE INTERVALS FOR MANIPULATING FASTENERS

Table 39

Predicted Probabilities and Confidence Intervals for Closing Fasteners

Fastener		24 Months			30 Months			36 Months		
		P	Lower	Upper	P	Lower	Upper	P	Lower	Upper
1 cm Buttons	Boys	0.0027	0.0004	0.0194	0.0143	0.0032	0.0613	0.0726	0.0262	0.1855
	Girls	0.0262	0.0063	0.1031	0.1264	0.0491	0.2885	0.4379	0.2634	0.6292
2 cm Buttons	Boys	0.0100	0.0019	0.0516	0.0537	0.0168	0.1583	0.2415	0.1220	0.4218
	Girls	0.0440	0.0119	0.1497	0.2055	0.0917	0.3985	0.5922	0.3976	0.7616
Hammer-on Snaps		0.0110	0.0023	0.0511	0.0611	0.0221	0.1581	0.2760	0.1679	0.4186
Hook and Loop Fasteners		0.5482	0.2910	0.7819	0.9037	0.7664	0.9641	0.9864	0.8996	0.9983
Conventional Zipper		0.5659	0.3003	0.7984	0.9303	0.7847	0.9799	0.9927	0.9065	0.9995
Large Zipper		0.5785	0.3059	0.8105	0.9614	0.7909	0.9939	0.9978	0.9047	1.0000
Separating Zipper		0.0142	0.0034	0.0567	0.0477	0.0173	0.1249	0.1485	0.0797	0.2599

Table 39--Continued

Predicted Probabilities and Confidence Intervals for Closing Fasteners

Fastener		42 Months			48 Months			54 Months		
		P	Lower	Upper	P	Lower	Upper	P	Lower	Upper
1 cm Buttons	Boys	0.2965	0.1613	0.4801	0.6940	0.4978	0.8384	0.9243	0.7927	0.9750
	Girls	0.8074	0.6389	0.9086	0.9576	0.8700	0.9870	0.9918	0.9579	0.9985
2 cm Buttons	Boys	0.6412	0.4538	0.7936	0.9094	0.7758	0.9668	0.9826	0.9245	0.9962
	Girls	0.8907	0.7493	0.9570	0.9786	0.9165	0.9948	0.9961	0.9739	0.9994
Hammer-on Snaps		0.6905	0.5550	0.7996	0.9289	0.8333	0.9715	0.9871	0.9463	0.9970
Hook and Loop Fasteners		0.9982	0.9533	0.9999	0.9998	0.9781	1.0000	1.0000	0.9897	1.0000
Conventional Zipper		0.9993	0.9569	1.0000	0.9999	0.9800	1.0000	1.0000	0.9908	1.0000
Large Zipper		0.9999	0.9553	1.0000	1.0000	0.9791	1.0000	1.0000	0.9903	1.0000
Separating Zipper		0.3775	0.2739	0.4937	0.6784	0.5493	0.7850	0.8801	0.7588	0.9448

Table 40

Predicted Probabilities and Confidence Intervals for Opening Fasteners

Fastener		24 Months			30 Months			36 Months		
		P	Lower	Upper	P	Lower	Upper	P	Lower	Upper
1 cm Buttons	Boys	0.0034	0.0005	0.0238	0.0191	0.0045	0.0773	0.1008	0.0391	0.2358
	Girls	0.0419	0.0111	0.1452	0.2014	0.0889	0.3946	0.5928	0.3968	0.7632
2 cm Buttons	Boys	0.0041	0.0004	0.0409	0.0527	0.0128	0.1924	0.4321	0.2368	0.6510
	Girls	0.0291	0.0055	0.1391	0.2904	0.1275	0.5339	0.8483	0.6339	0.9475
Hammer-on Snaps		0.7500	0.4481	0.9172	0.9999	0.0000	1.0000	1.0000	0.0000	1.0000
Hook and Loop Fasteners		0.9848	0.9415	0.9962	0.9848	0.9415	0.9962	0.9848	0.9415	0.9962
Conventional Zipper		0.9924	0.9482	0.9989	0.9924	0.9482	0.9989	0.9924	0.9482	0.9989
Large* Zipper		--	--	--	--	--	--	--	--	--
Separating Zipper		0.6232	0.3545	0.8328	0.9111	0.7850	0.9664	0.9845	0.8962	0.9979

*Every child tested was able to open the large zipper.

Table 40--Continued

Predicted Probabilities and Confidence Intervals for Opening Fasteners

Fastener		42 Months			48 Months			54 Months		
		P	Lower	Upper	P	Lower	Upper	P	Lower	Upper
1 cm Buttons	Boys	0.3929	0.2316	0.5815	0.7888	0.6023	0.9021	0.9557	0.8532	0.9876
	Girls	0.8936	0.7525	0.9587	0.9798	0.9191	0.9952	0.9964	0.9752	0.9995
2 cm Buttons	Boys	0.9122	0.7465	0.9735	0.9930	0.9449	0.9992	0.9995	0.9890	1.0000
	Girls	0.9871	0.9161	0.9981	0.9990	0.9832	0.9999	0.9999	0.9967	1.0000
Hammer-on Snaps		1.0000	0.0000	1.0000	1.0000	0.0000	1.0000	1.0000	0.0000	1.0000
Hook and Loop Fasteners		0.9848	0.9415	0.9962	0.9848	0.9415	0.9962	0.9848	0.9415	0.9962
Conventional Zipper		0.9924	0.9482	0.9989	0.9924	0.9482	0.9989	0.9924	0.9482	0.9989
Large* Zipper		--	--	--	--	--	--	--	--	--
Separating Zipper		0.9975	0.9436	0.9999	0.9996	0.9688	1.0000	0.9999	0.9827	1.0000

*Every child tested was able to open the large zipper.

Table 41

Predicted Probabilities and Confidence Intervals for Closing and Opening Fasteners

Fastener		24 Months			30 Months			36 Months		
		P	Lower	Upper	P	Lower	Upper	P	Lower	Upper
1 cm Buttons	Boys	0.0008	0.0001	0.0091	0.0054	0.0009	0.0329	0.0346	0.0096	0.1165
	Girls	0.0087	0.0014	0.0507	0.0544	0.0157	0.1715	0.2746	0.1355	0.4776
2 cm Buttons	Boys	0.0057	0.0009	0.0361	0.0361	0.0098	0.1243	0.1975	0.0914	0.3759
	Girls	0.0330	0.0080	0.1265	0.1834	0.0769	0.3772	0.5962	0.3932	0.7708
Hammer-on Snaps		0.0110	0.0023	0.0511	0.0611	0.0221	0.1581	0.2760	0.1679	0.4186
Hook and Loop Fasteners		0.5739	0.3228	0.7920	0.8691	0.7444	0.9380	0.9703	0.8824	0.9930
Conventional Zipper		0.5659	0.3003	0.7984	0.9303	0.7847	0.9799	0.9927	0.9065	0.9995
Large Zipper		0.5785	0.3059	0.8105	0.9614	0.7909	0.9939	0.9978	0.9047	1.0000
Separating Zipper		0.0142	0.0034	0.0567	0.0477	0.0173	0.1249	0.1485	0.0797	0.2599

Table 41--Continued

Predicted Probabilities and Confidence Intervals for Closing and Opening Fasteners

Fastener		42 Months			48 Months			54 Months		
		P	Lower	Upper	P	Lower	Upper	P	Lower	Upper
1 cm Buttons	Boys	0.1907	0.0872	0.3676	0.6079	0.4011	0.7821	0.9107	0.7601	0.9705
	Girls	0.7135	0.5207	0.8509	0.9425	0.8355	0.9814	0.9908	0.9525	0.9983
2 cm Buttons	Boys	0.6181	0.4237	0.7808	0.9141	0.7774	0.9701	0.9859	0.9320	0.9972
	Girls	0.9066	0.7670	0.9662	0.9846	0.9301	0.9967	0.9976	0.9803	0.9997
Hammer-on Snaps		0.6905	0.5550	0.7996	0.9289	0.8333	0.9715	0.9871	0.9463	0.9970
Hook and Loop Fastener		0.9938	0.9386	0.9994	0.9987	0.9673	1.0000	0.9997	0.9826	1.0000
Conventional Zipper		0.9993	0.9569	1.0000	0.9999	0.9800	1.0000	1.0000	0.9908	1.0000
Large Zipper		0.9999	0.9553	1.0000	1.0000	0.9791	1.0000	1.0000	0.9903	1.0000
Separating Zipper		0.3775	0.2739	0.4937	0.6784	0.5493	0.7850	0.8801	0.7588	0.9448

Appendix L

GRAPHS OF PREDICTED PROBABILITIES

OF MANIPULATING FASTENERS

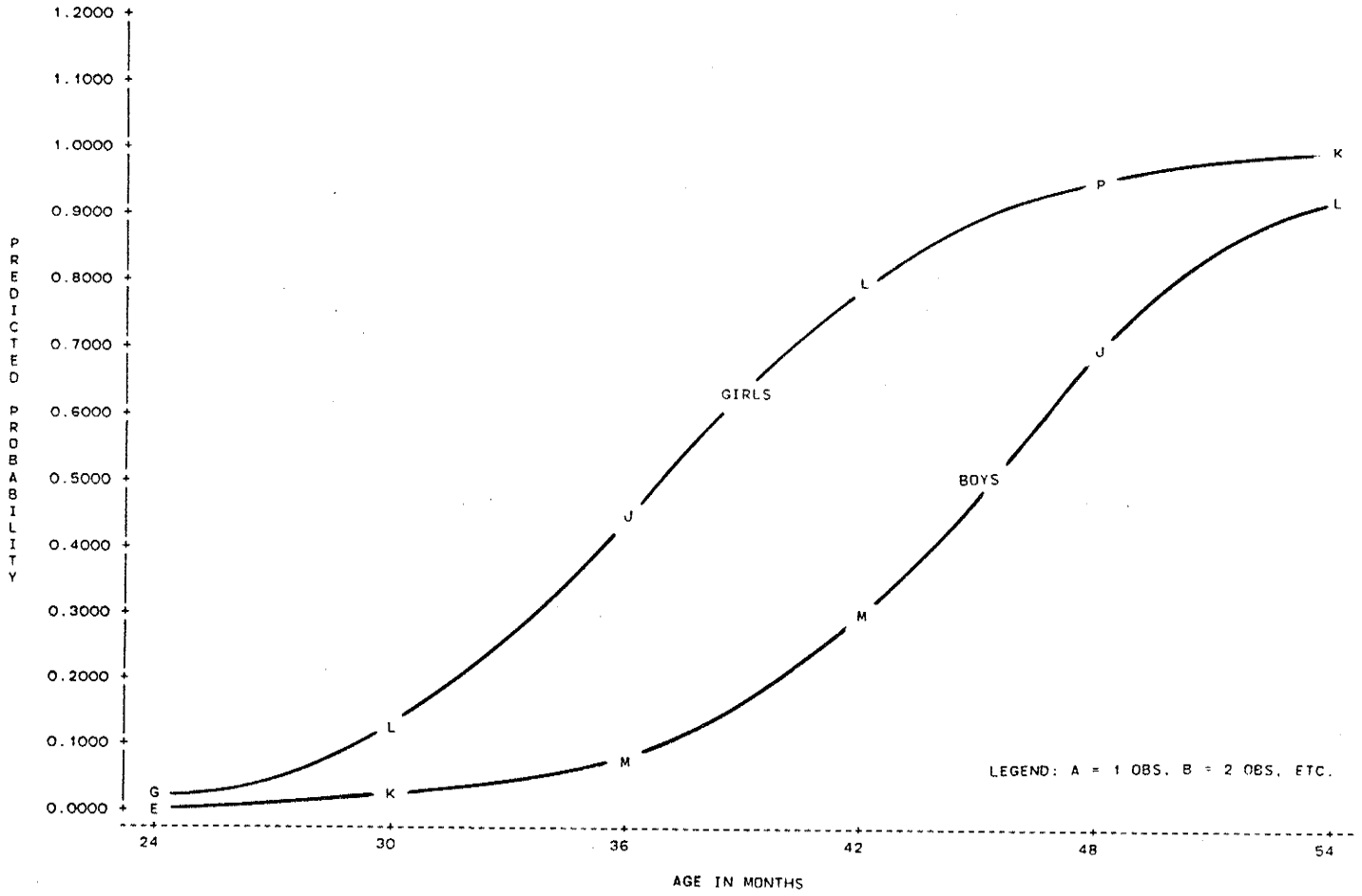

Figure 33

Predicted Probability of Closing 1 cm Buttons

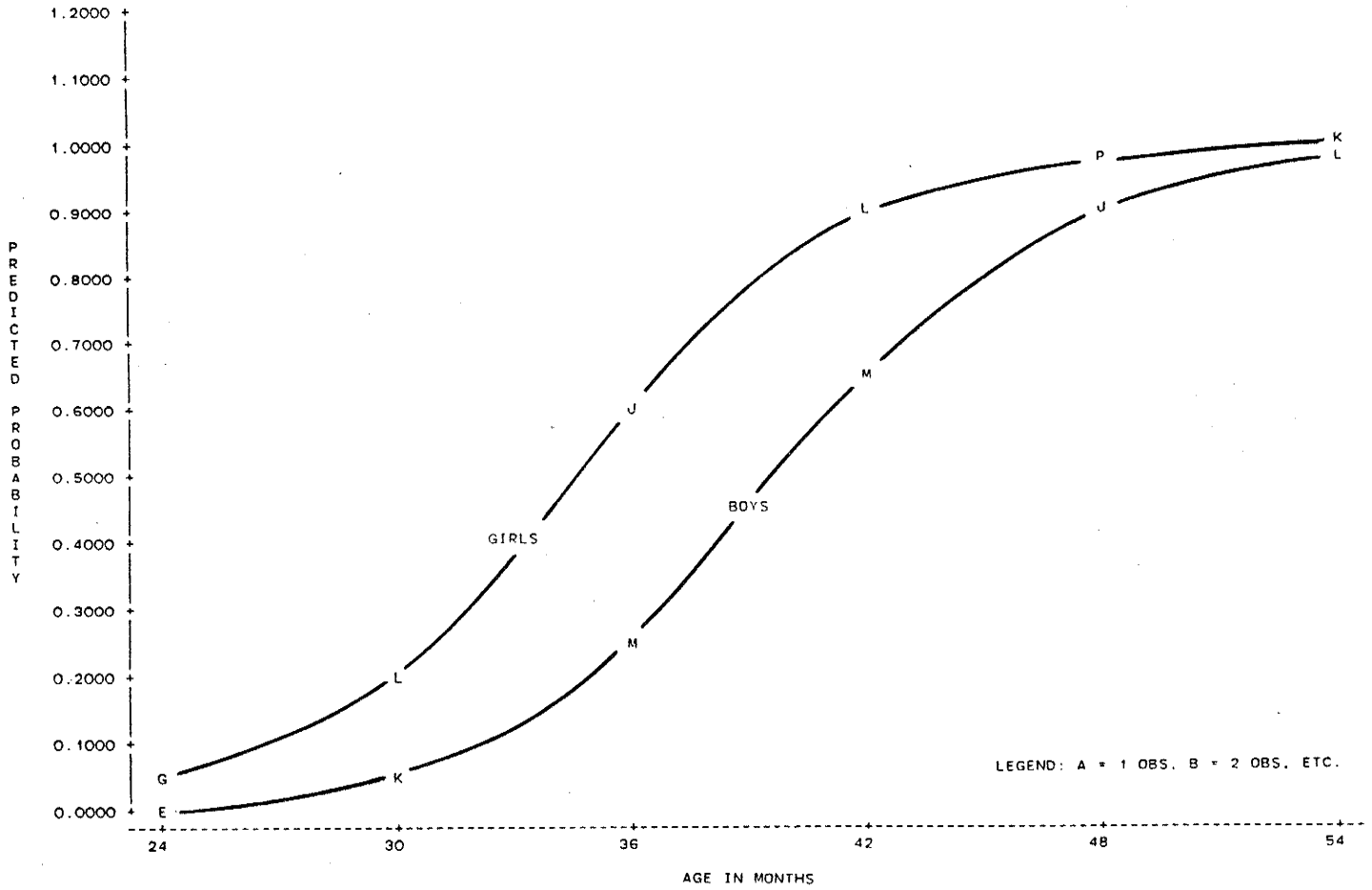

Figure 34

Predicted Probability of Closing 2 cm Buttons

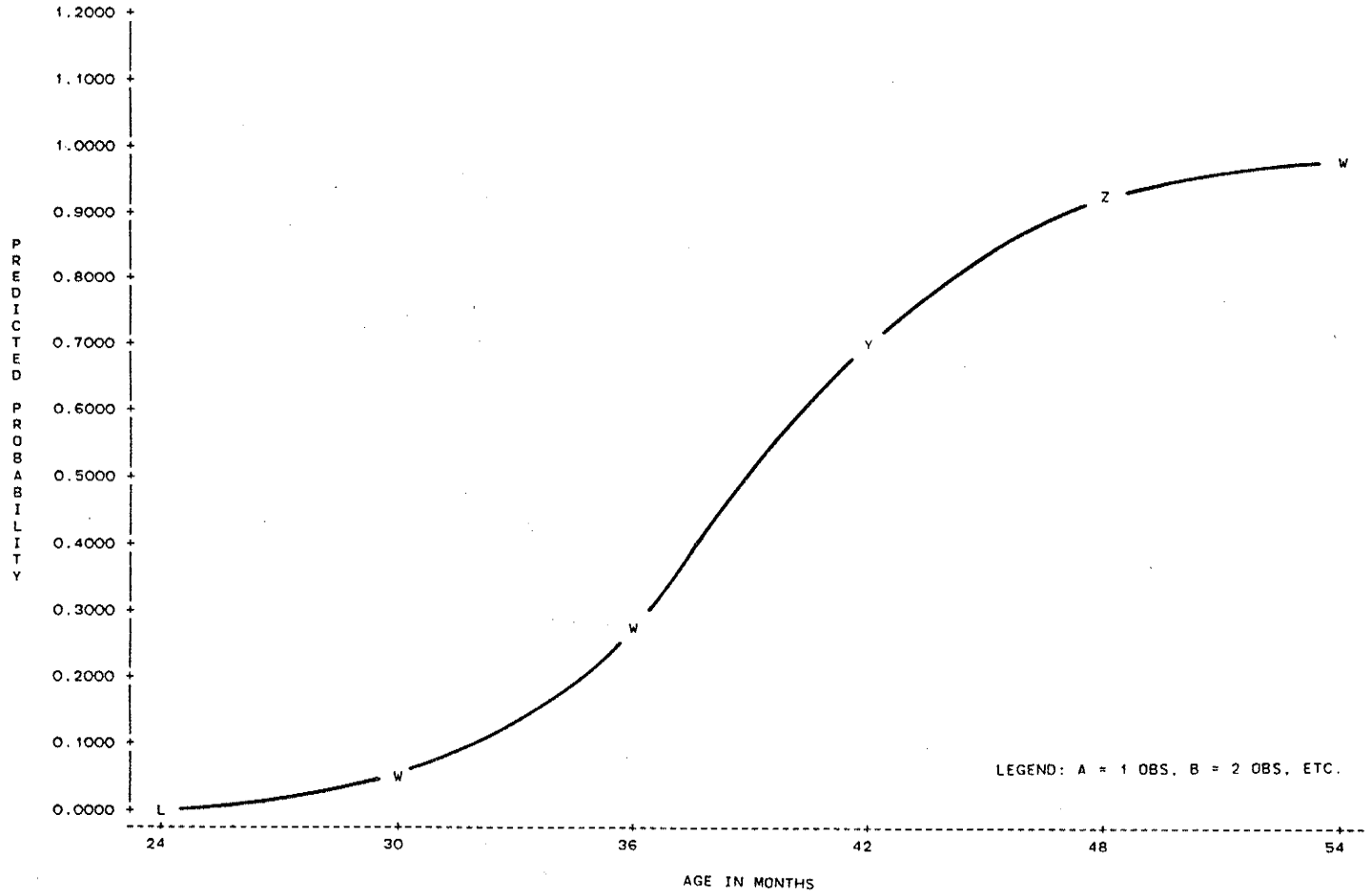

Figure 35

Predicted Probability of Closing Hammer-on Snaps

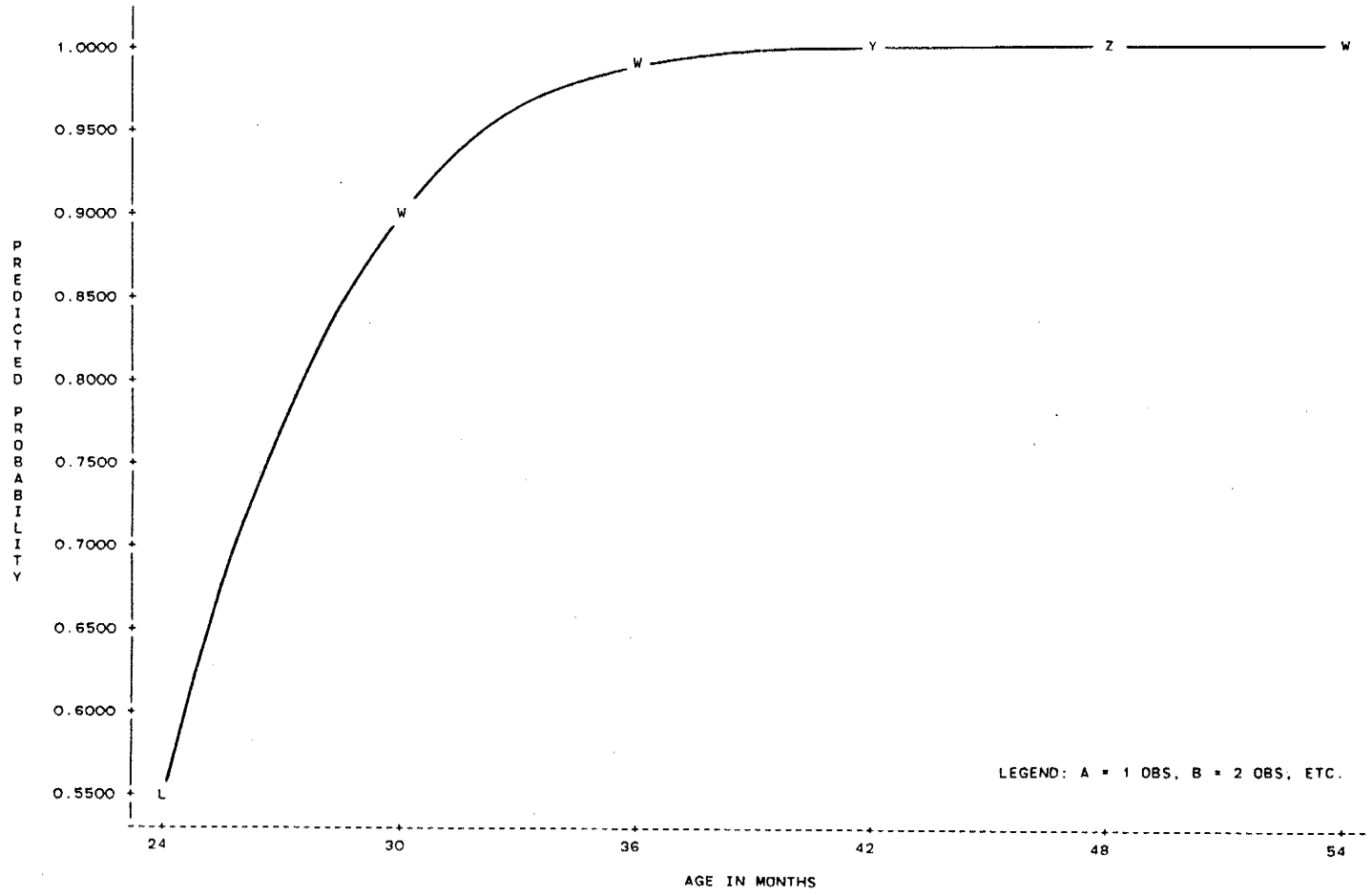

Figure 36

Predicted Probability of Closing Hook and Loop Fasteners

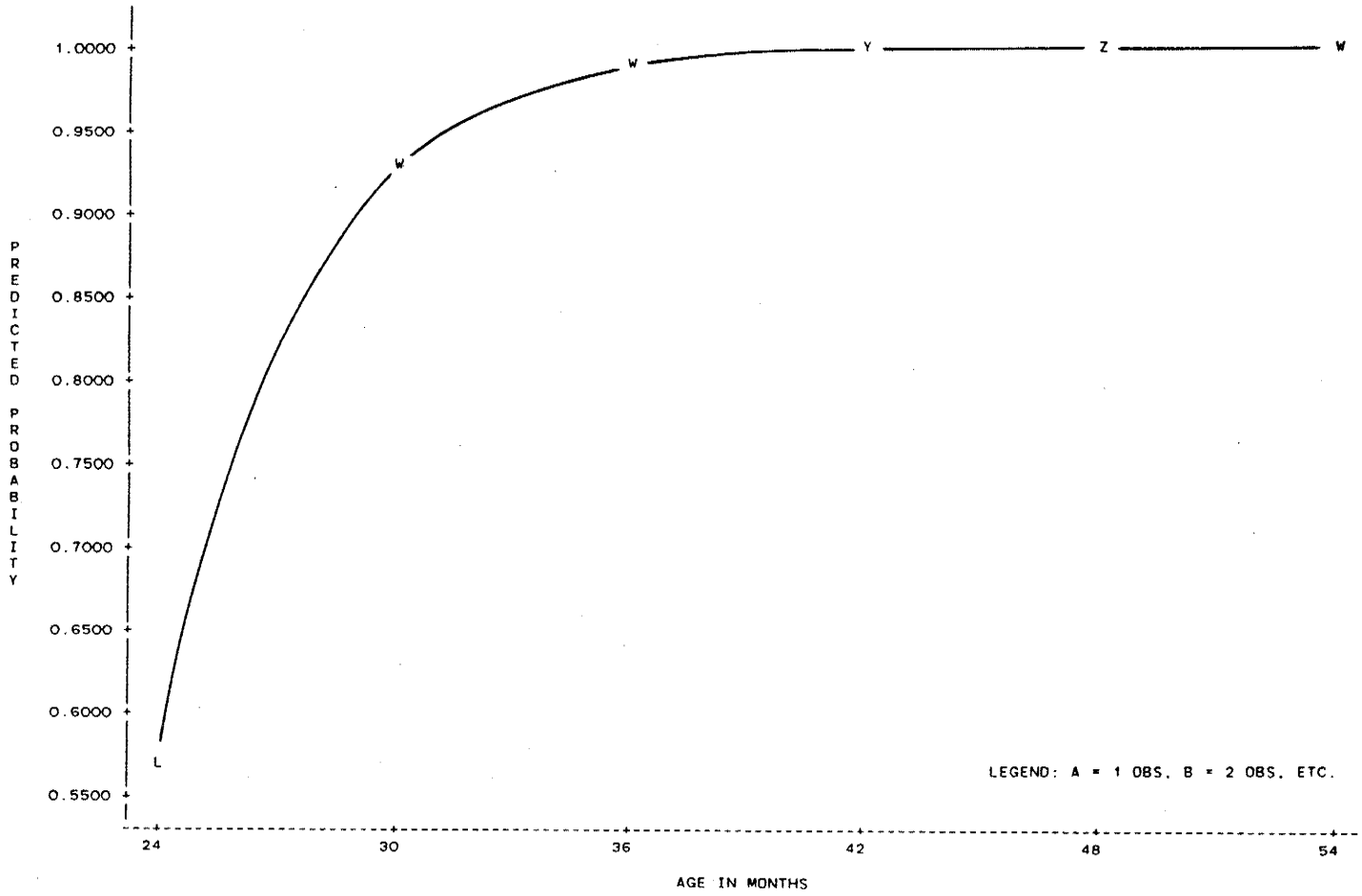

Figure 37

Predicted Probability of Closing Conventional Zipper

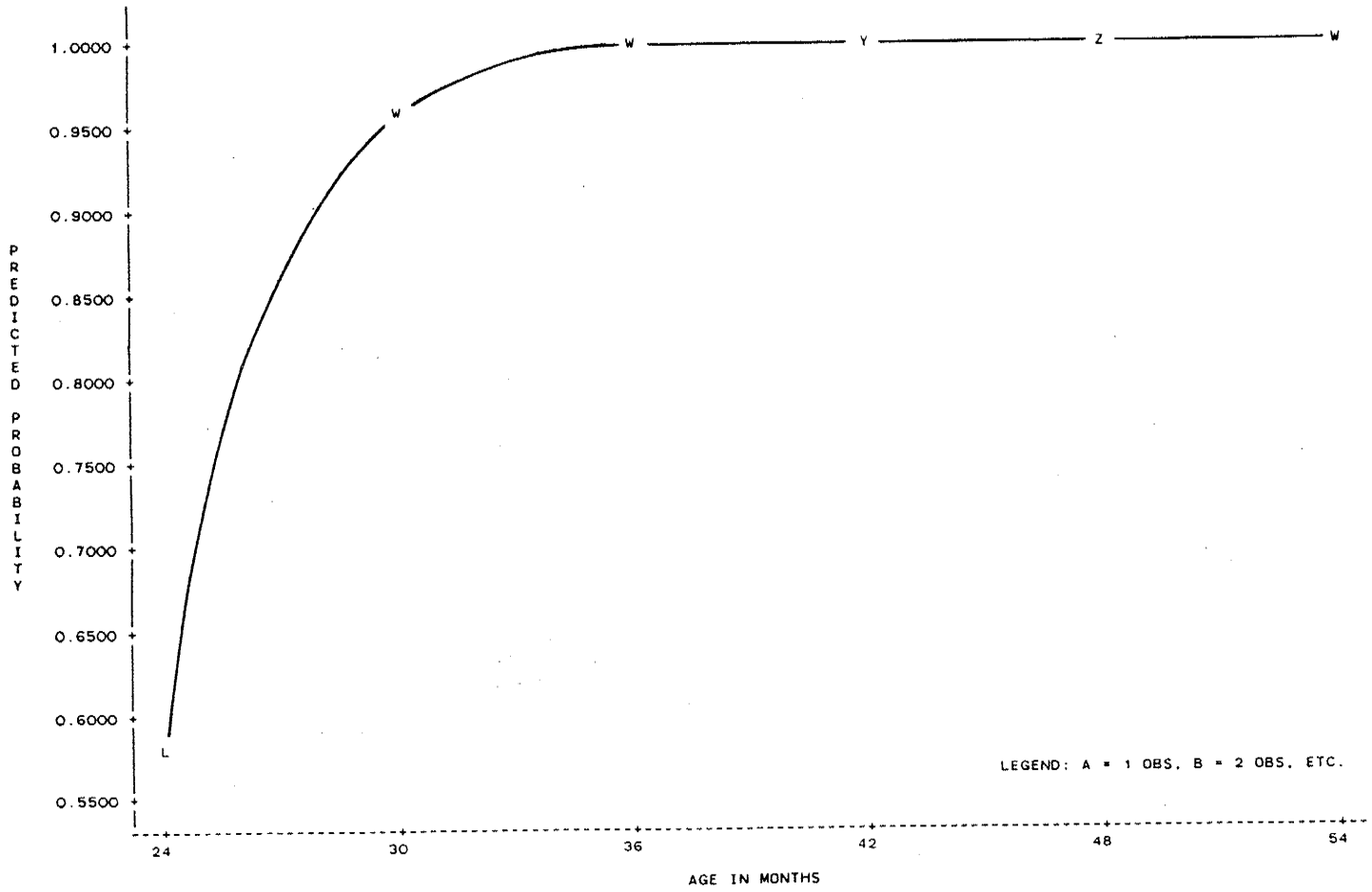

Figure 38

Predicted Probability of Closing Large Zipper

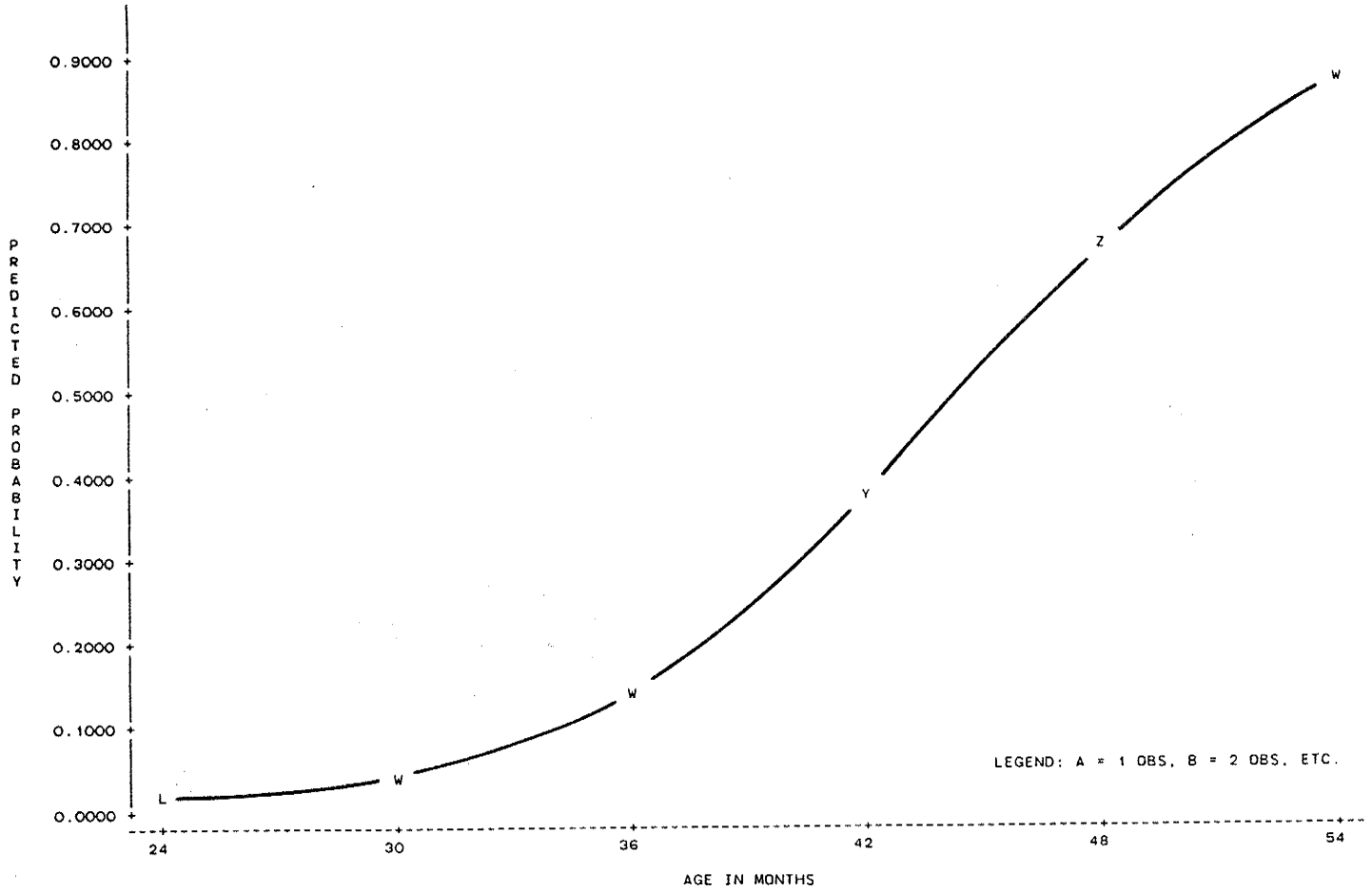

Figure 39

Predicted Probability of Closing Separating Zipper

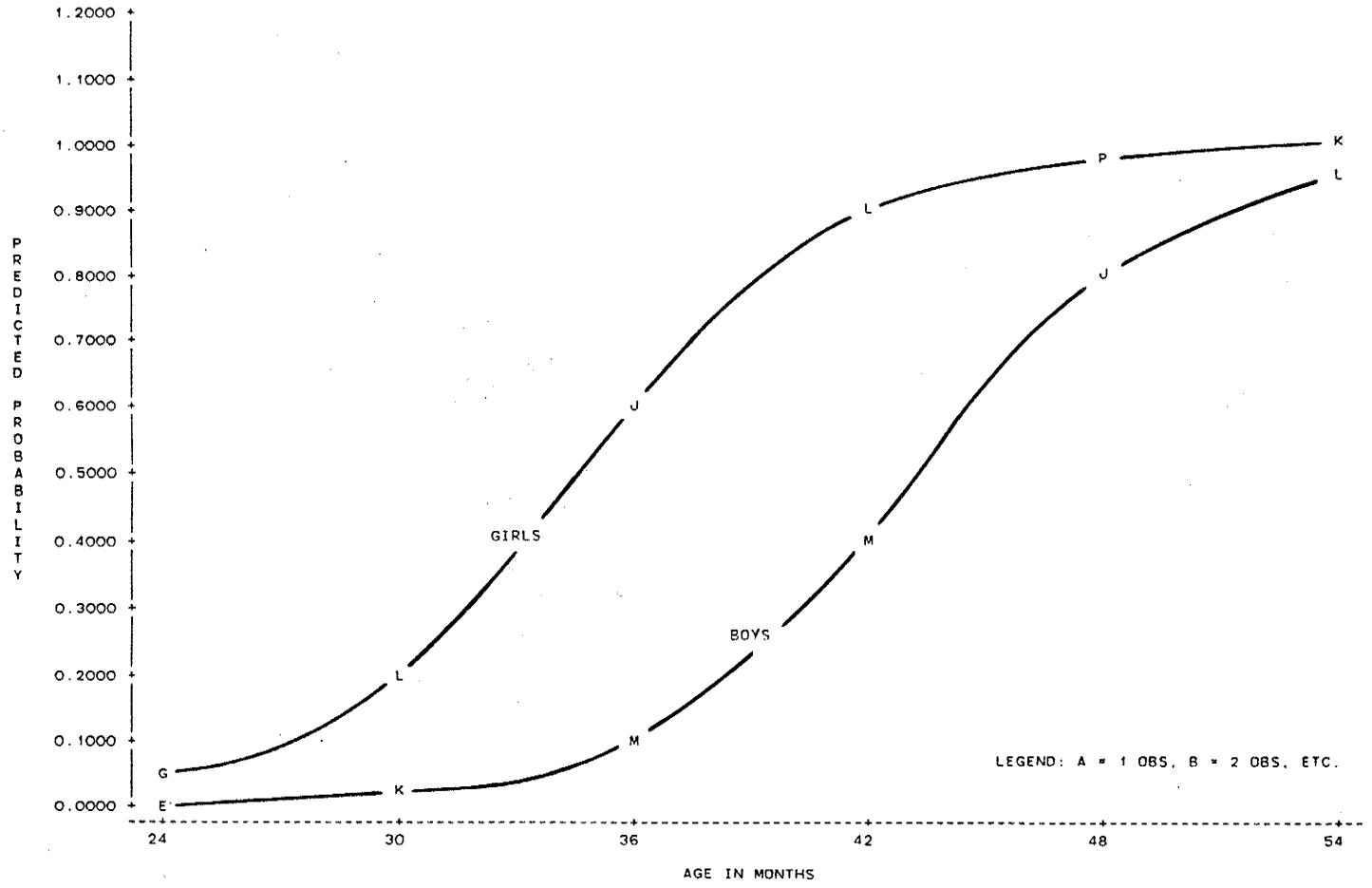

Figure 40

Predicted Probability of Opening 1 cm Buttons

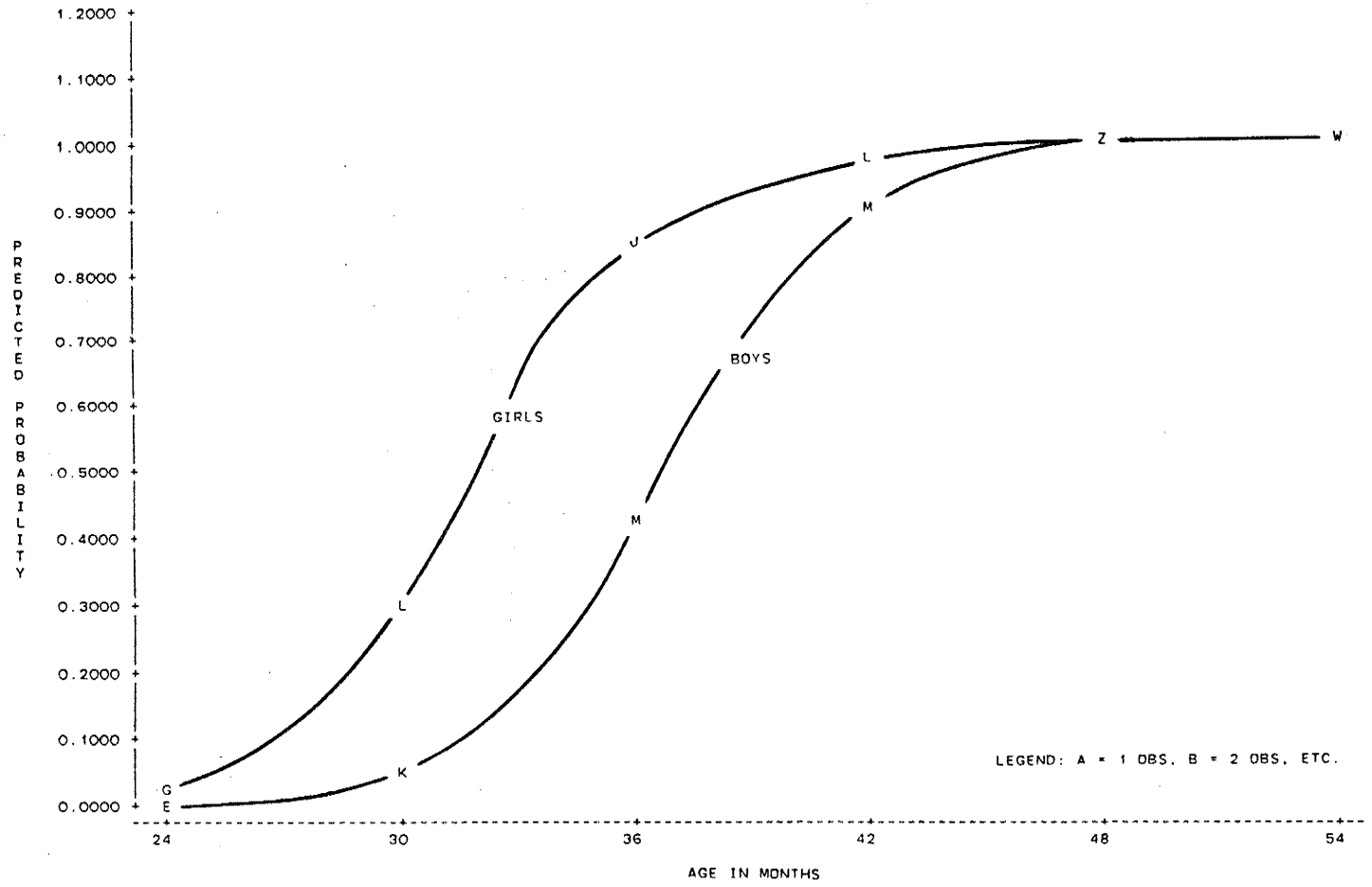

Figure 41

Predicted Probability of Opening 2 cm Buttons

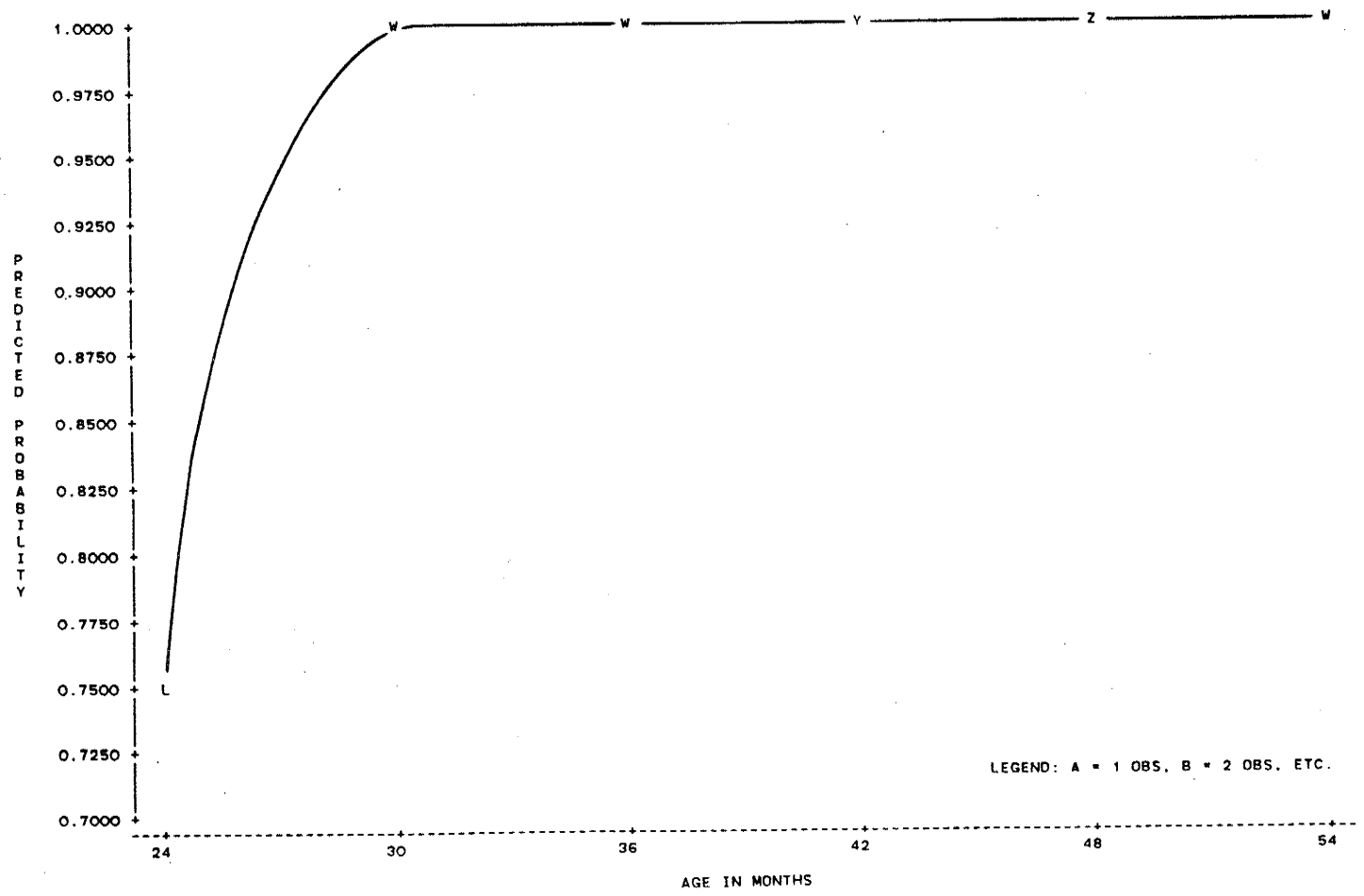

Figure 42

Predicted Probability of Opening Hammer-on Snaps

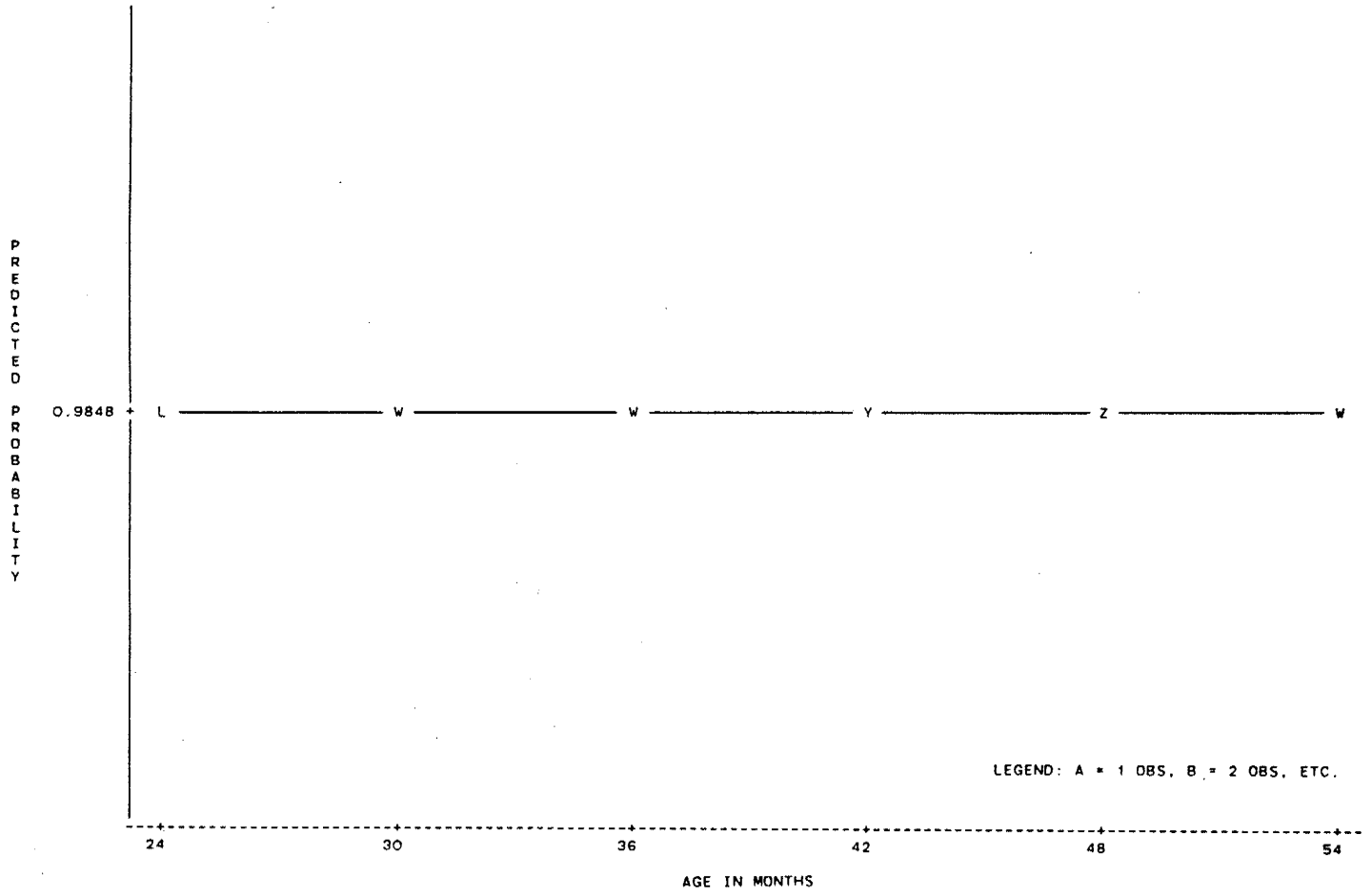

Figure 43

Predicted Probability of Opening Hook and Loop Fasteners

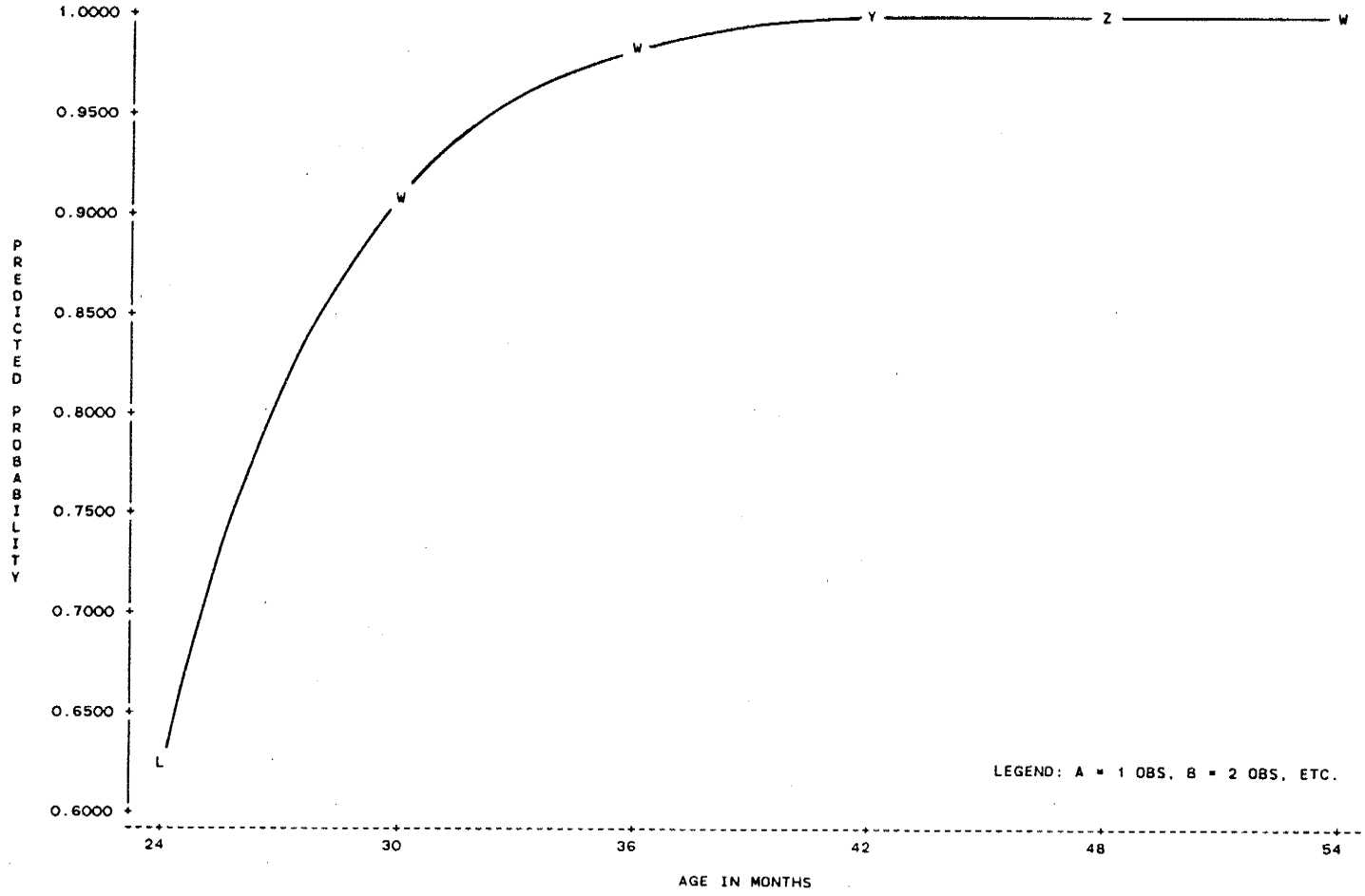

Figure 45

Predicted Probability of Opening Separating Zipper

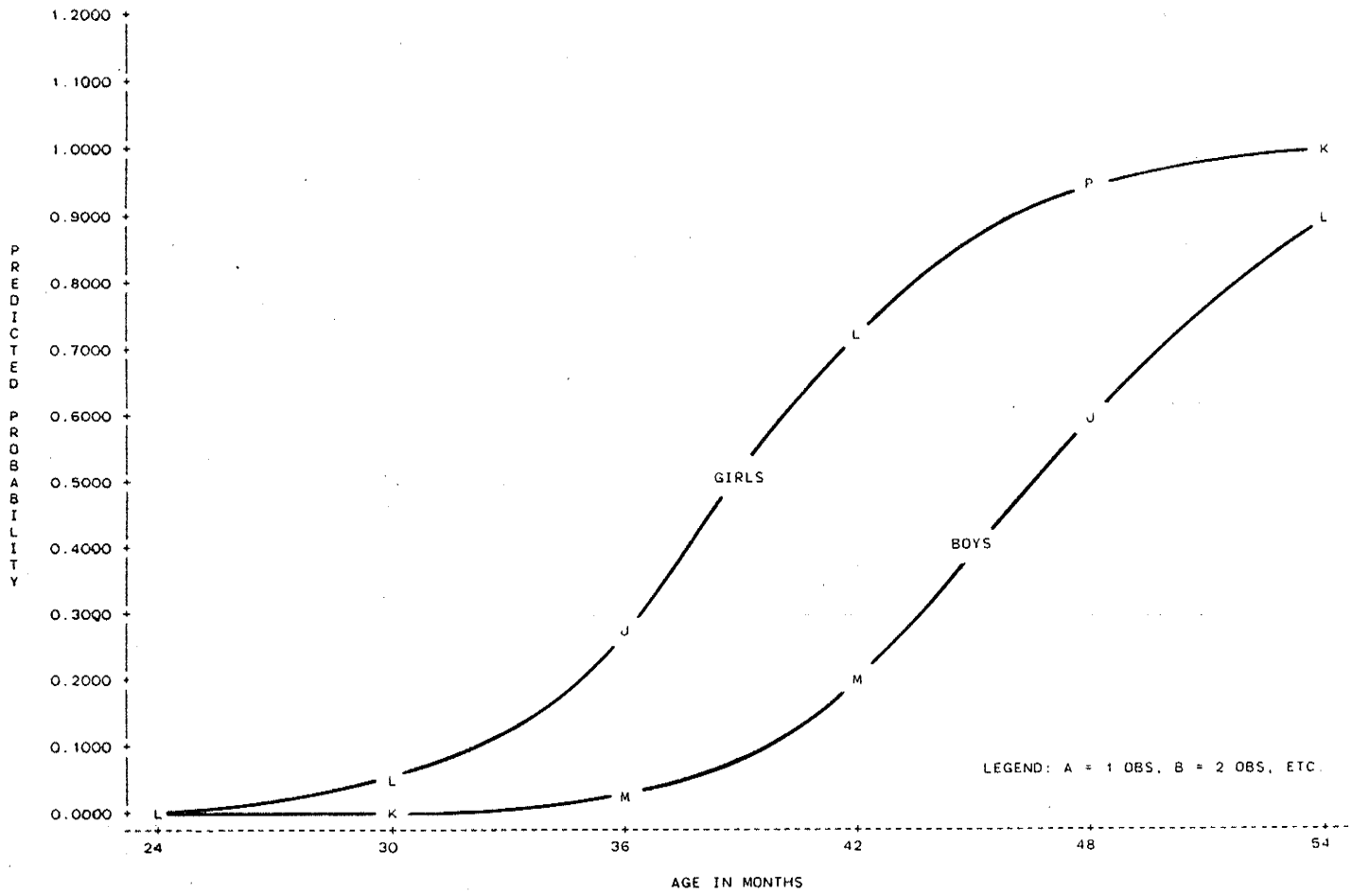

Figure 46

Predicted Probability of Closing and Opening 1 cm Buttons

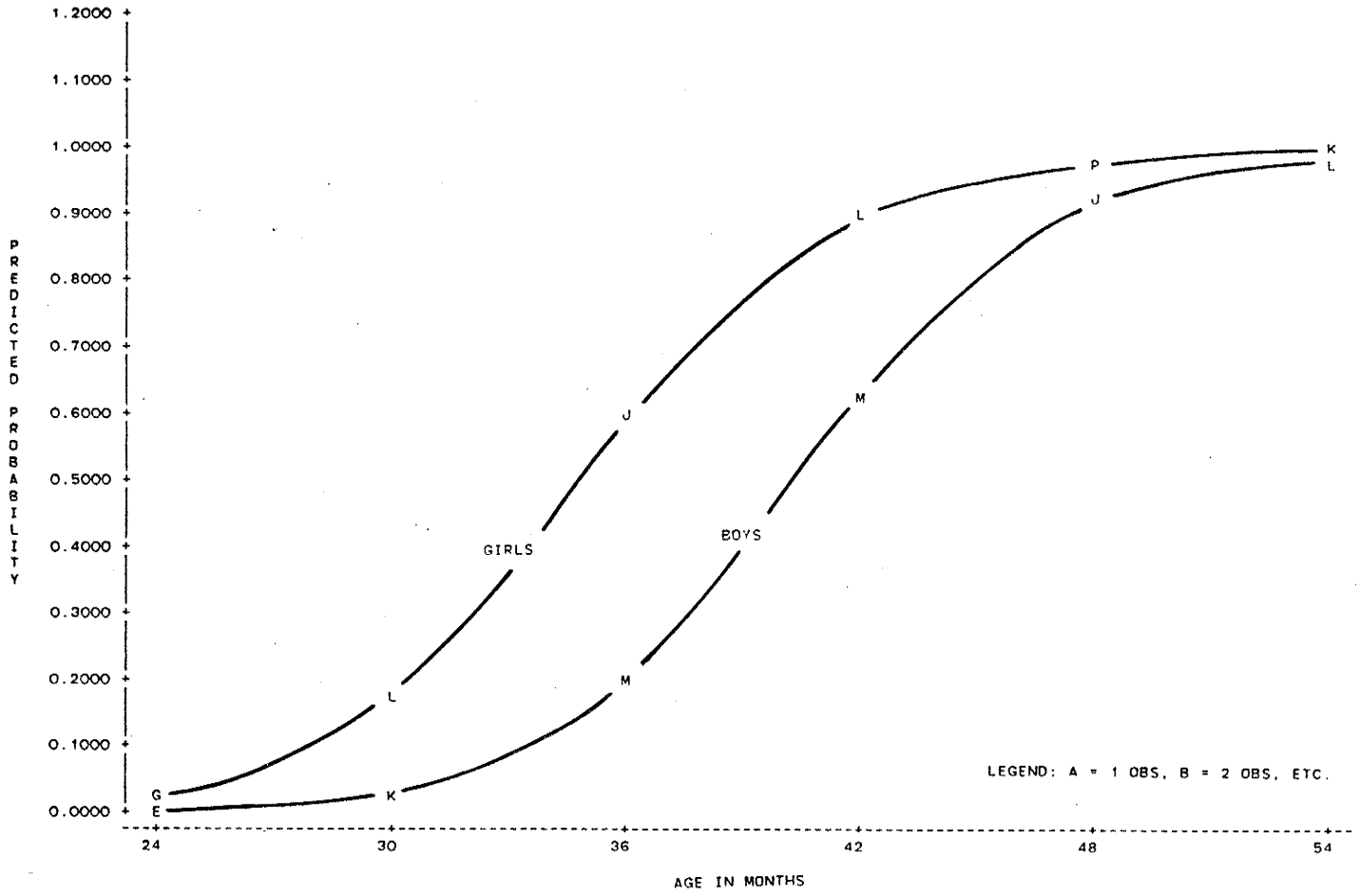

Figure 47

Predicted Probability of Closing and Opening 2 cm Buttons

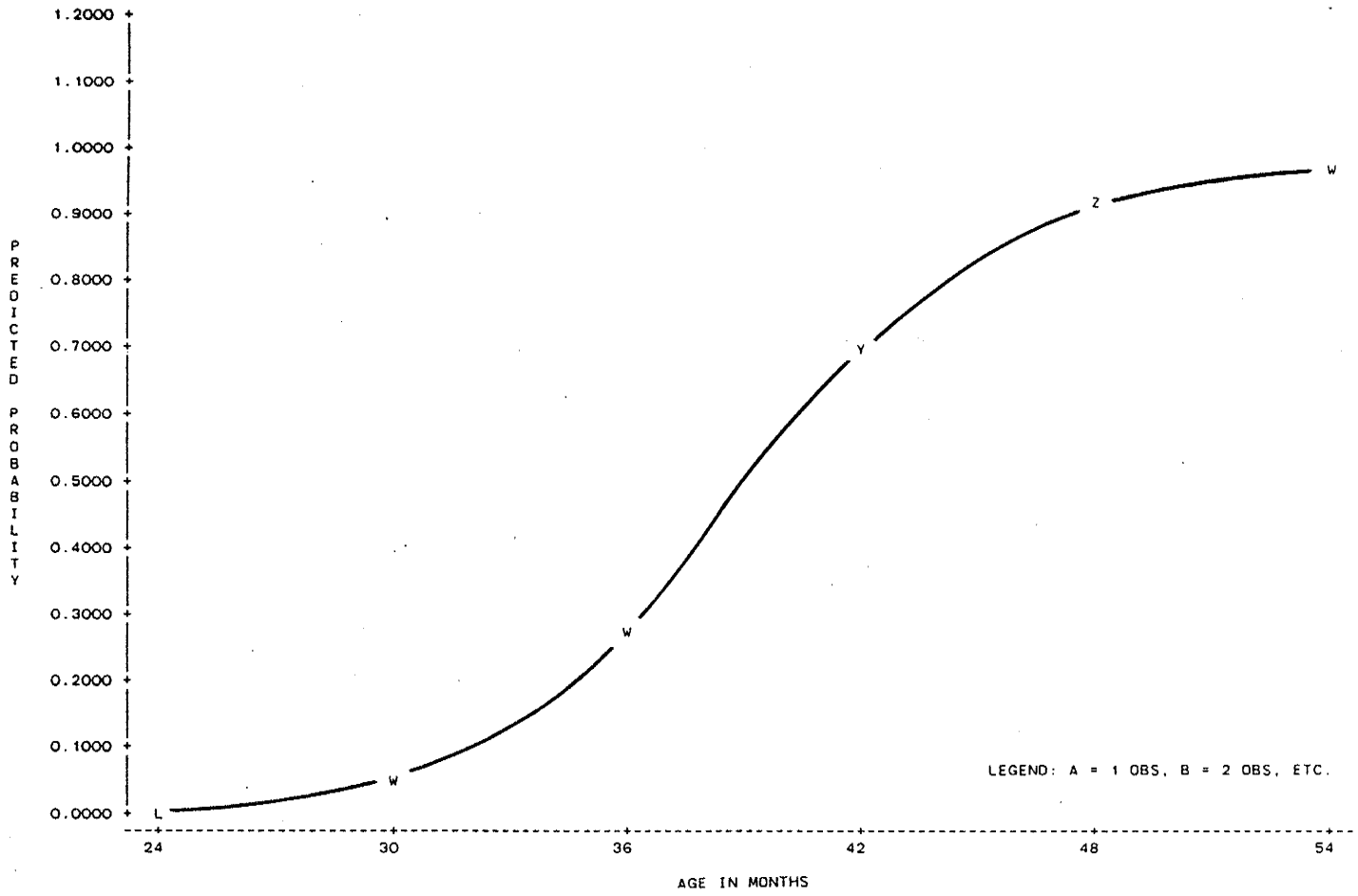

Figure 48

Predicted Probability of Closing and Opening Hammer-on Snaps

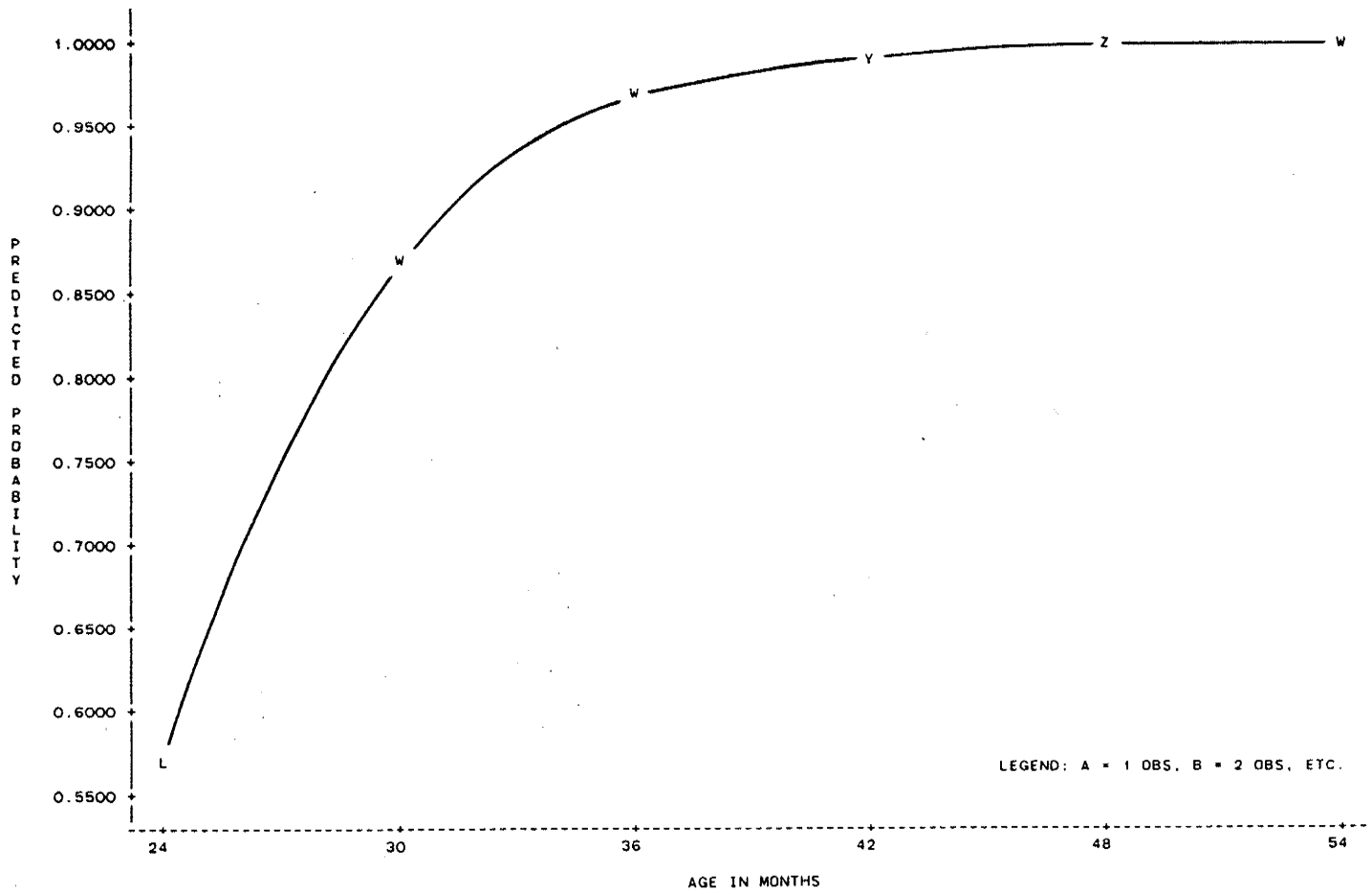

Figure 49

Predicted Probability of Closing and Opening Hook and Loop Fasteners

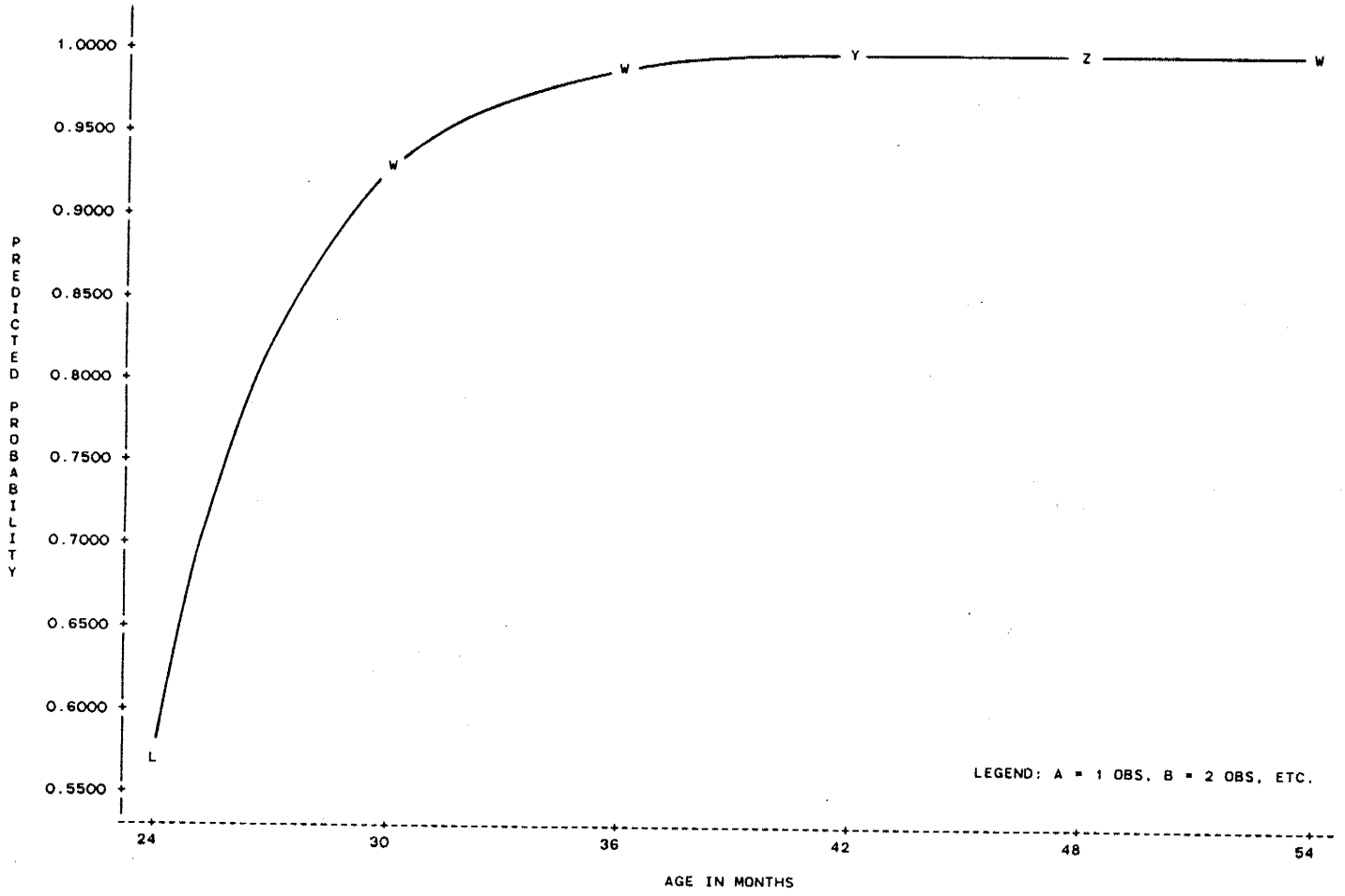

Figure 50

Predicted Probability of Closing and Opening Conventional Zipper

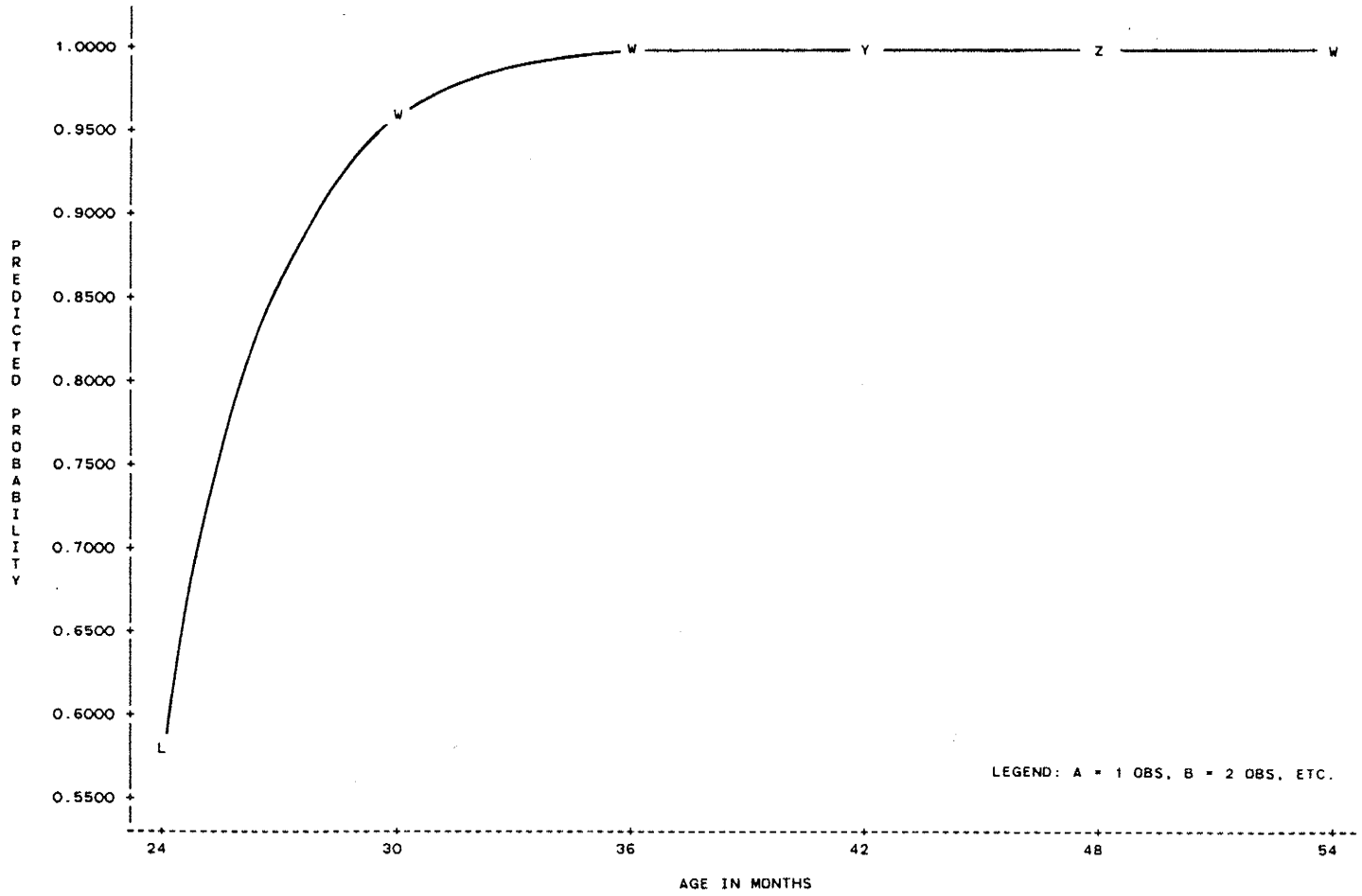

Figure 51

Predicted Probability of Closing and Opening Large Zipper

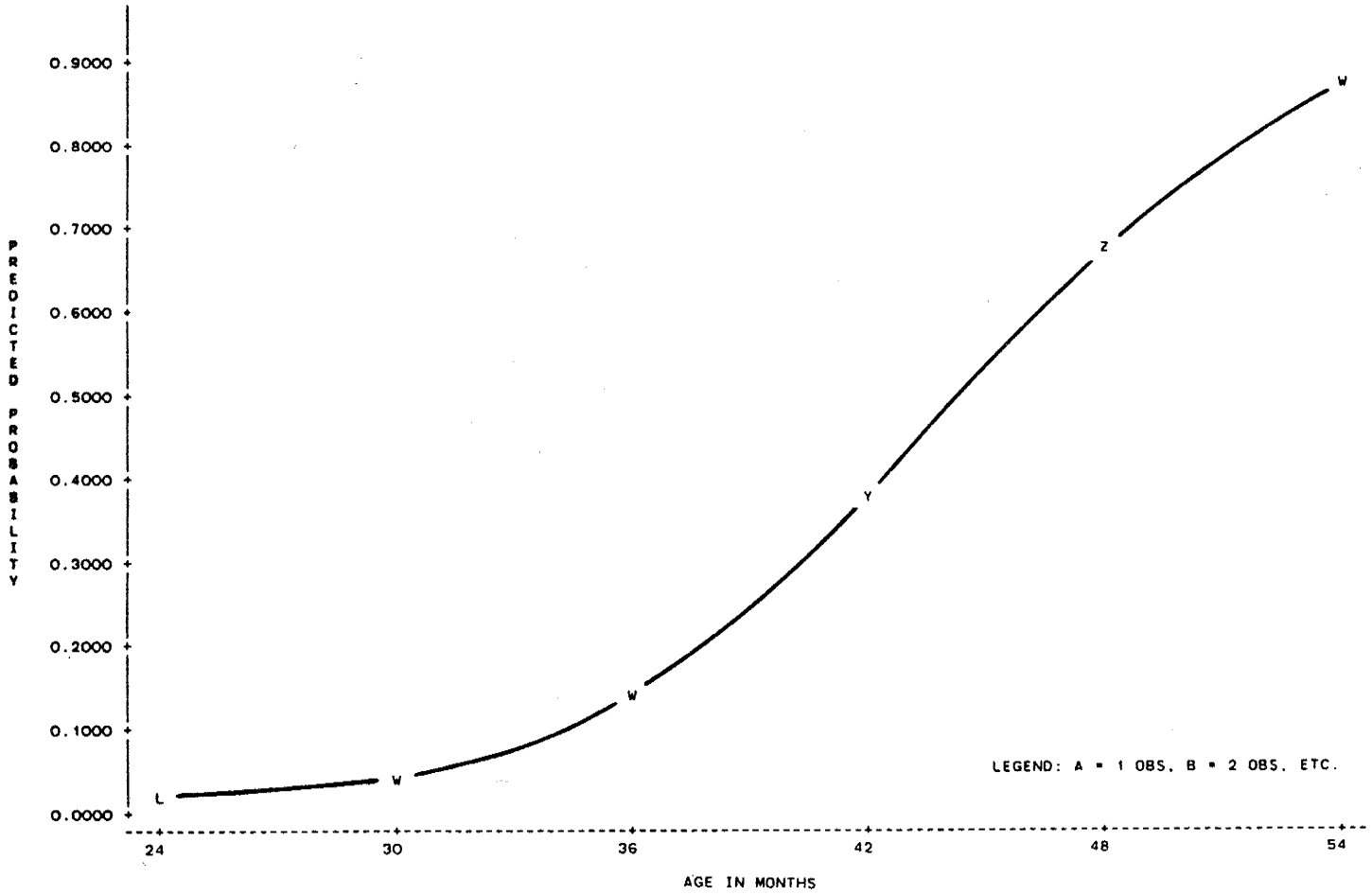

Figure 52

Predicted Probability of Closing and Opening Separating Zipper

Appendix M

GRAPHS OF CONFIDENCE INTERVALS FOR PREDICTED PROBABILITIES OF MANIPULATING FASTENERS

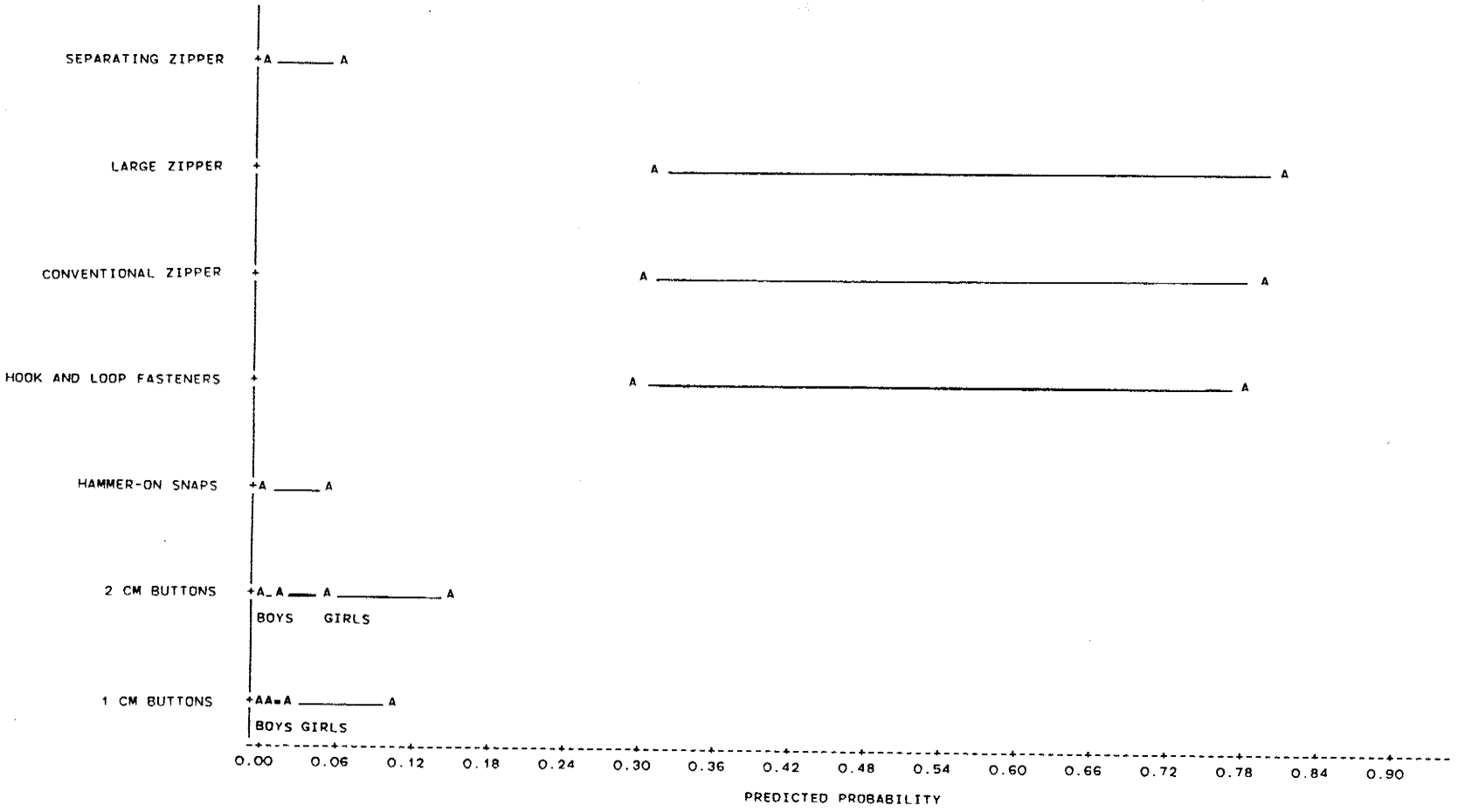

Figure 53

Confidence Intervals for Predicted Probabilities
of 24 Month Old Children Closing Fasteners

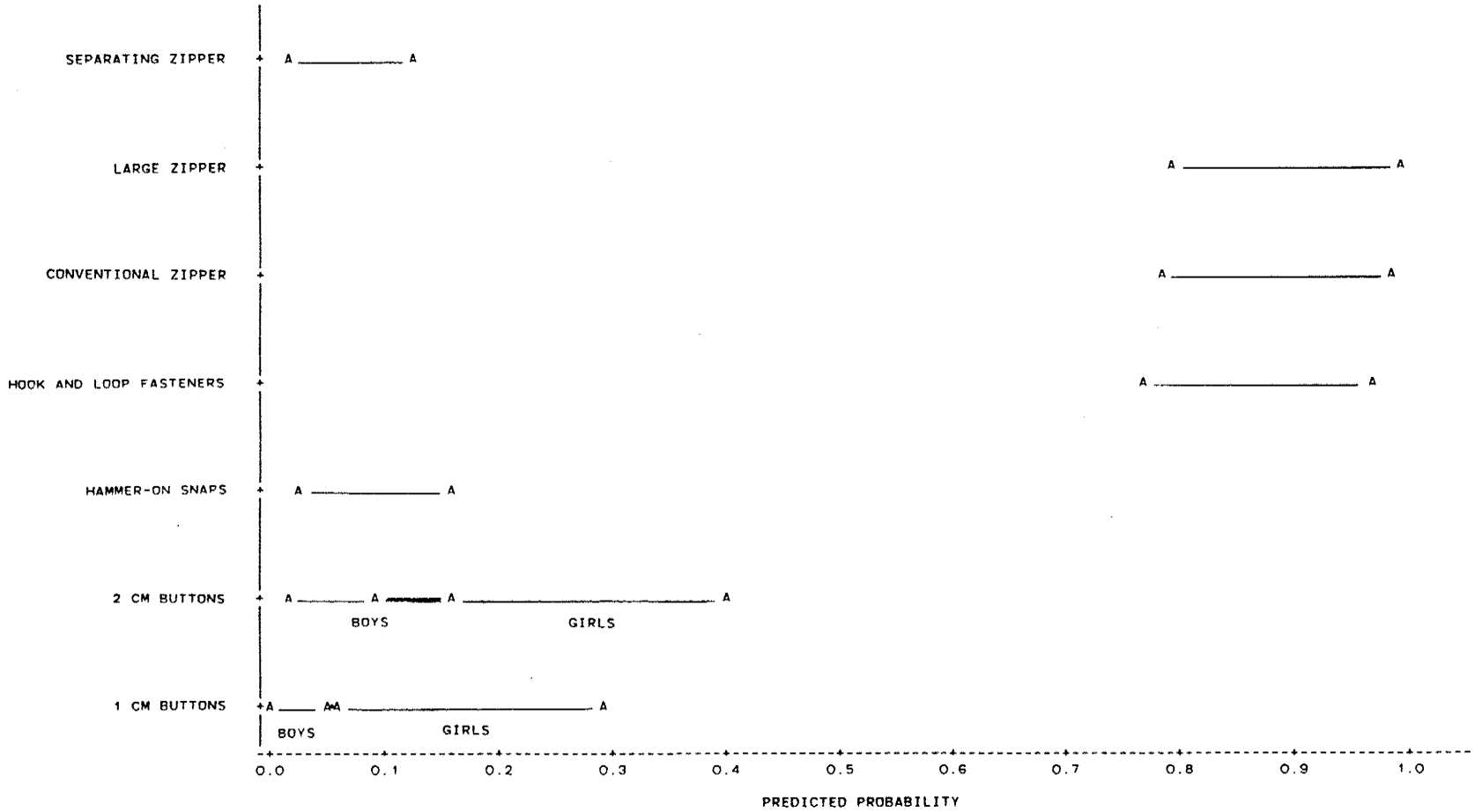

Figure 54

Confidence Intervals for Predicted Probabilities
of 30 Month Old Children Closing Fasteners

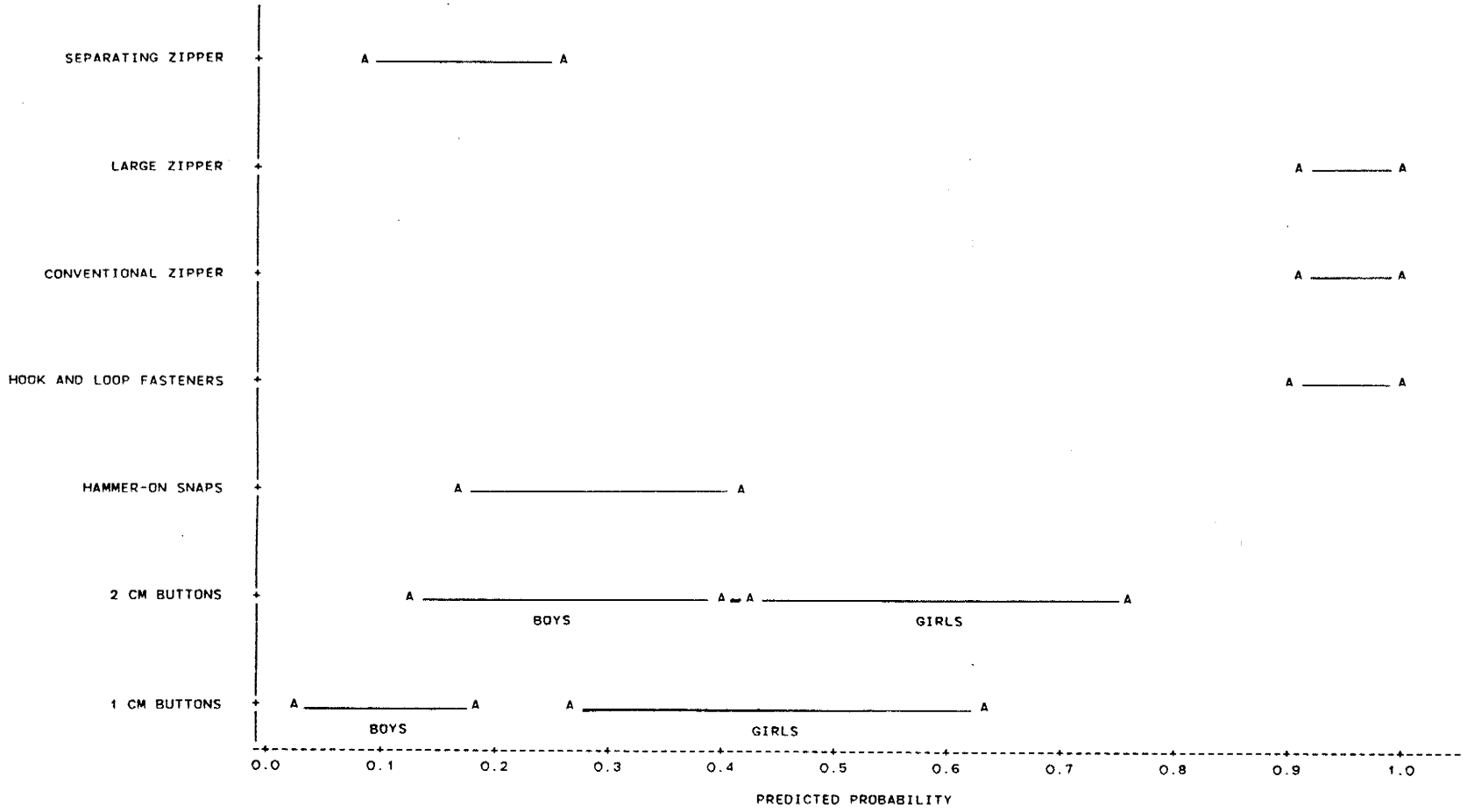

Figure 55

Confidence Intervals for Predicted Probabilities
of 36 Month Old Children Closing Fasteners

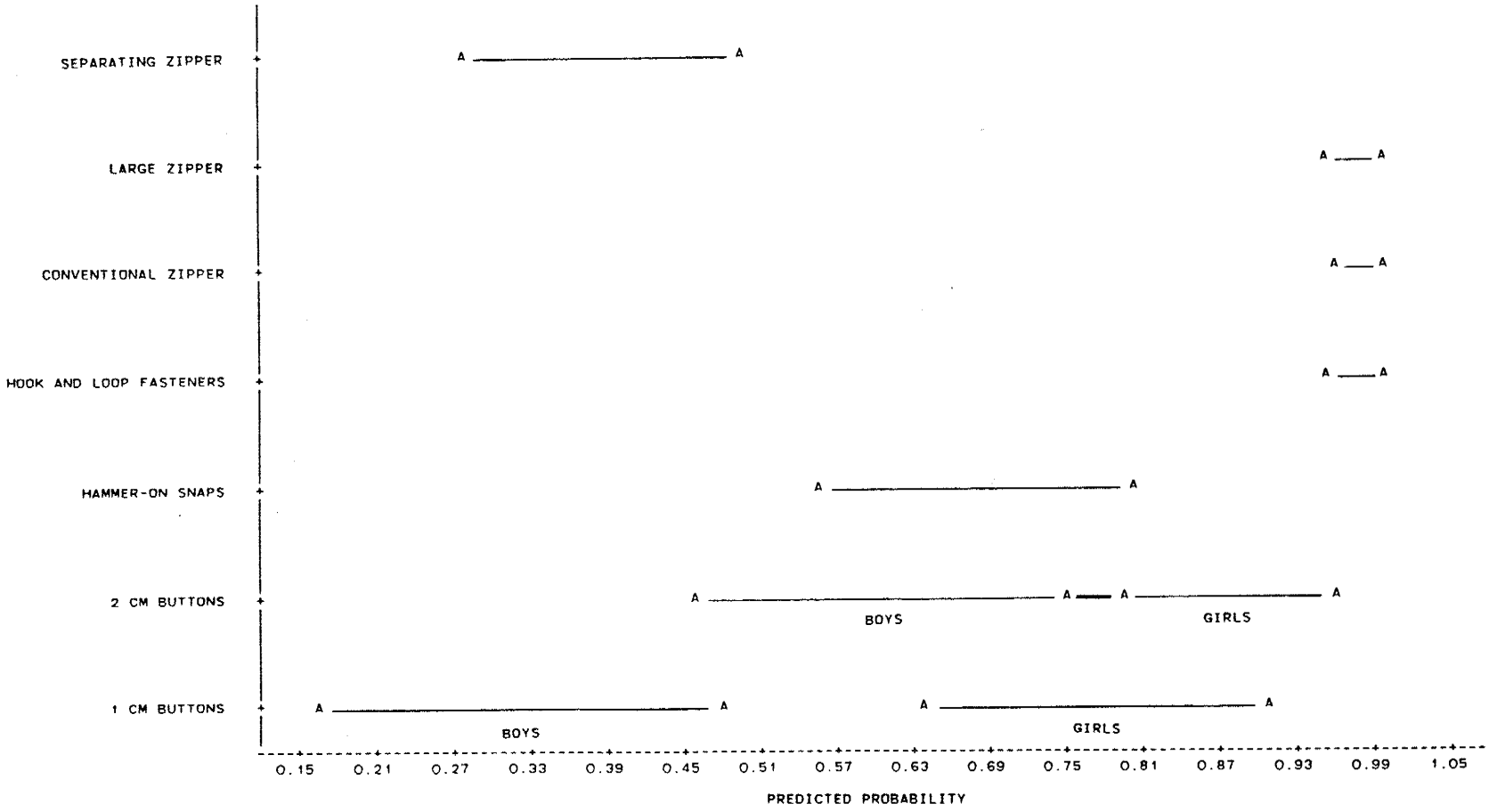

Figure 56

Confidence Intervals for Predicted Probabilities
of 42 Month Old Children Closing Fasteners

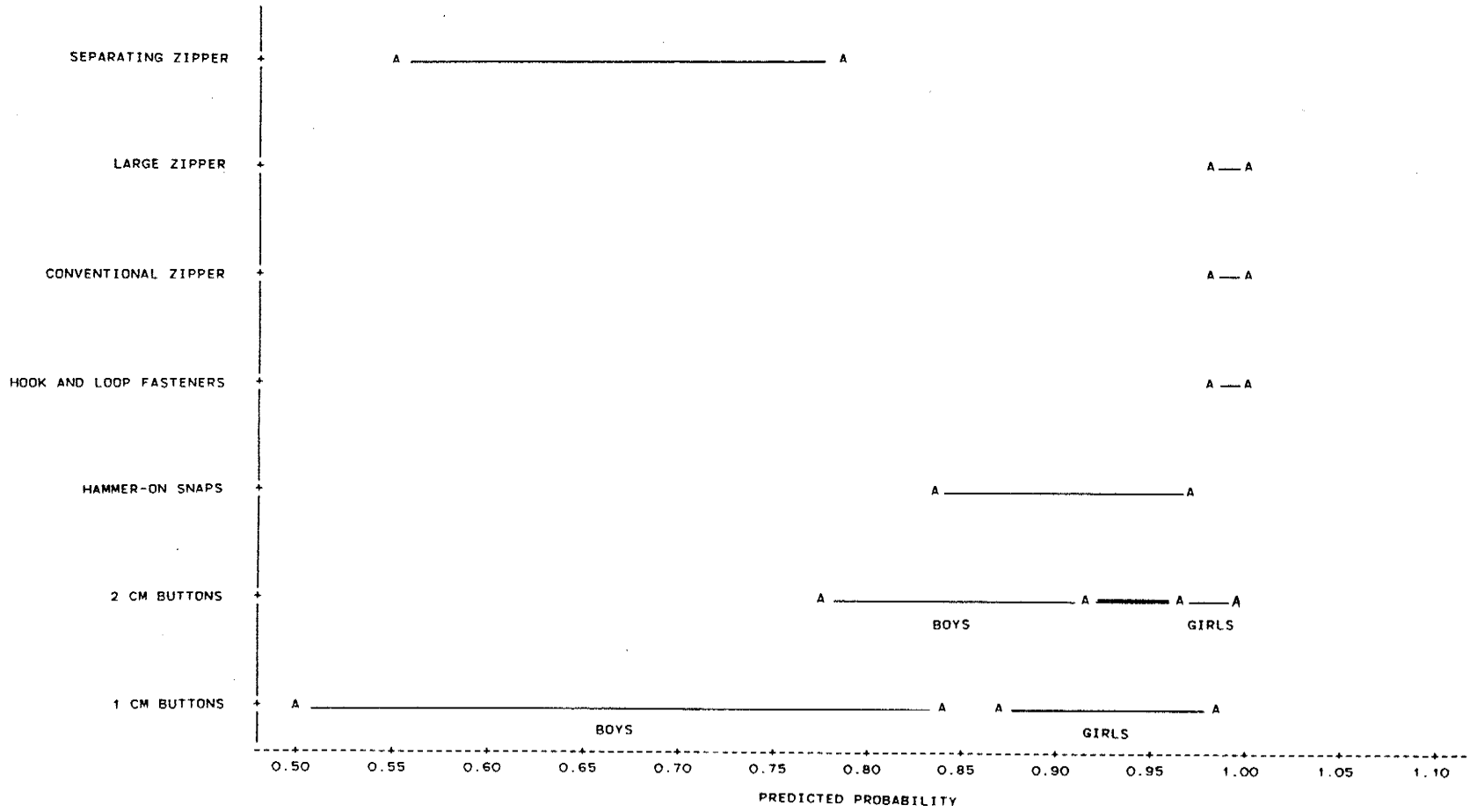

Figure 57

Confidence Intervals for Predicted Probabilities
of 48 Month Old Children Closing Fasteners

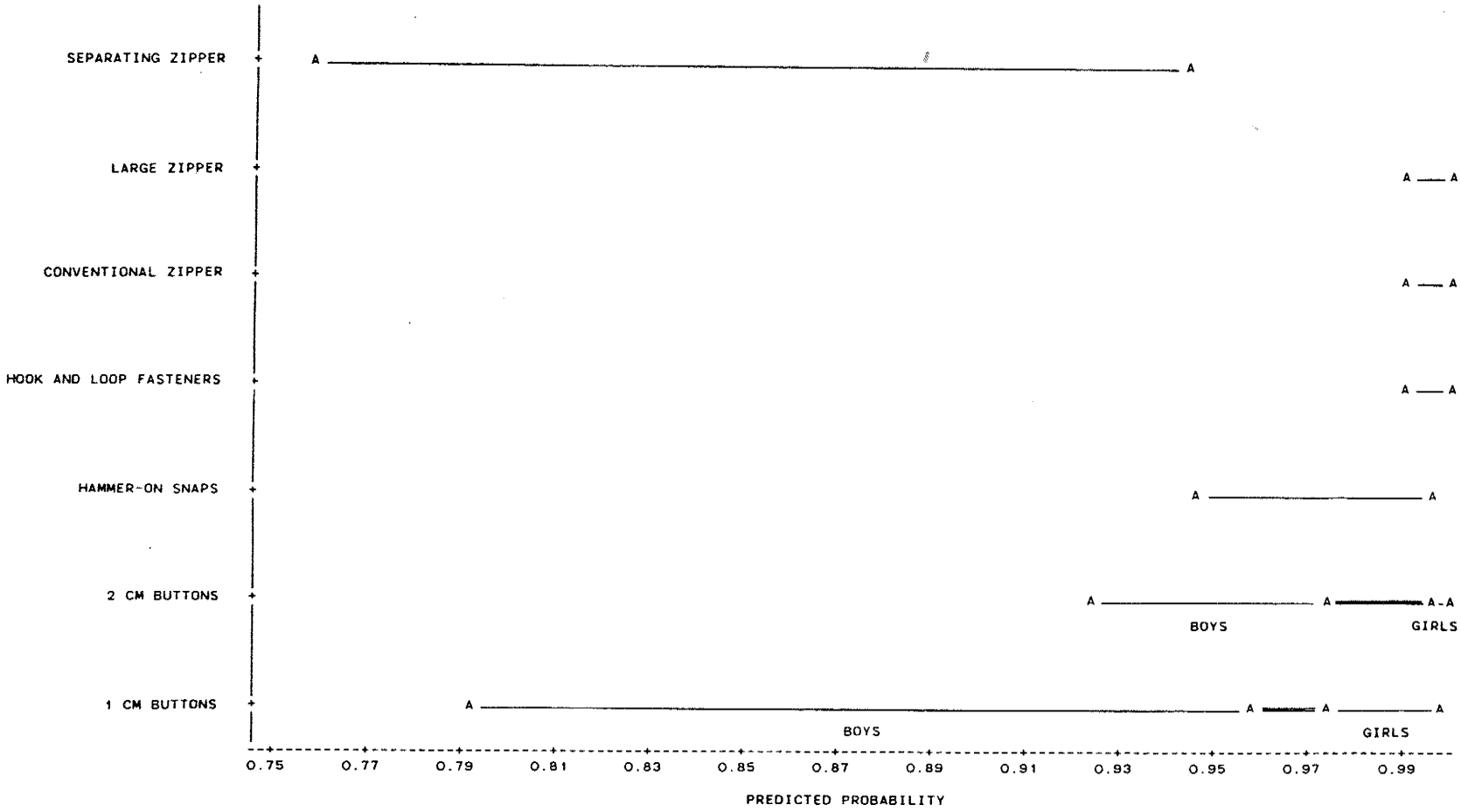

Figure 58

Confidence Intervals for Predicted Probabilities
of 54 Month Old Children Closing Fasteners

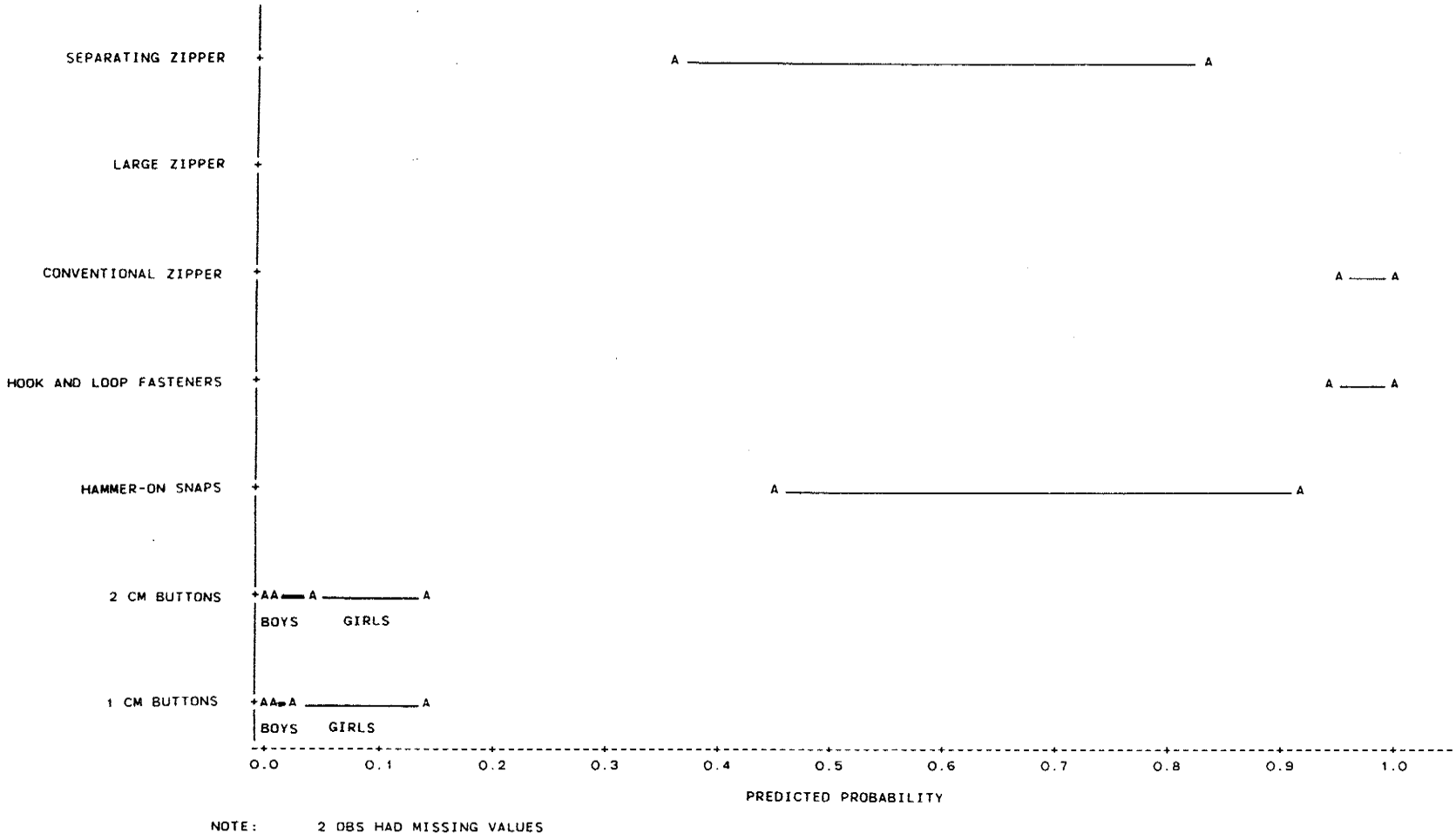

Figure 59

Confidence Intervals for Predicted Probabilities
of 24 Month Old Children Opening Fasteners

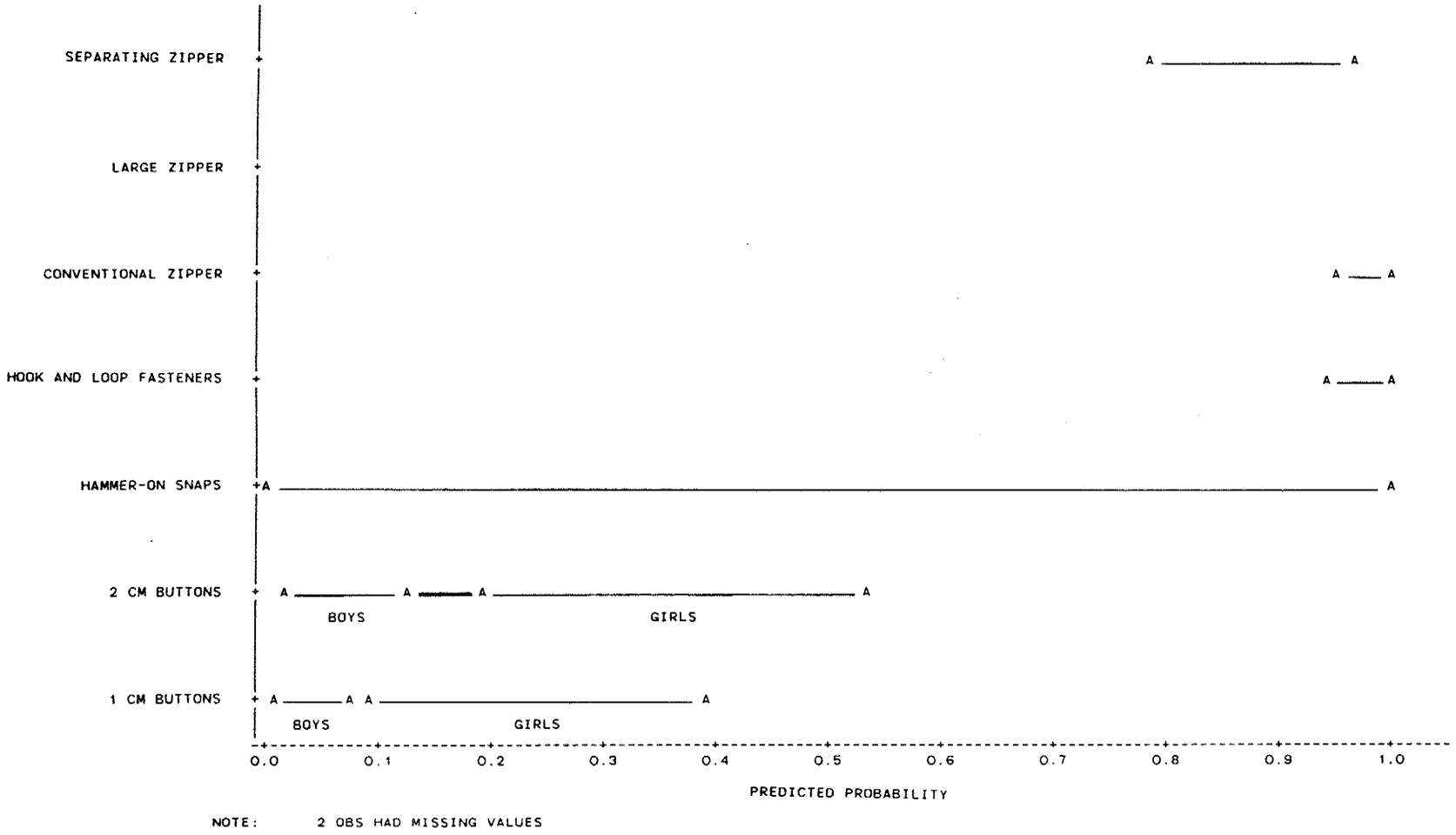

Figure 60

Confidence Intervals for Predicted Probabilities
of 30 Month Old Children Opening Fasteners

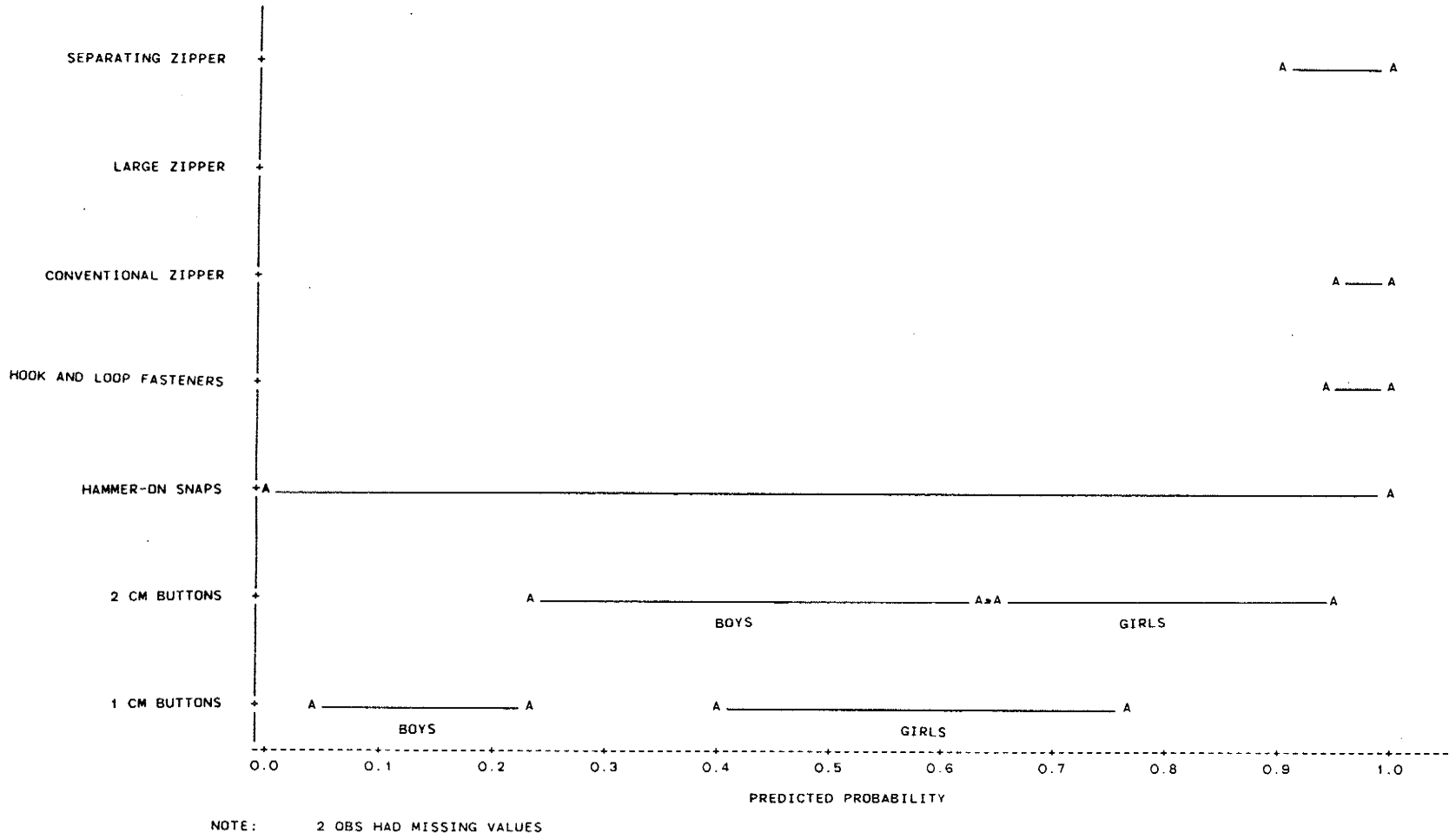

Figure 61

Confidence Intervals for Predicted Probabilities
of 36 Month Old Children Opening Fasteners

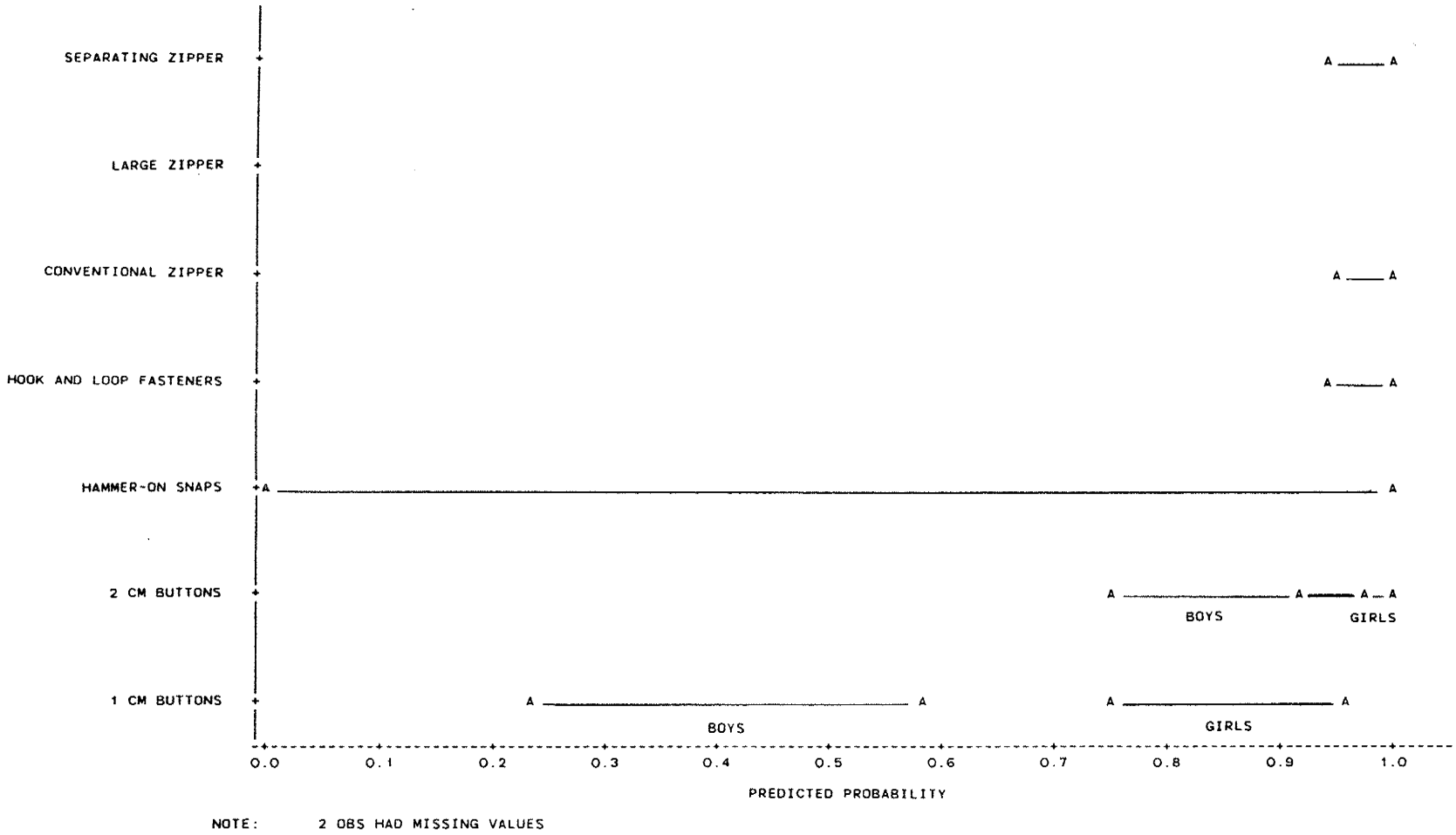

Figure 62

Confidence Intervals for Predicted Probabilities
of 42 Month Old Children Opening Fasteners

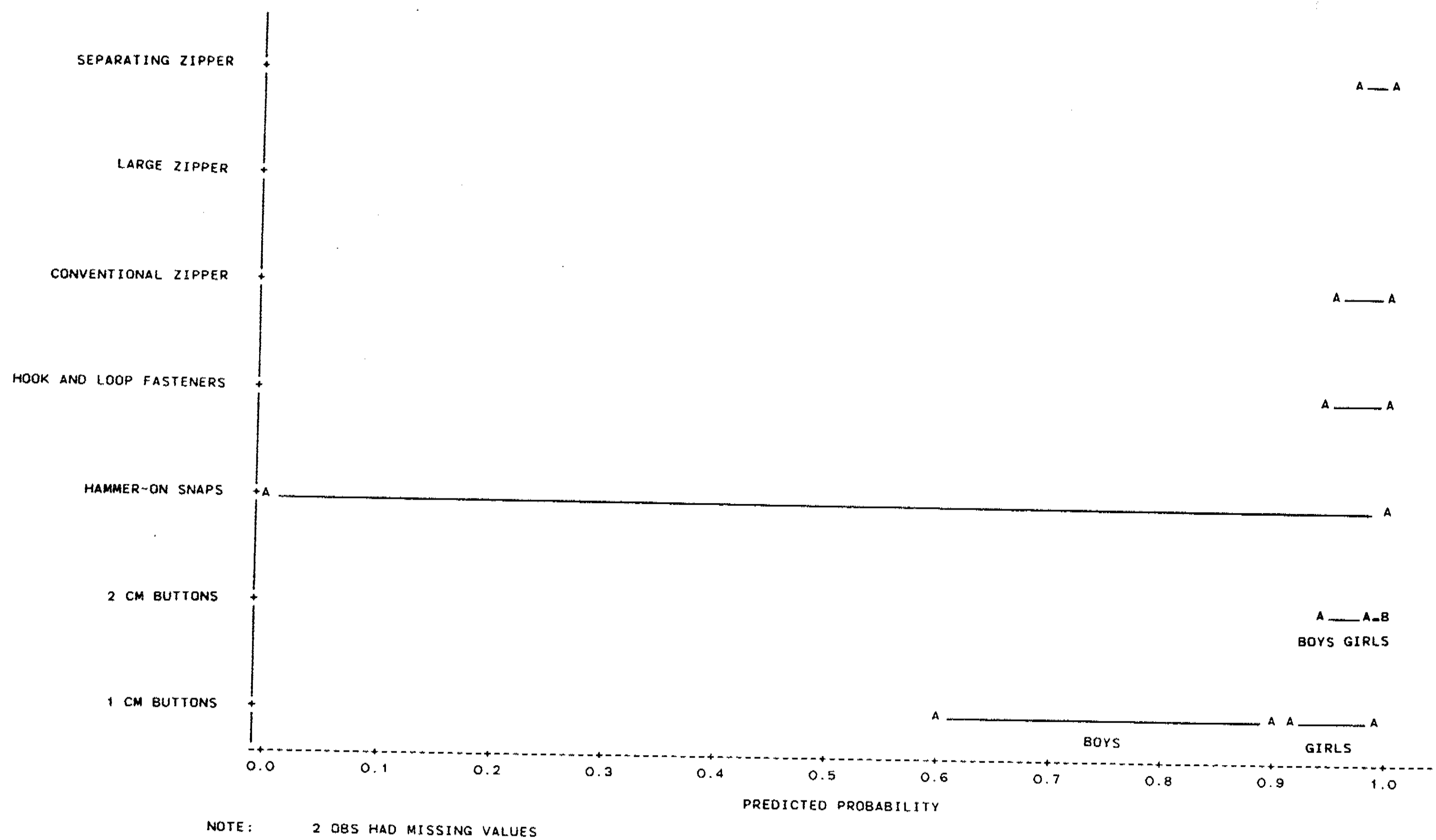

Figure 63

Confidence Intervals for Predicted Probabilities
of 48 Month Old Children Opening Fasteners

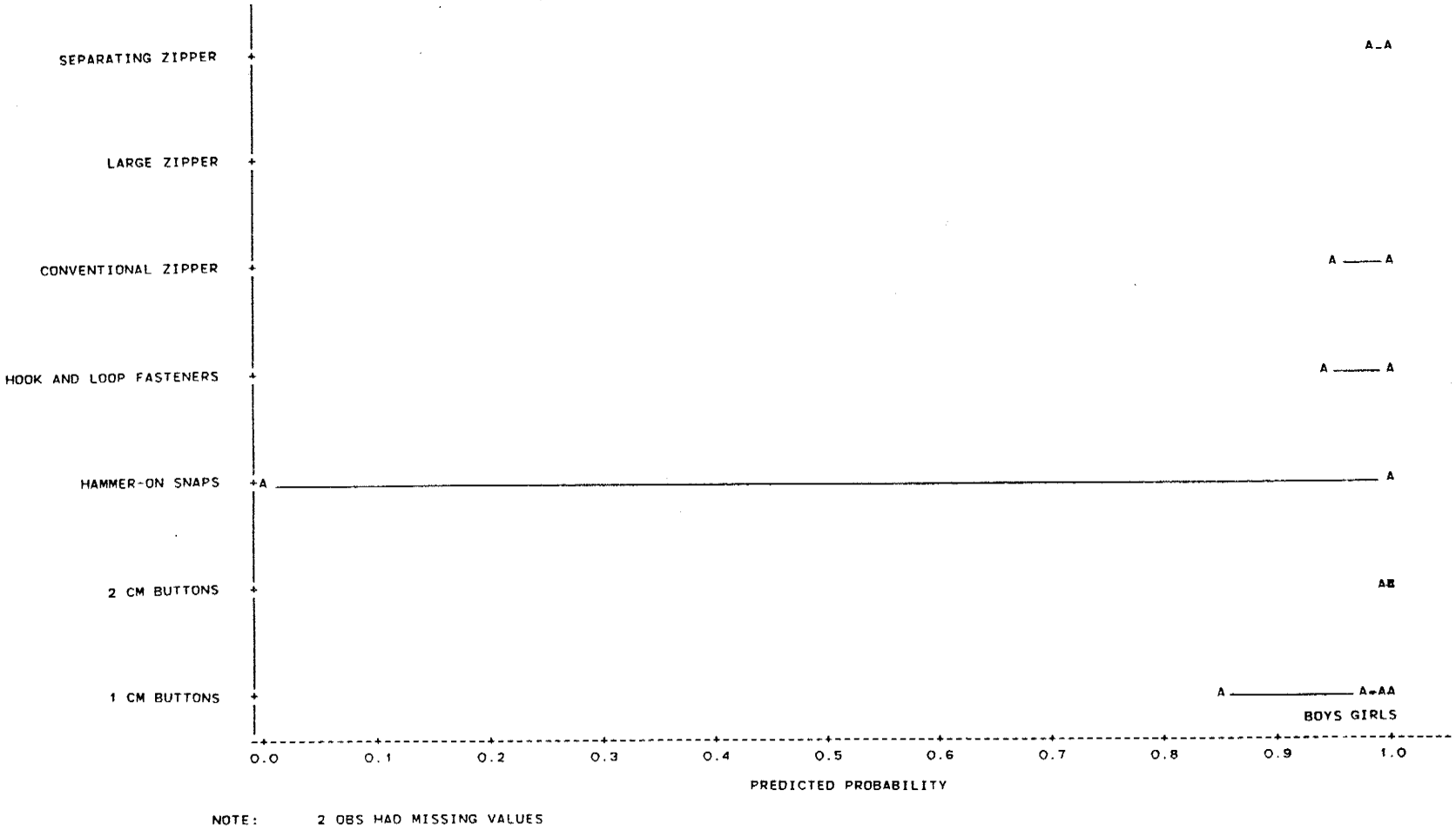

Figure 64

Confidence Intervals for Predicted Probabilities
of 54 Month Old Children Opening Fasteners

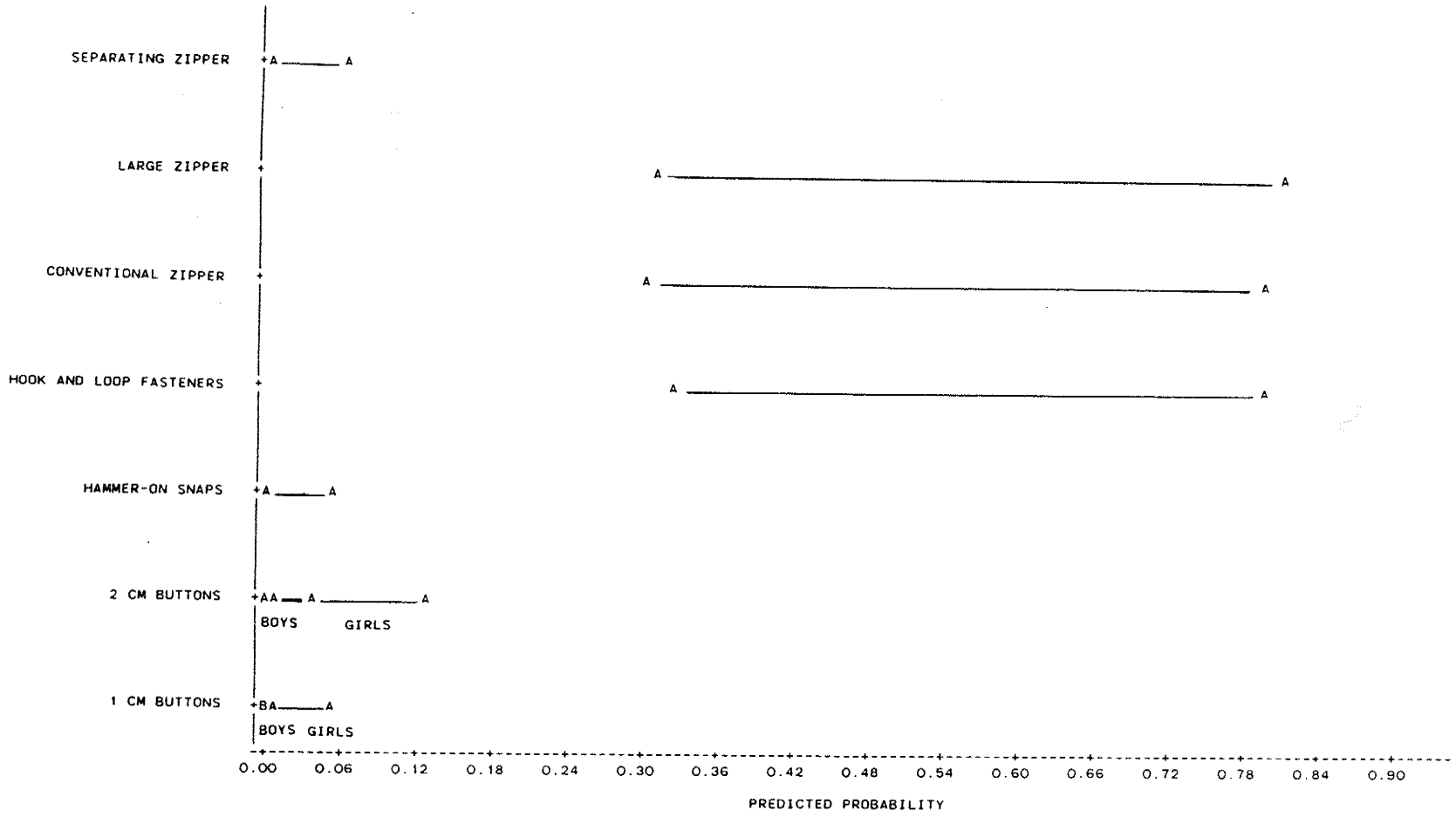

Figure 65

Confidence Intervals for Predicted Probabilities
of 24 Month Old Children Closing and Opening Fasteners

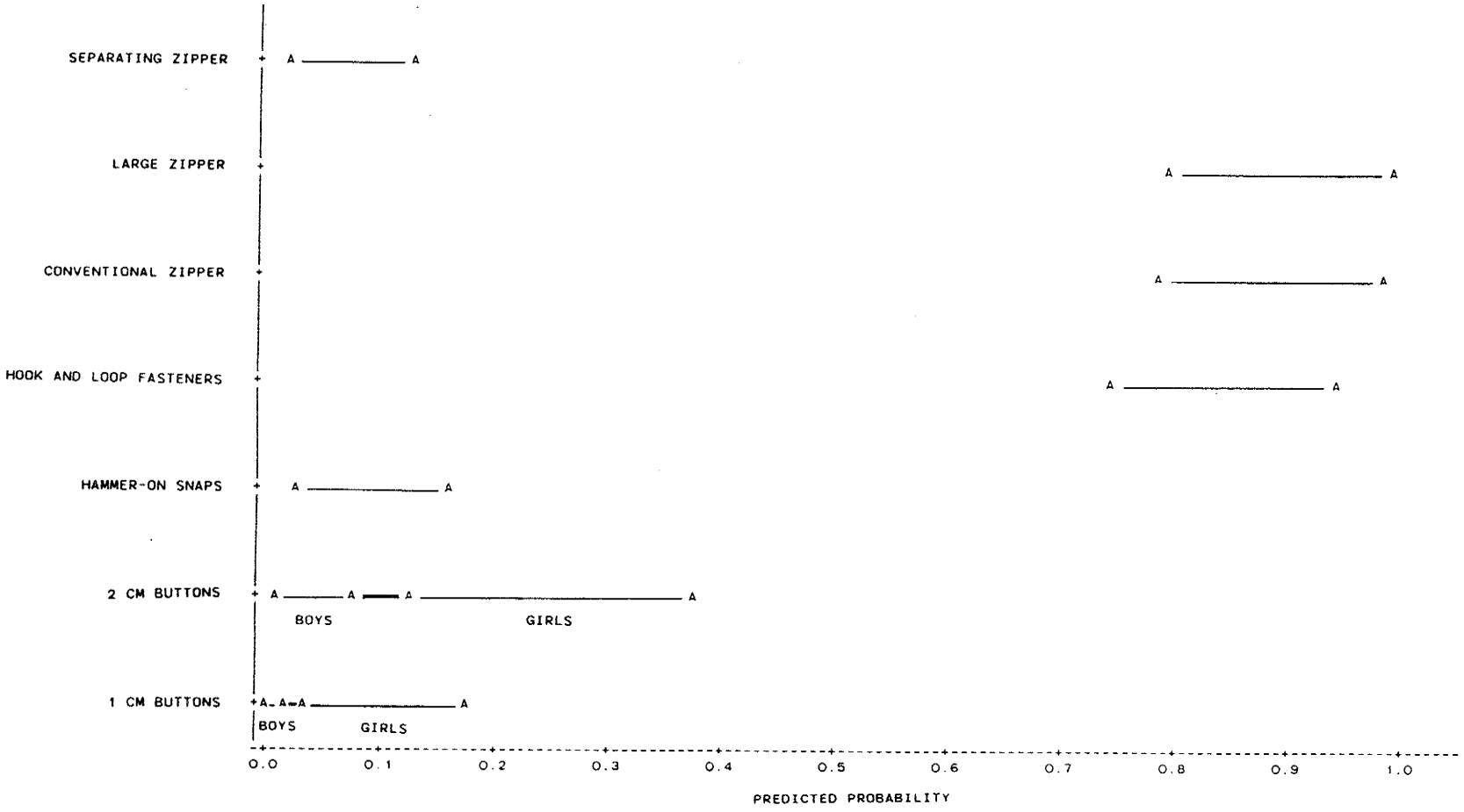

Figure 66

Confidence Intervals for Predicted Probabilities
of 30 Month Old Children Closing and Opening Fasteners

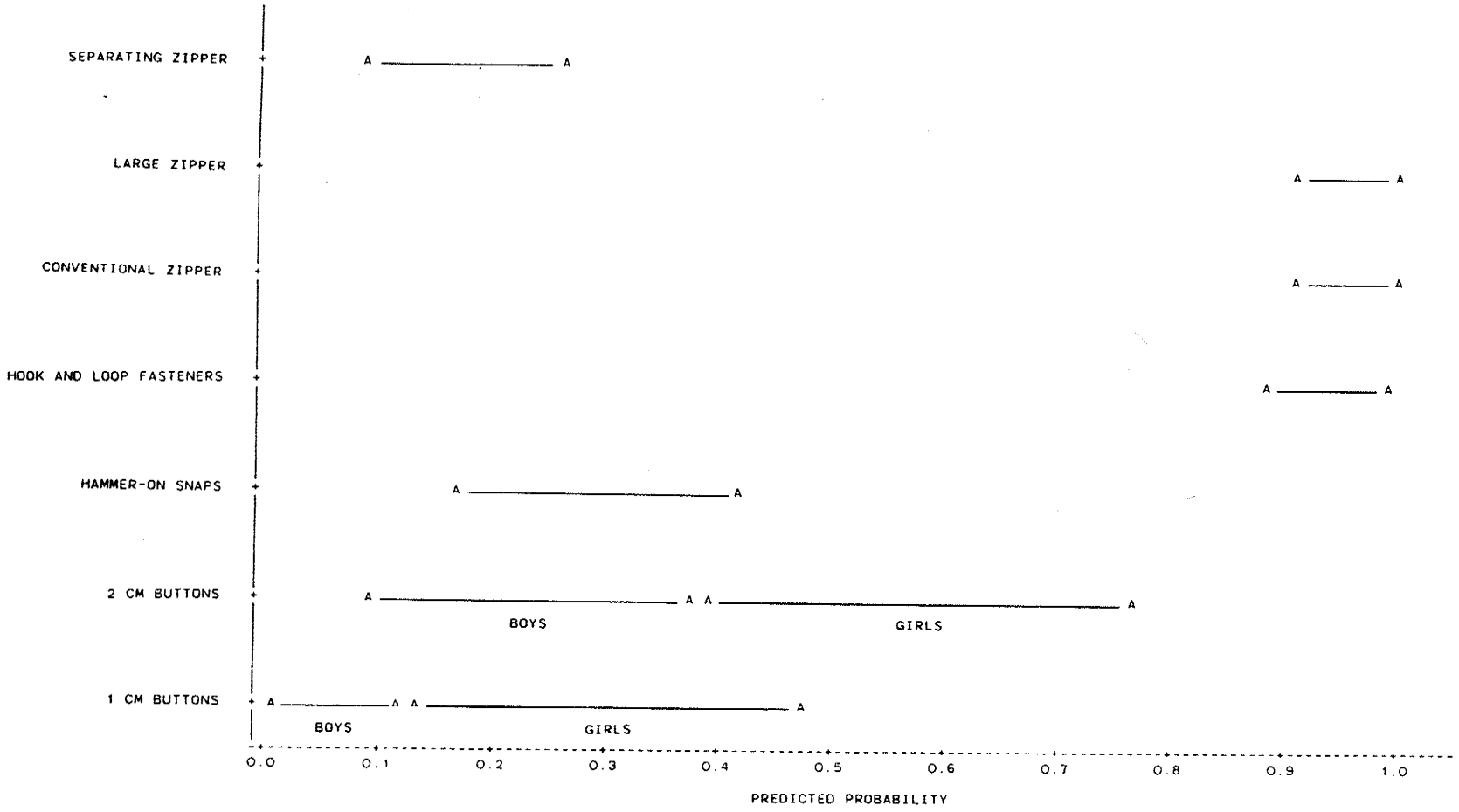

Figure 67

Confidence Intervals for Predicted Probabilities
of 36 Month Old Children Closing and Opening Fasteners

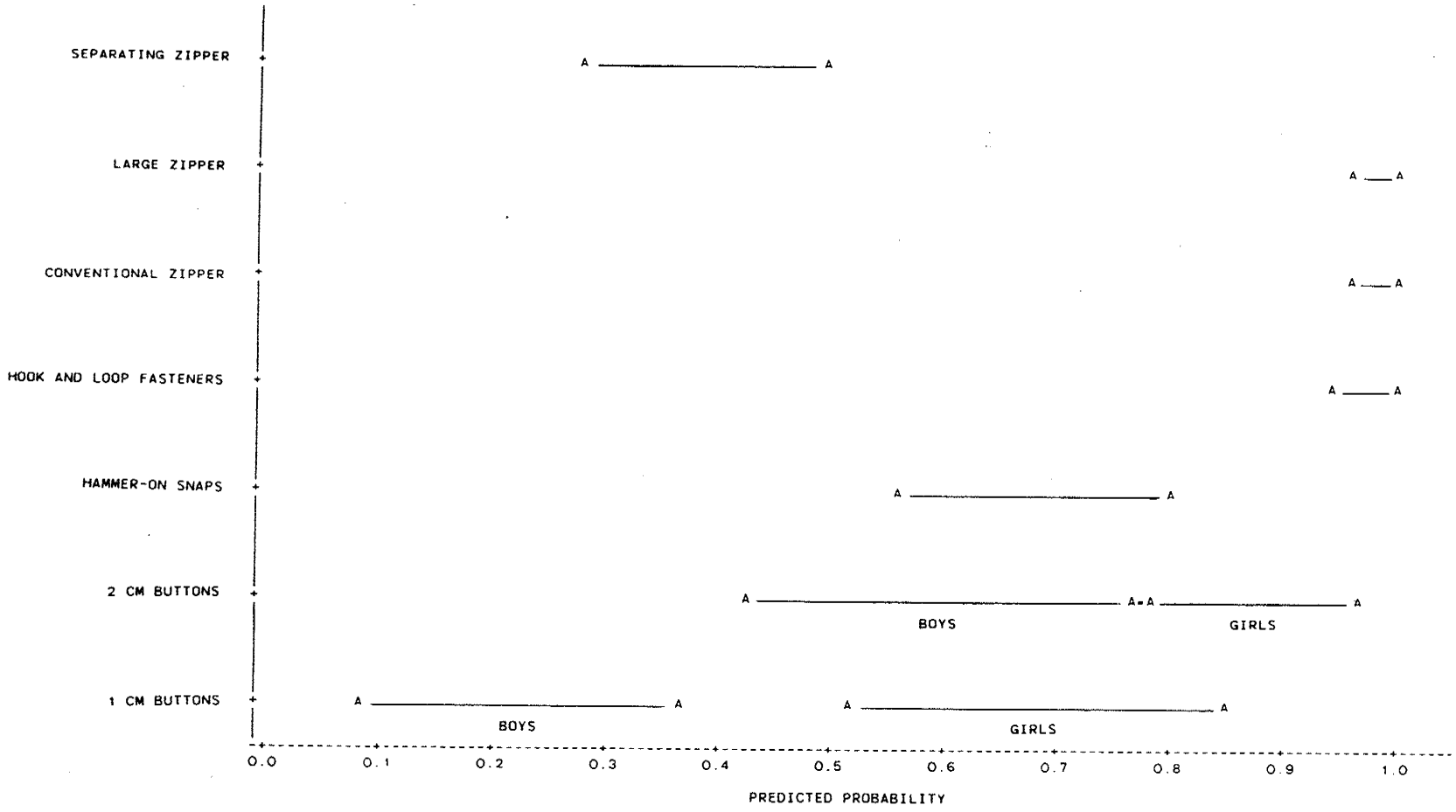

Figure 68

Confidence Intervals for Predicted Probabilities
of 42 Month Old Children Closing and Opening Fasteners

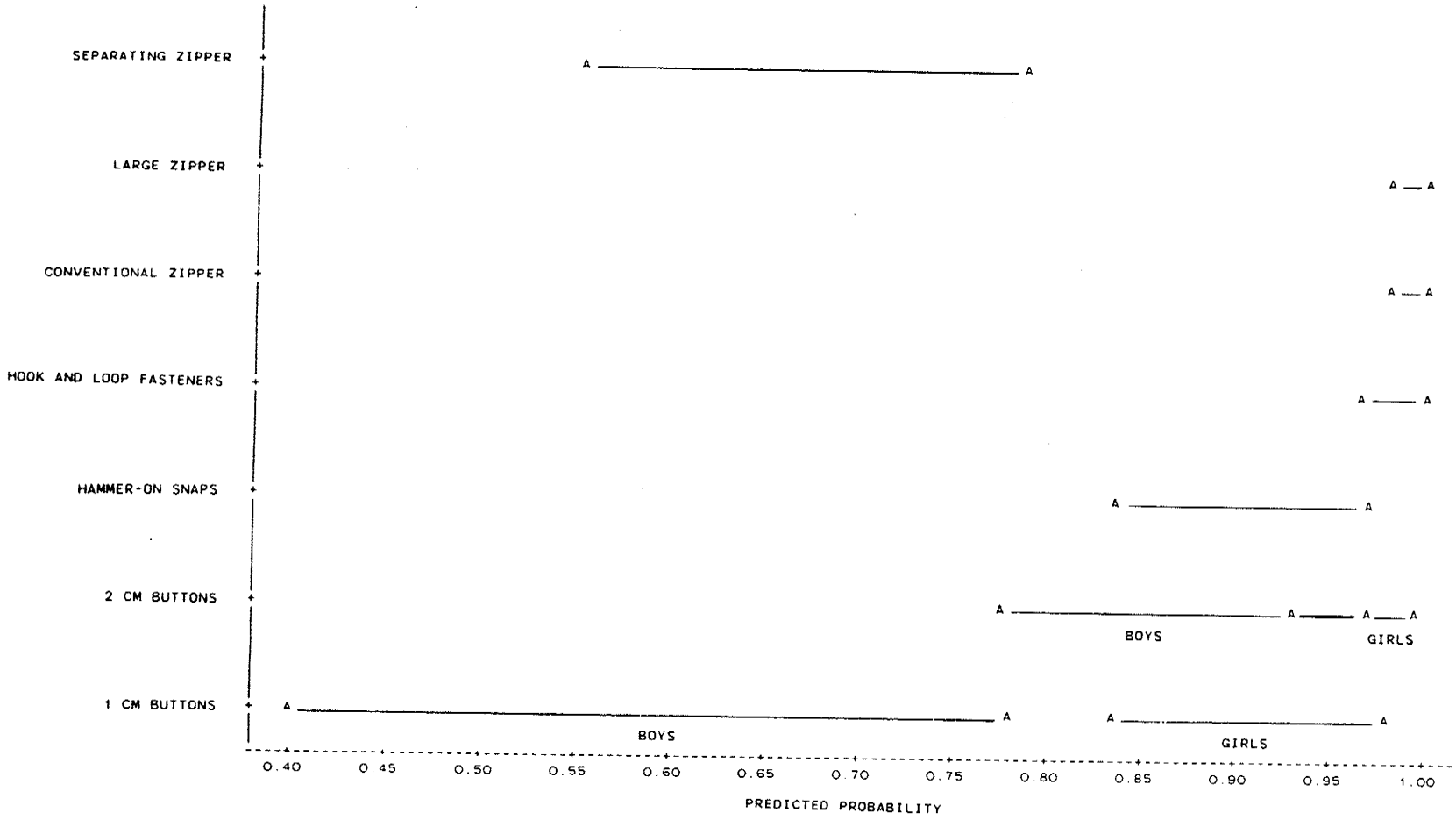

Figure 69

Confidence Intervals for Predicted Probabilities
of 48 Month Old Children Closing and Opening Fasteners

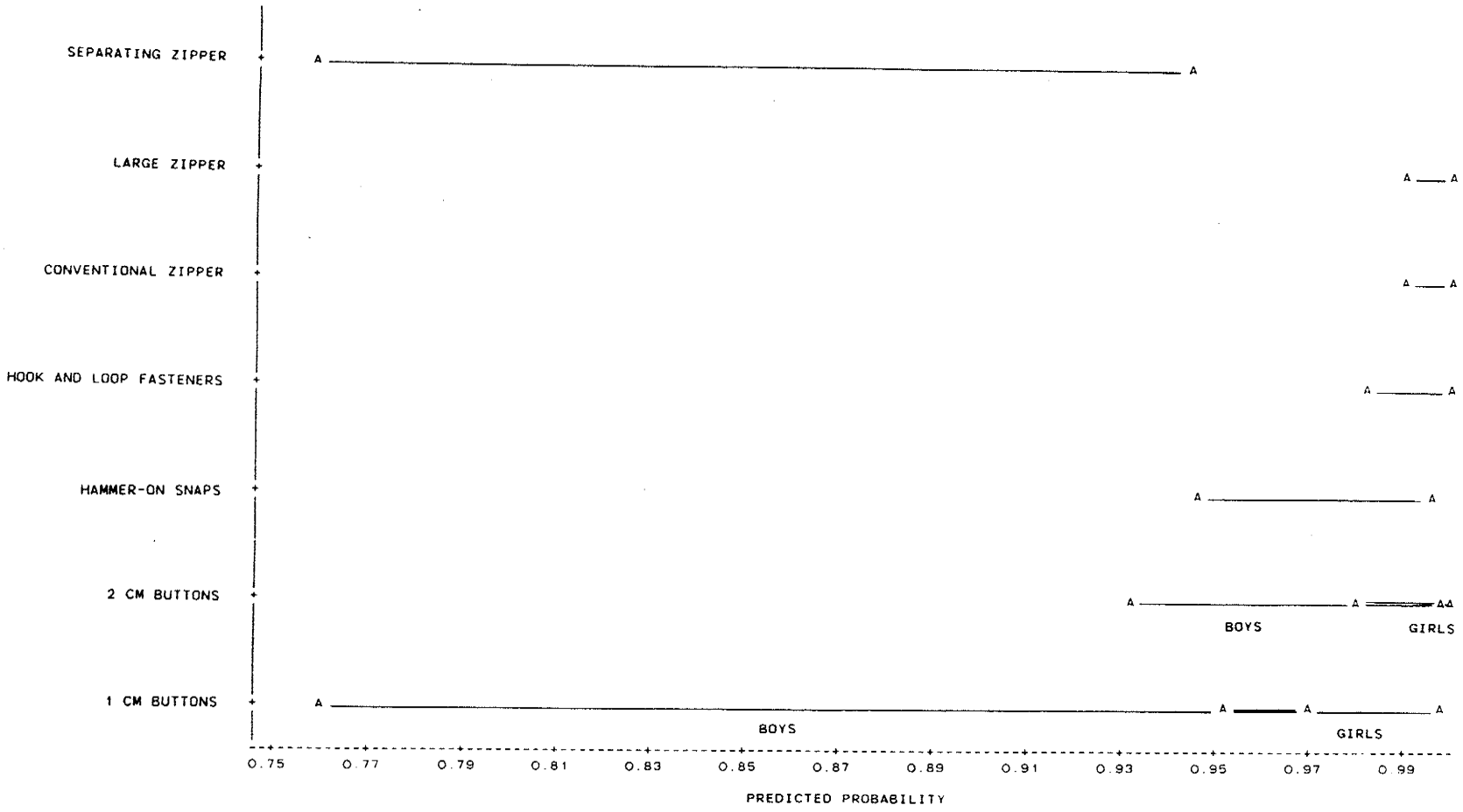

Figure 70

Confidence Intervals for Predicted Probabilities
of 54 Month Old Children Closing and Opening Fasteners

Appendix N

EXISTENCE OF SIGNIFICANT DIFFERENCES IN CONFIDENCE INTERVALS FOR MANIPULATING TWO SIZES OF THE SAME FASTENER

Table 42

Existence of Significant Differences in the Confidence Intervals for Predicted Probabilities of Manipulating Two Sizes of the Same Fastener, By Age

Ability to:	Age in Months	Two Sizes of the Same Fastener: 1 cm or 2 cm Buttons	Two Sizes of the Same Fastener: Conventional or Large Zippers
Close	24	NS	NS
	30	NS	NS
	36	NS	NS
	42	NS	NS
	48	NS	NS
	54	NS	NS
Open	24	NS	NS
	30	NS	NS
	36	S for boys NS for girls	NS
	42	S for boys NS for girls	NS
	48	S for boys NS for girls	NS
	54	S for boys NS for girls	NS
Close and Open	24	NS	NS
	30	NS	NS
	36	NS	NS
	42	S for boys NS for girls	NS
	48	NS	NS
	54	NS	NS

Note. "NS" means there is no significant difference and "S" means that there is a significant difference.

Appendix O

ESTIMATED PARAMETERS AND STATISTICAL TESTS FROM LOGISTIC REGRESSION EQUATIONS ON MANIPULATING WAISTLINE AND NECKLINE FASTENERS

Table 43

Estimated Parameters and Statistical Tests from Logistic Regression Equations on Manipulating Waistline Fasteners

Fastener	Number Not Able to Manipulate	Number Able to Manipulate	Variable	Beta	Standard Error of Beta	Chi-Square H_o:Beta=0	P Value	Fraction of Concordant Pairs of Predicted Probability & Responses
1 cm Button	68	64	Intercept	-16.2768	2.7645	34.67	0.0000	0.927
			Age	0.3004	0.0502	35.82	0.0000	
			Sex	2.5910	0.6757	14.70	0.0001	
2 cm Button	53	79	Intercept	-14.4300	2.6030	30.73	0.0000	0.924
			Age	0.3194	0.0549	33.90	0.0000	
			Sex	1.6630	0.6316	6.93	0.0085	
Hammer-on Snap	51	81	Intercept	-11.5695	2.0072	33.22	0.0000	0.902
			Age	0.3127	0.0531	34.74	0.0000	
Hook and Loop Fastener	6	126	Intercept	-4.1711	2.4332	2.94	0.0865	0.816
			Age	0.2169	0.0837	6.71	0.0096	

Table 44

Estimated Parameters and Statistical Tests from Logistic Regression Equations on Manipulating Neckline Fasteners

Fastener	Number Not Able to Manipulate	Number Able to Manipulate	Variable	Beta	Standard Error of Beta	Chi-Square H_o:Beta=0	P Value	Fraction of Concordant Pairs of Predicted Probability & Responses
1 cm Button	83	49	Intercept	-19.6877	3.5208	31.27	0.0000	0.936
			Age	0.3426	0.0611	31.40	0.0000	
			Sex	2.7875	0.7337	14.44	0.0001	
2 cm Button	75	57	Intercept	-14.1013	2.3638	35.59	0.0000	0.886
			Age	0.2694	0.0443	36.90	0.0000	
			Sex	1.6594	0.5705	8.46	0.0036	
Hammer-on Snap	84	48	Intercept	-10.7085	1.8159	34.99	0.0000	0.841
			Age	0.2368	0.0403	34.52	0.0000	
Hook and Loop Fastener	14	118	Intercept	-5.3823	1.7546	9.41	0.0022	0.826
			Age	0.2198	0.0572	14.75	0.0001	

Appendix P

PREDICTED PROBABILITIES AND CONFIDENCE INTERVALS FOR MANIPULATING WAISTLINE AND NECKLINE FASTENERS

Table 45

Predicted Probabilities and Confidence Intervals for Closing and Opening Waistline and Neckline Fasteners

Fastener		24 Months			30 Months			36 Months		
		P	Lower	Upper	P	Lower	Upper	P	Lower	Upper
Waistline 1 cm Button	Boys	0.0015	0.0002	0.0136	0.0092	0.0018	0.0466	0.0536	0.0173	0.1542
Neckline 1 cm Button	Boys	0.0002	0.0000	0.0036	0.0013	0.0001	0.0143	0.0103	0.0018	0.0557
Waistline 1 cm Button	Girls	0.0201	0.0043	0.0882	0.1107	0.0404	0.2692	0.4302	0.2523	0.6283
Neckline 1 cm Button	Girls	0.0028	0.0003	0.0263	0.0212	0.0042	0.0990	0.1446	0.0551	0.3287
Waistline 2 cm Button	Boys	0.0060	0.0009	0.0383	0.0397	0.0109	0.1338	0.2193	0.1042	0.4042
Neckline 2 cm Button	Boys	0.0025	0.0003	0.0182	0.0126	0.0028	0.0551	0.0604	0.0210	0.1614

Table 45--Continued

Predicted Probabilities and Confidence Intervals for Closing and Opening Waistline and Neckline Fasteners

Fastener		24 Months			30 Months			36 Months		
		P	Lower	Upper	P	Lower	Upper	P	Lower	Upper
Waistline 2 cm Button	Girls	0.0311	0.0073	0.1223	0.1791	0.0741	0.3730	0.5971	0.3924	0.7728
Neckline 2 cm Button	Girls	0.0131	0.0026	0.0633	0.0629	0.0202	0.1793	0.2524	0.1277	0.4376
Waistline Hammer-on Snap		0.0169	0.0038	0.0719	0.1008	0.0414	0.2256	0.4227	0.2913	0.5661
Neckline Hammer-on Snap		0.0063	0.0012	0.0337	0.0256	0.0075	0.0845	0.0983	0.0450	0.2012
Waistline Hook & Loop Fastener		0.7380	0.4703	0.8993	0.9119	0.8065	0.9626	0.9744	0.8942	0.9942
Neckline Hook & Loop Fastener		0.4732	0.2598	0.6969	0.7705	0.6386	0.8645	0.9262	0.8333	0.9693

Table 45--Continued

Predicted Probabilities and Confidence Intervals for Closing and Opening Waistline and Neckline Fasteners

Fastener		42 Months			48 Months			54 Months		
		P	Lower	Upper	P	Lower	Upper	P	Lower	Upper
Waistline 1 cm Button	Boys	0.2555	0.1299	0.4409	0.6754	0.4722	0.8288	0.9266	0.7924	0.9766
Neckline 1 cm Button	Boys	0.0752	0.0246	0.2075	0.3885	0.2102	0.6027	0.8323	0.6260	0.9364
Waistline 1 cm Button	Girls	0.8208	0.6495	0.9188	0.9652	0.8835	0.9903	0.9941	0.9652	0.9990
Neckline 1 cm Button	Girls	0.5691	0.3701	0.7480	0.9116	0.7741	0.9688	0.9877	0.9378	0.9977
Waistline 2 cm Button	Boys	0.6563	0.4602	0.8105	0.9284	0.8020	0.9765	0.9888	0.9415	0.9979
Neckline 2 cm Button	Boys	0.2443	0.1267	0.4188	0.6194	0.4249	0.7819	0.8912	0.7371	0.9599

Table 45--Continued

Predicted Probabilities and Confidence Intervals for Closing and Opening Waistline and Neckline Fasteners

Fastener		42 Months			48 Months			54 Months		
		P	Lower	Upper	P	Lower	Upper	P	Lower	Upper
Waistline 2 cm Button	Girls	0.9097	0.7705	0.9680	0.9856	0.9326	0.9971	0.9979	0.9814	0.9998
Neckline 2 cm Button	Girls	0.6295	0.4482	0.7805	0.8953	0.7647	0.9575	0.9773	0.9164	0.9941
Waistline Hammer-on Snap		0.8270	0.6971	0.9085	0.9690	0.9012	0.9907	0.9951	0.9709	0.9992
Neckline Hammer-on Snap		0.3109	0.2101	0.4336	0.6513	0.5178	0.7647	0.8855	0.7614	0.9493
Waistline Hook & Loop Fastener		0.9929	0.9286	0.9993	0.9981	0.9494	0.9999	0.9995	0.9636	1.0000
Neckline Hook & Loop Fastener		0.9791	0.9144	0.9952	0.9943	0.9552	0.9993	0.9985	0.9766	0.9990

Appendix Q

GRAPHS OF PREDICTED PROBABILITIES OF MANIPULATING WAISTLINE AND NECKLINE FASTENERS

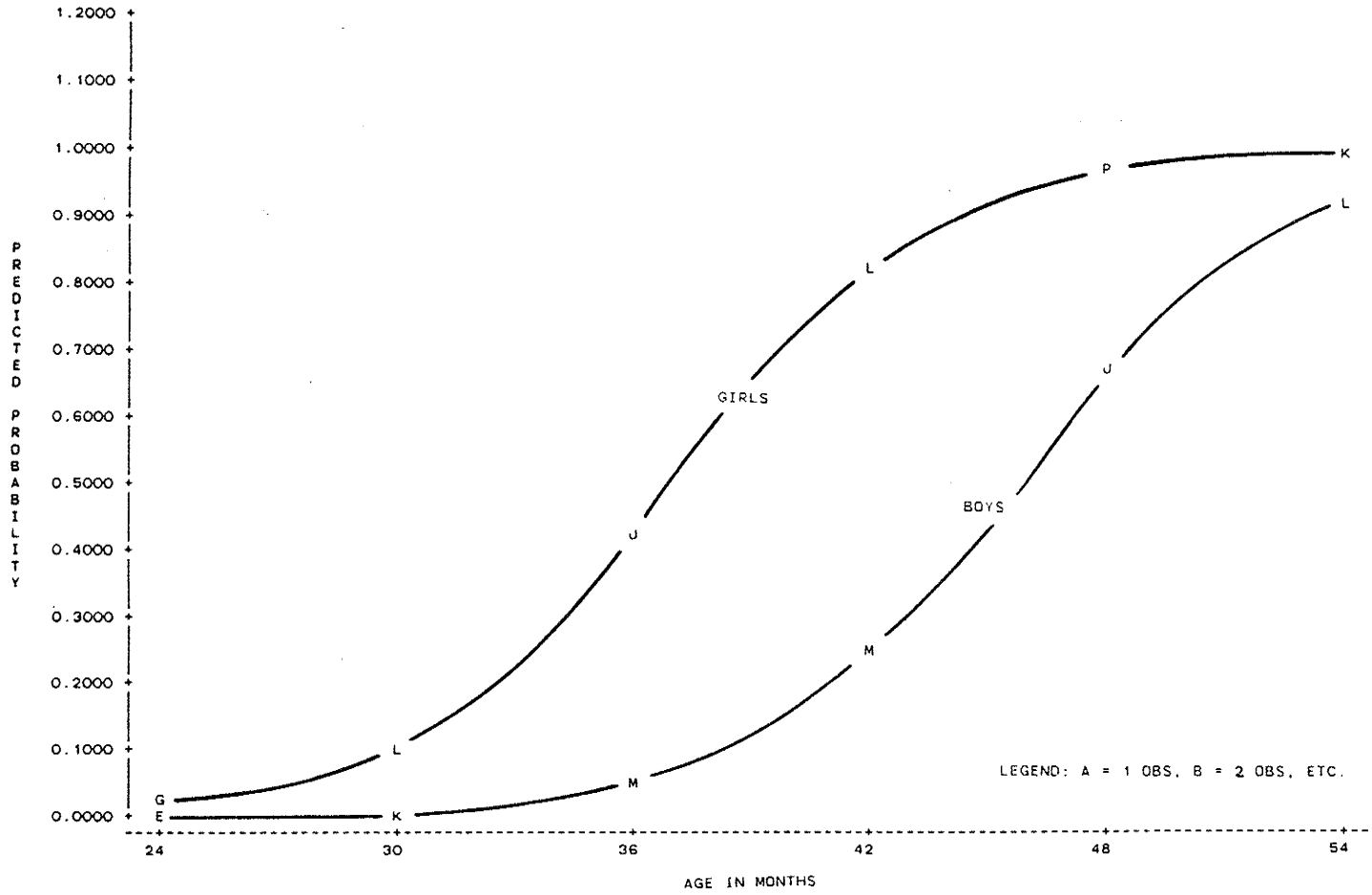

Figure 71

Predicted Probability of Closing and Opening Waistline 1 cm Button

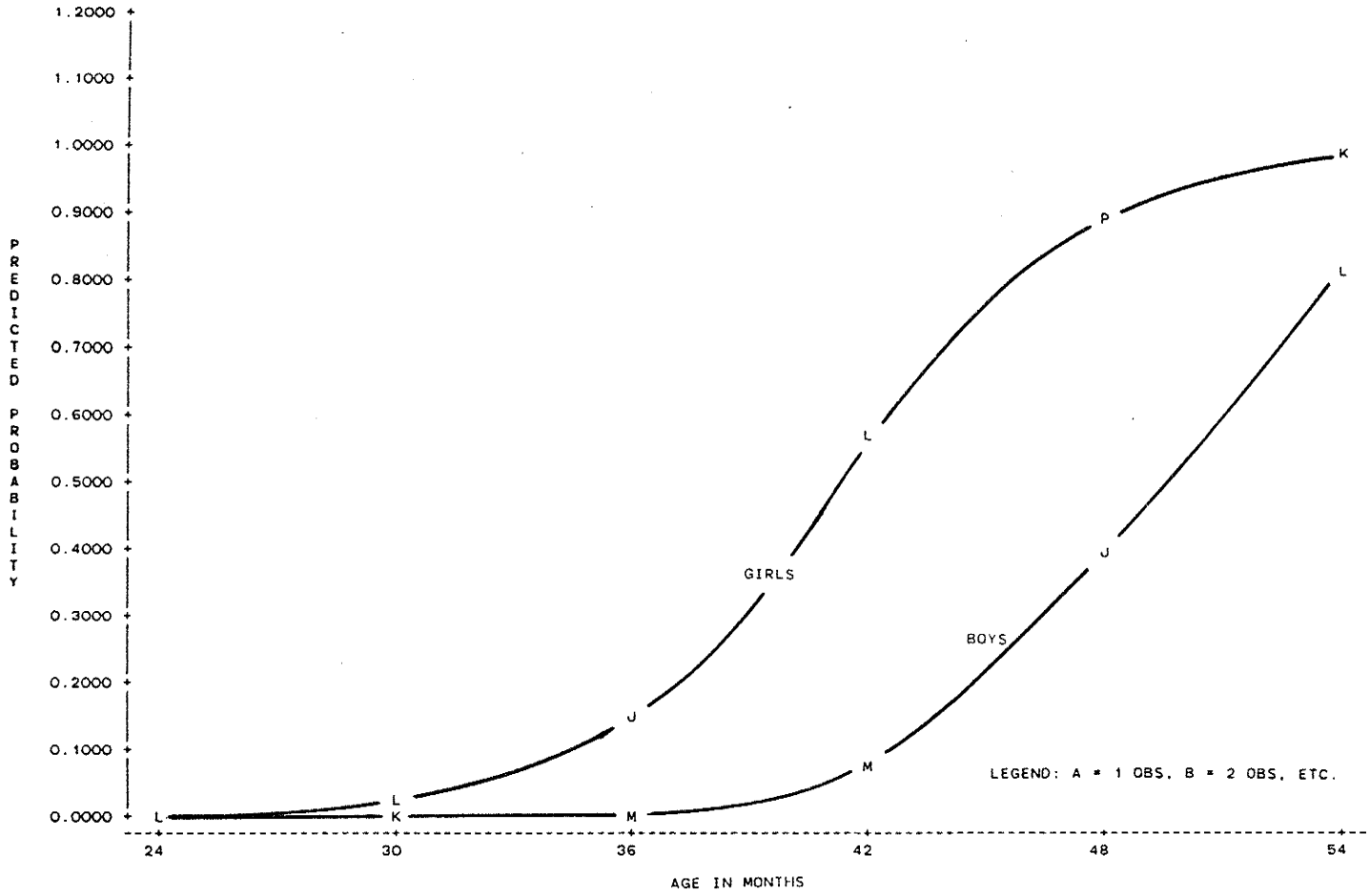

Figure 72

Predicted Probability of Closing and Opening Neckline 1 cm Button

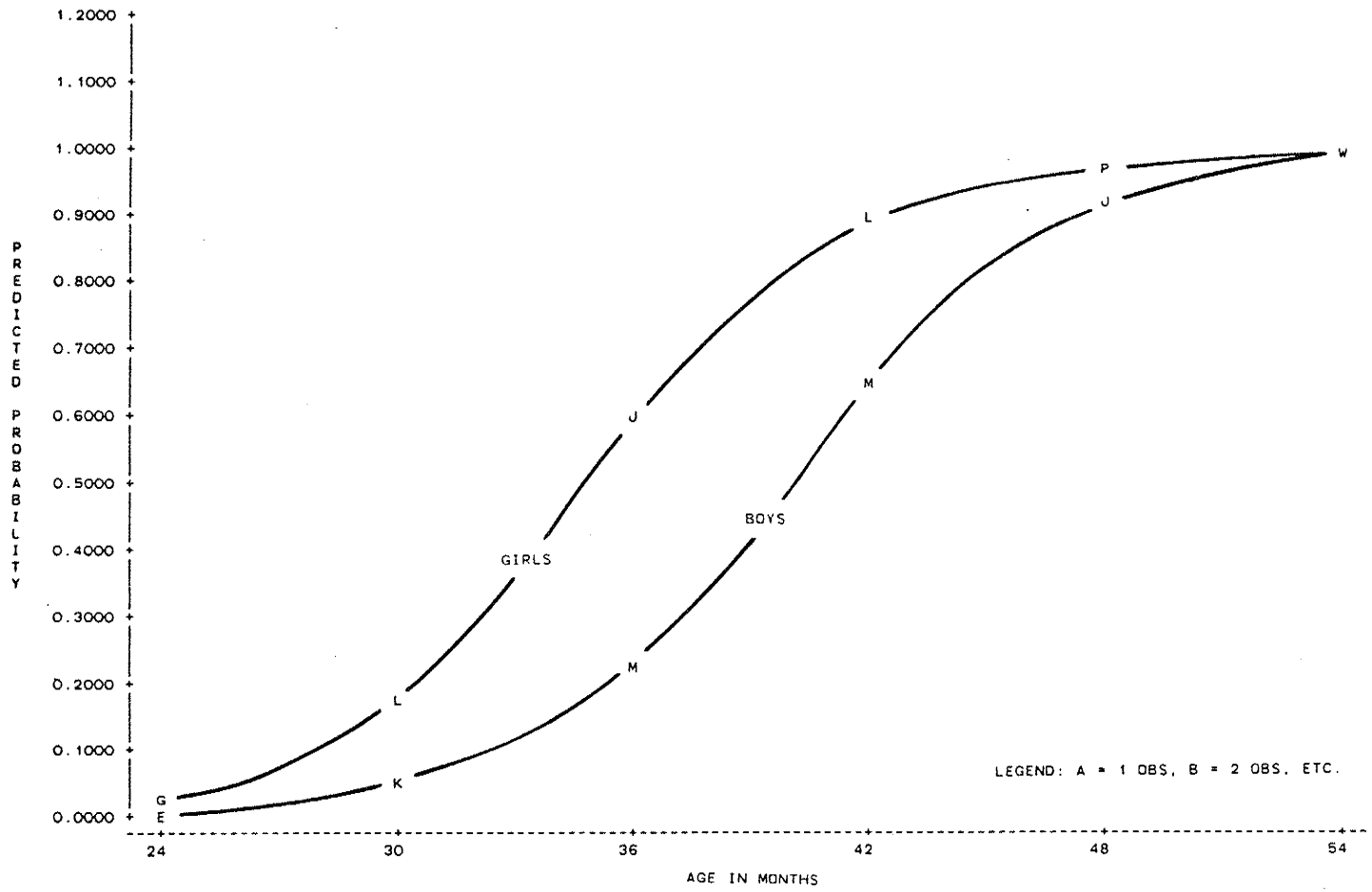

Figure 73

Predicted Probability of Closing and Opening Waistline 2 cm Button

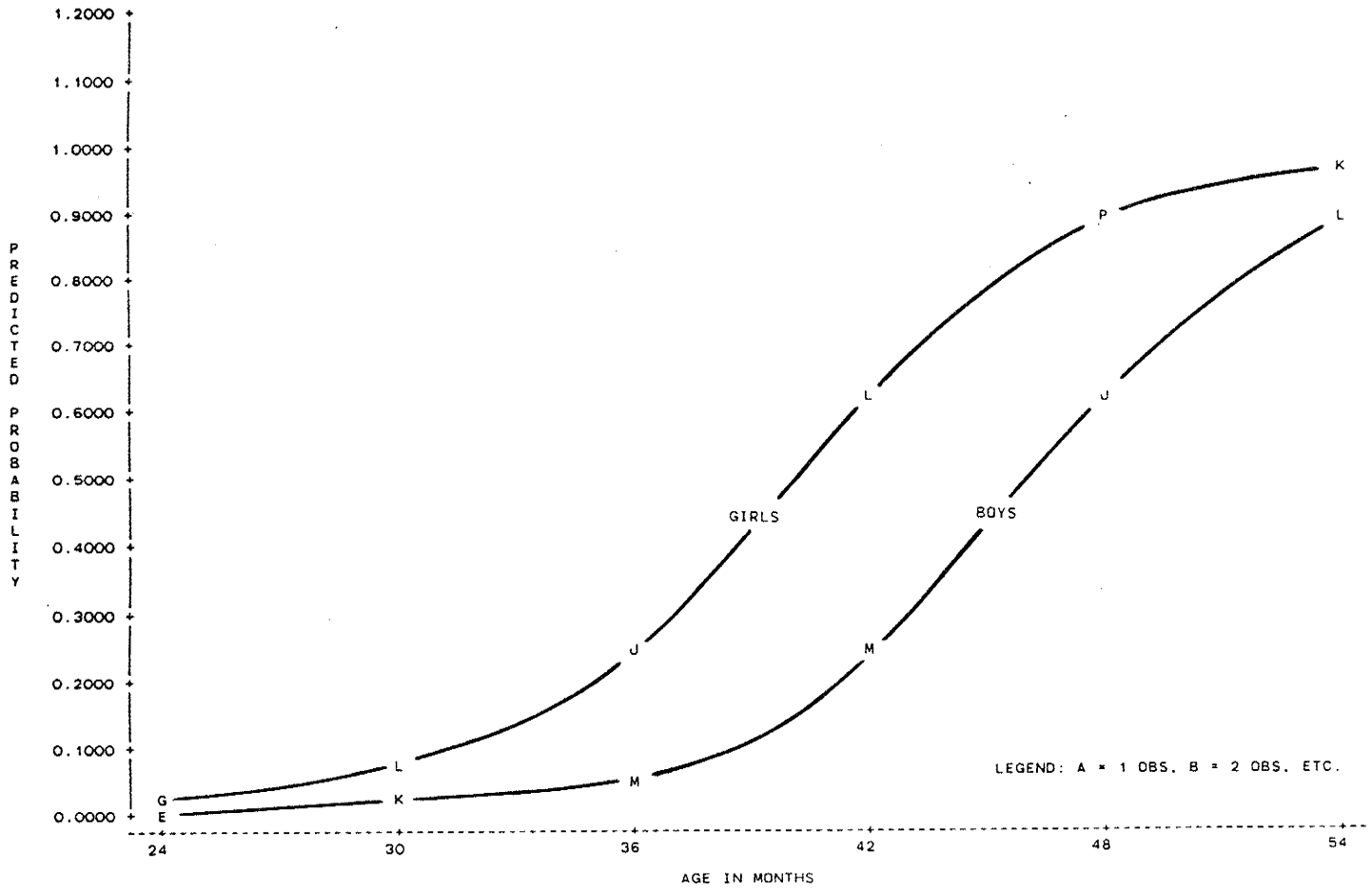

Figure 74

Predicted Probability of Closing and Opening Neckline 2 cm Button

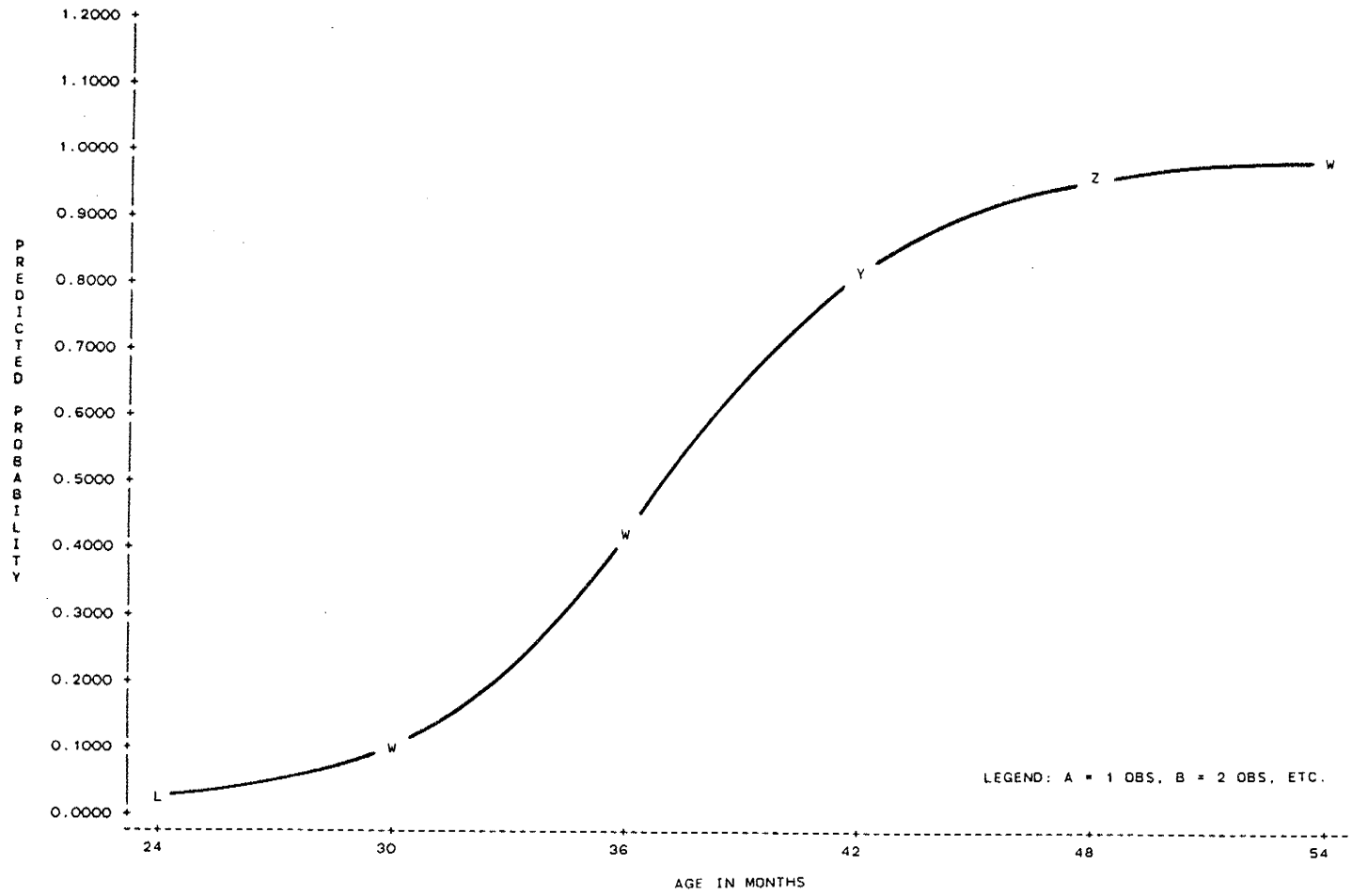

Figure 75

Predicted Probability of Closing and Opening Waistline Hammer-on Snap

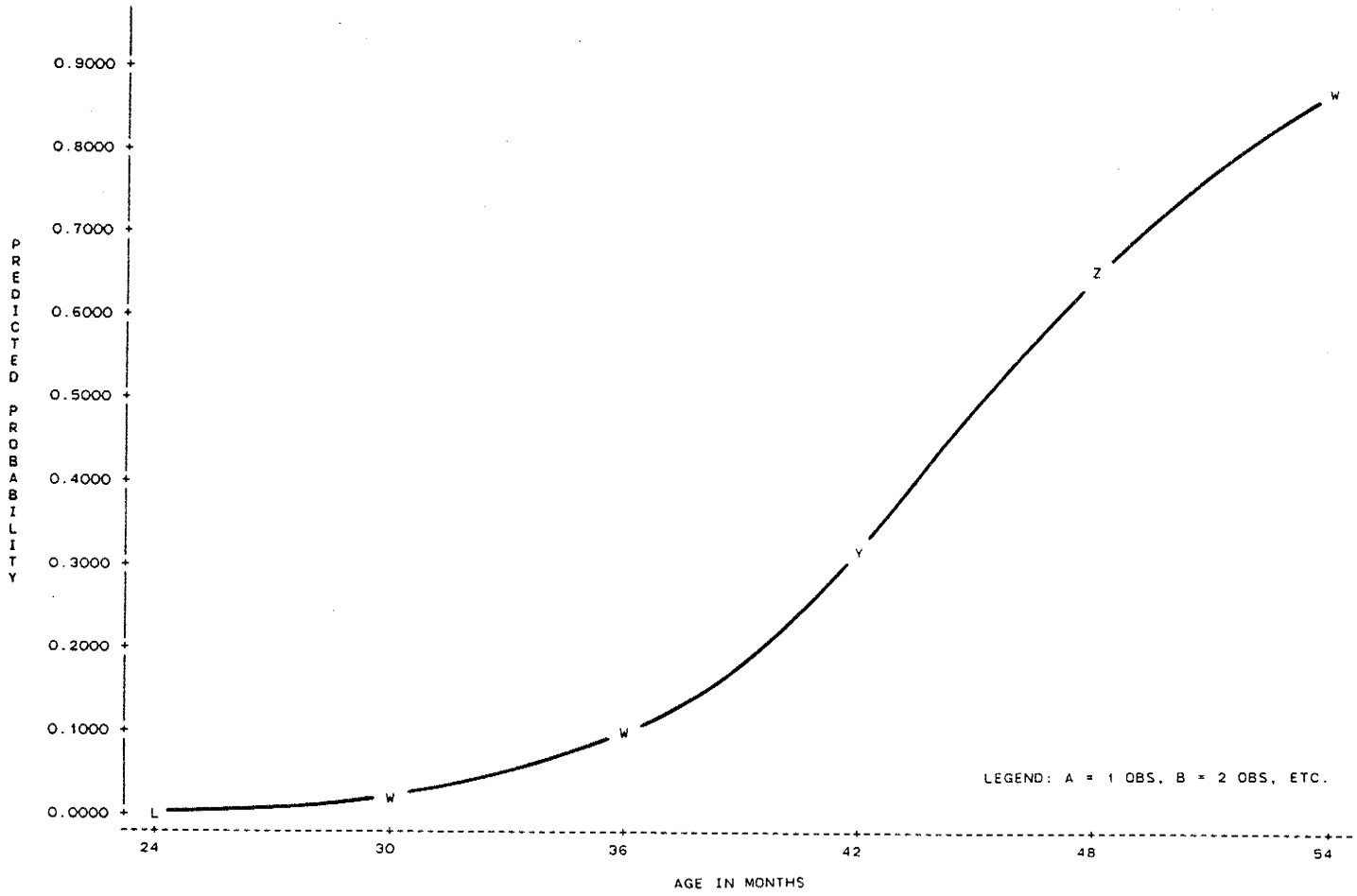

Figure 76

Predicted Probability of Closing and Opening Neckline Hammer-on Snap

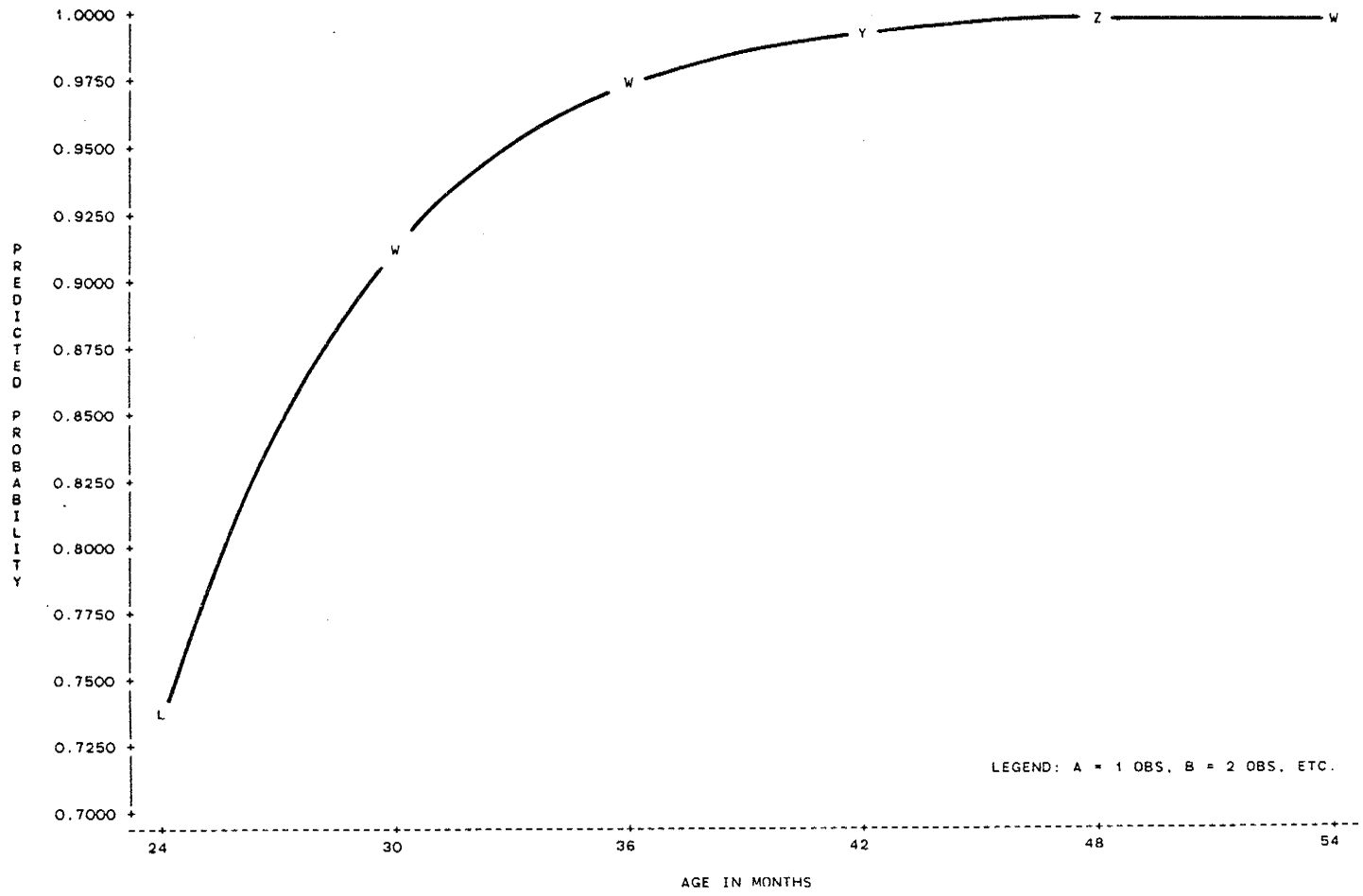

Figure 77

Predicted Probability of Closing and Opening Waistline Hook and Loop Fastener

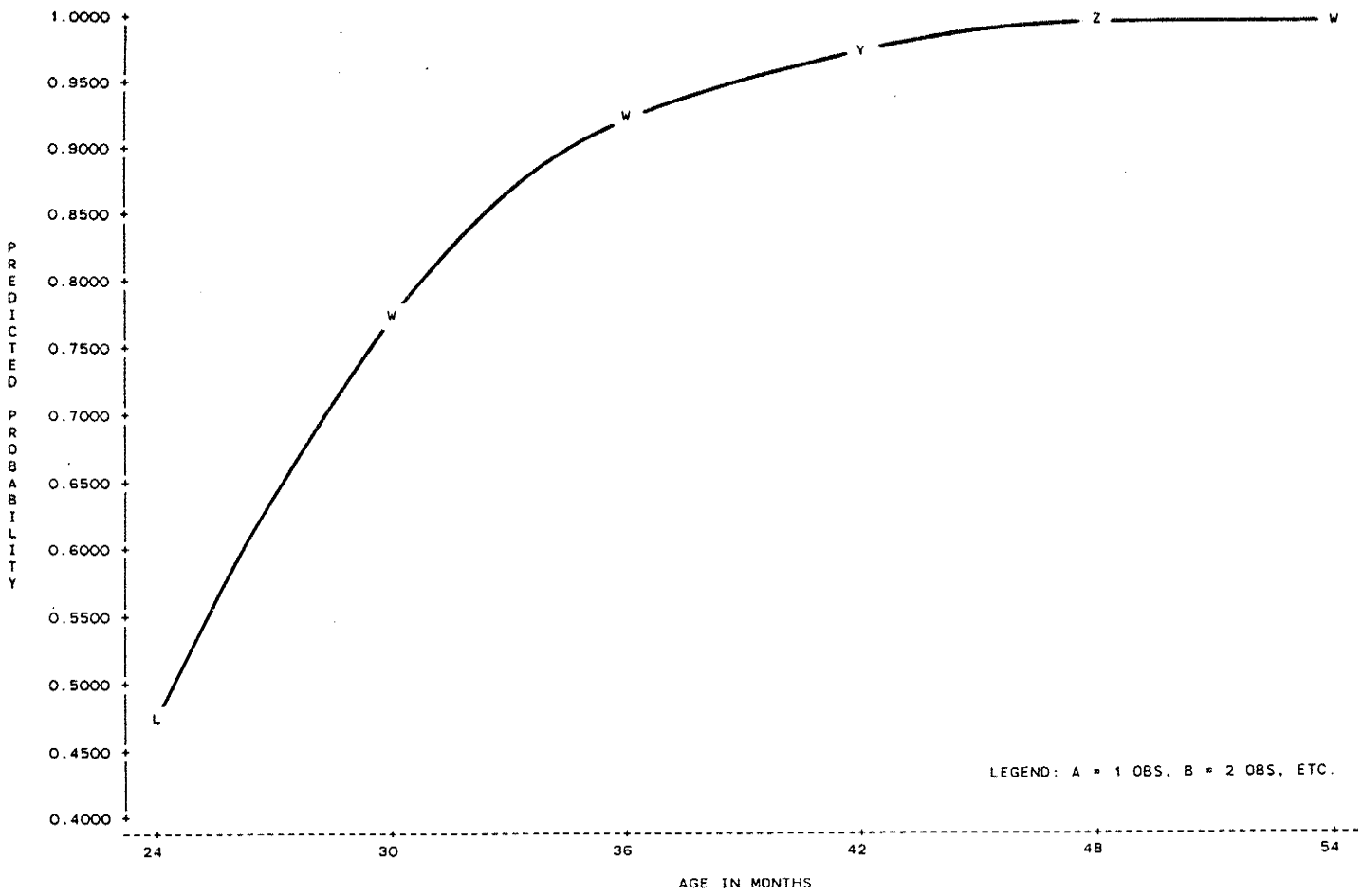

Figure 78

Predicted Probability of Closing and Opening Neckline Hook and Loop Fastener

Appendix R

GRAPHS OF CONFIDENCE INTERVALS FOR PREDICTED PROBABILITIES OF MANIPULATING WAISTLINE AND NECKLINE FASTENERS

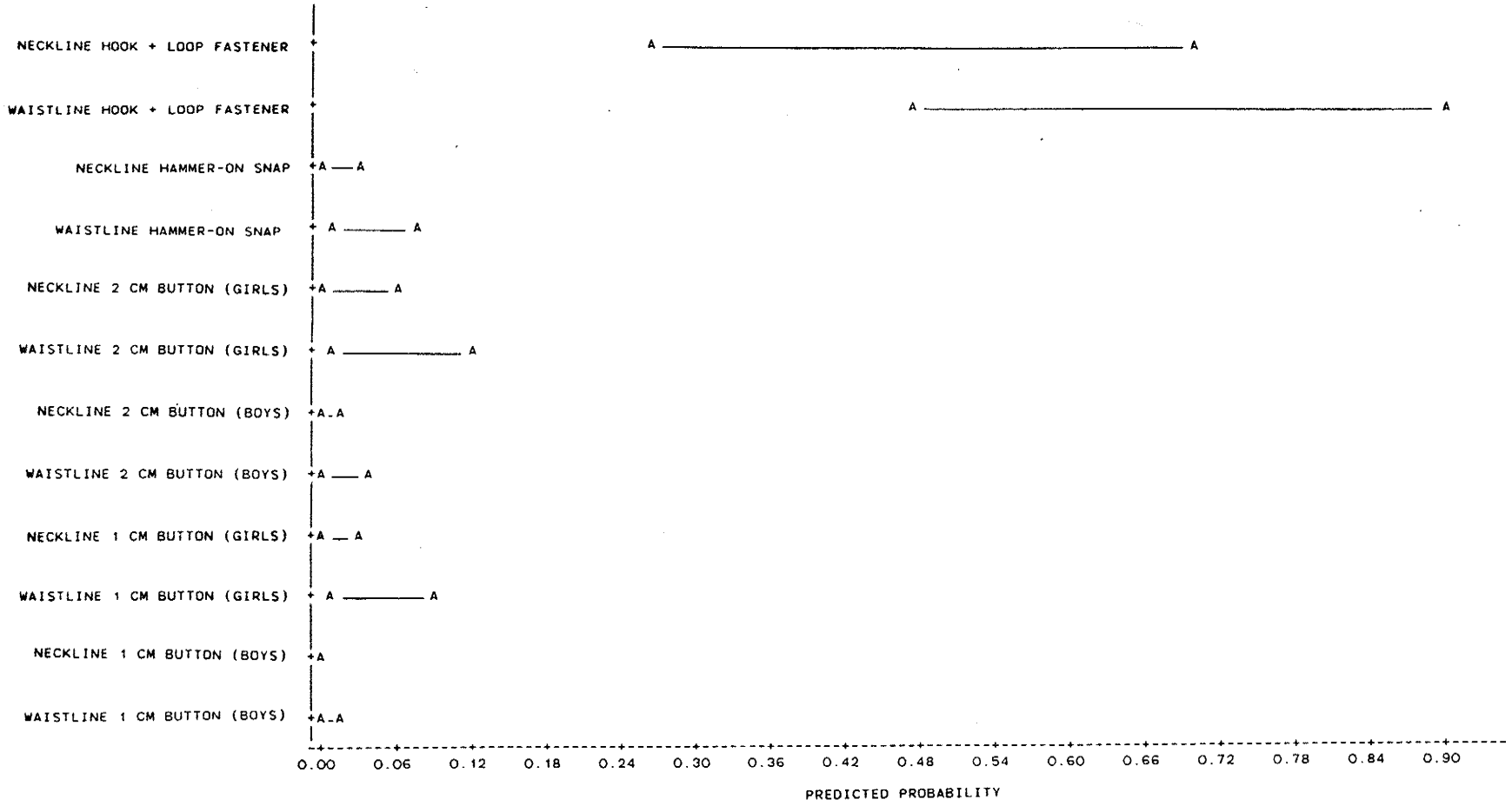

Figure 79

Confidence Intervals for Predicted Probabilities of 24 Month Old Children
Closing and Opening Waistline and Neckline Fasteners

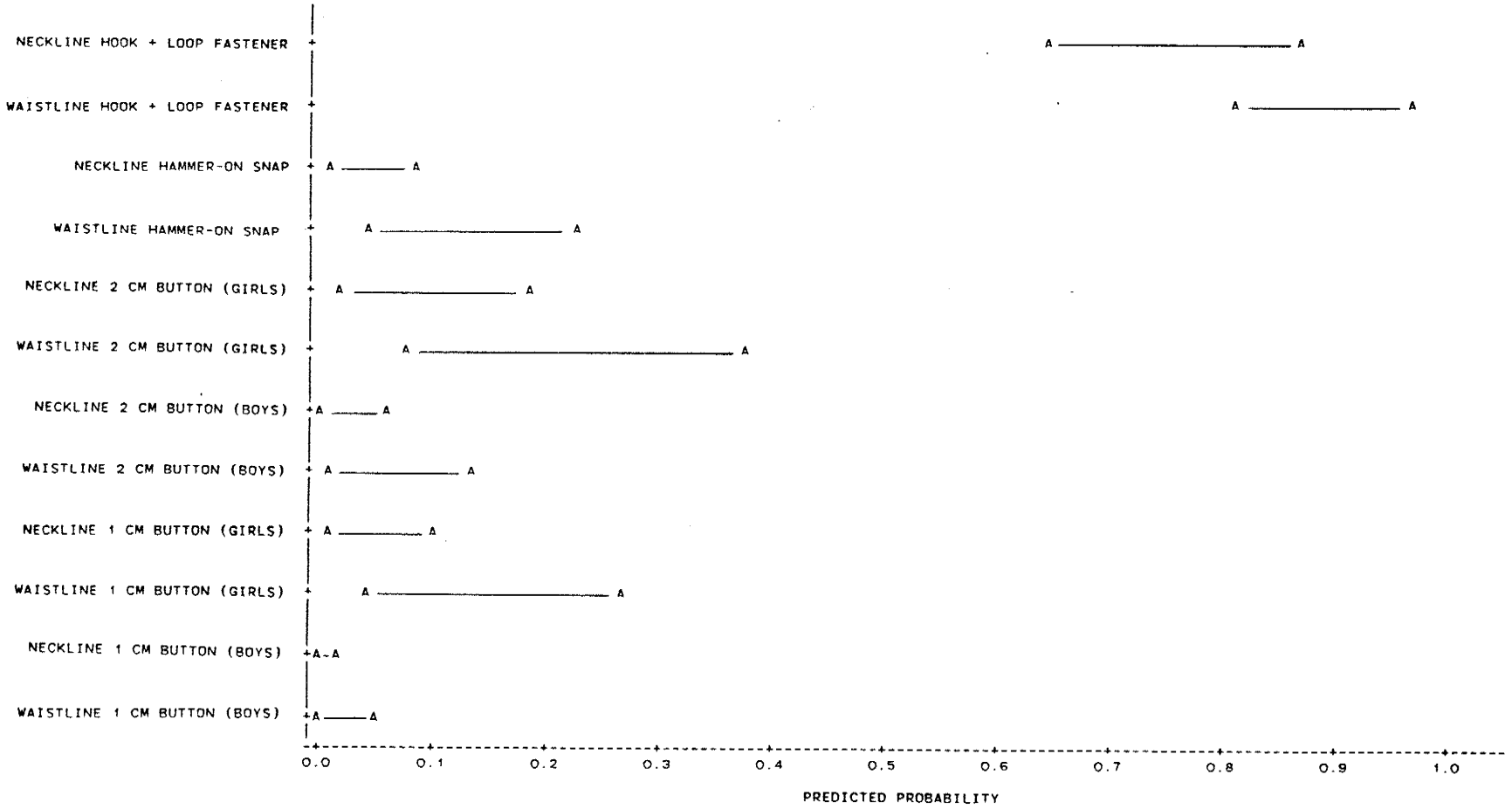

Figure 80

Confidence Intervals for Predicted Probabilities of 30 Month Old Children Closing and Opening Waistline and Neckline Fasteners

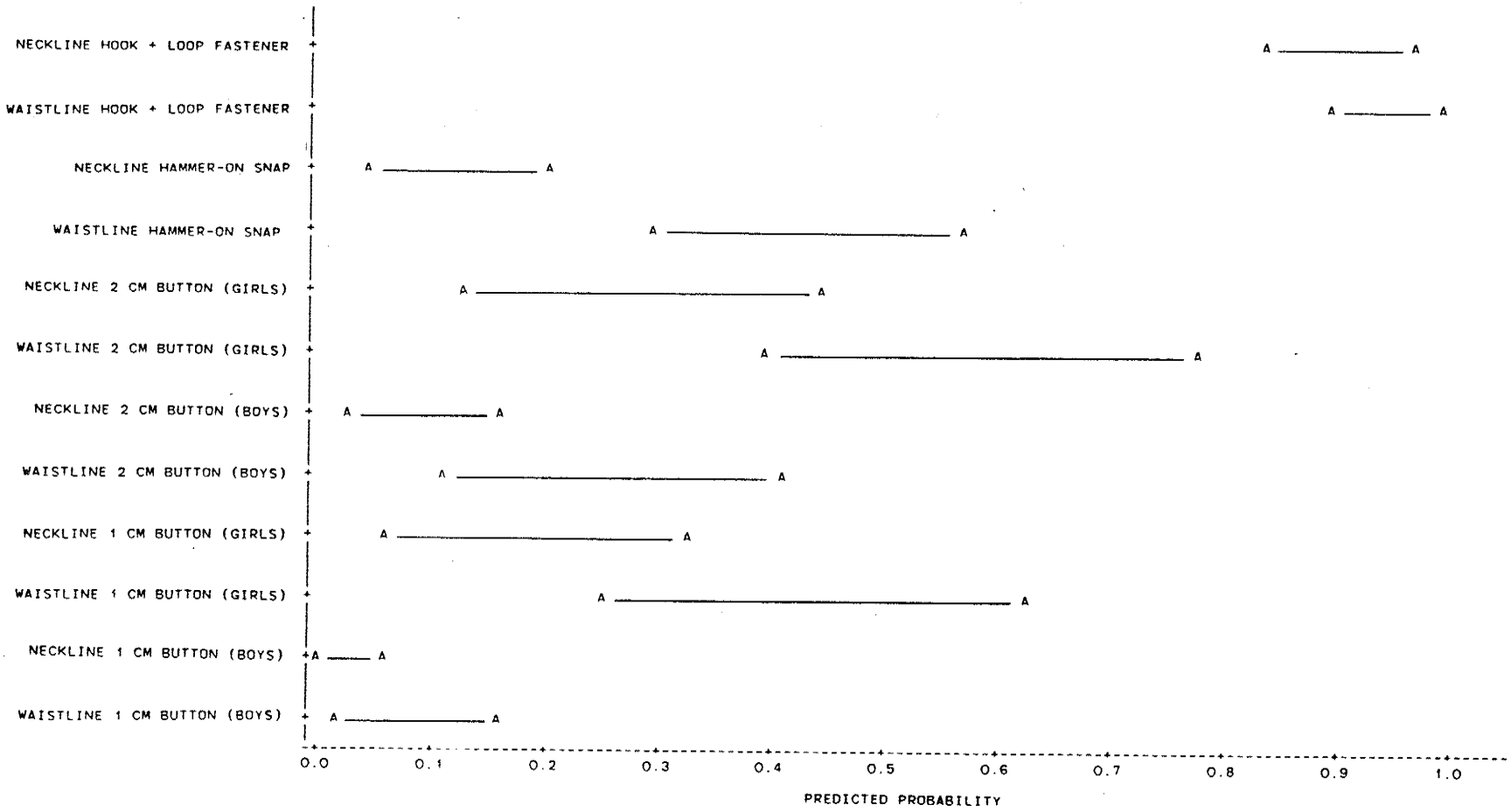

Figure 81

Confidence Intervals for Predicted Probabilities of 36 Month Old Children
Closing and Opening Waistline and Neckline Fasteners

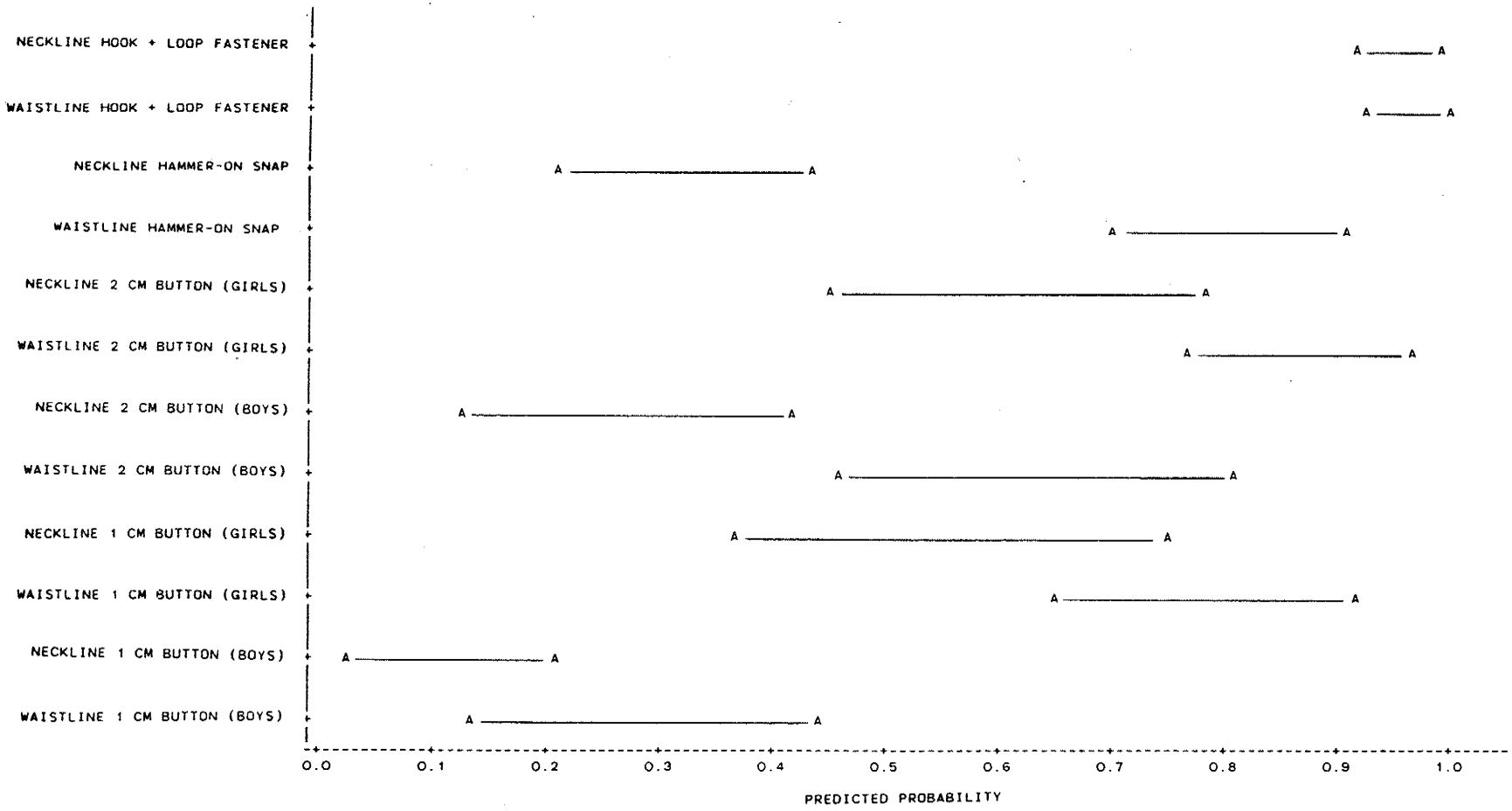

Figure 82

Confidence Intervals for Predicted Probabilities of 42 Month Old Children
Closing and Opening Waistline and Neckline Fasteners

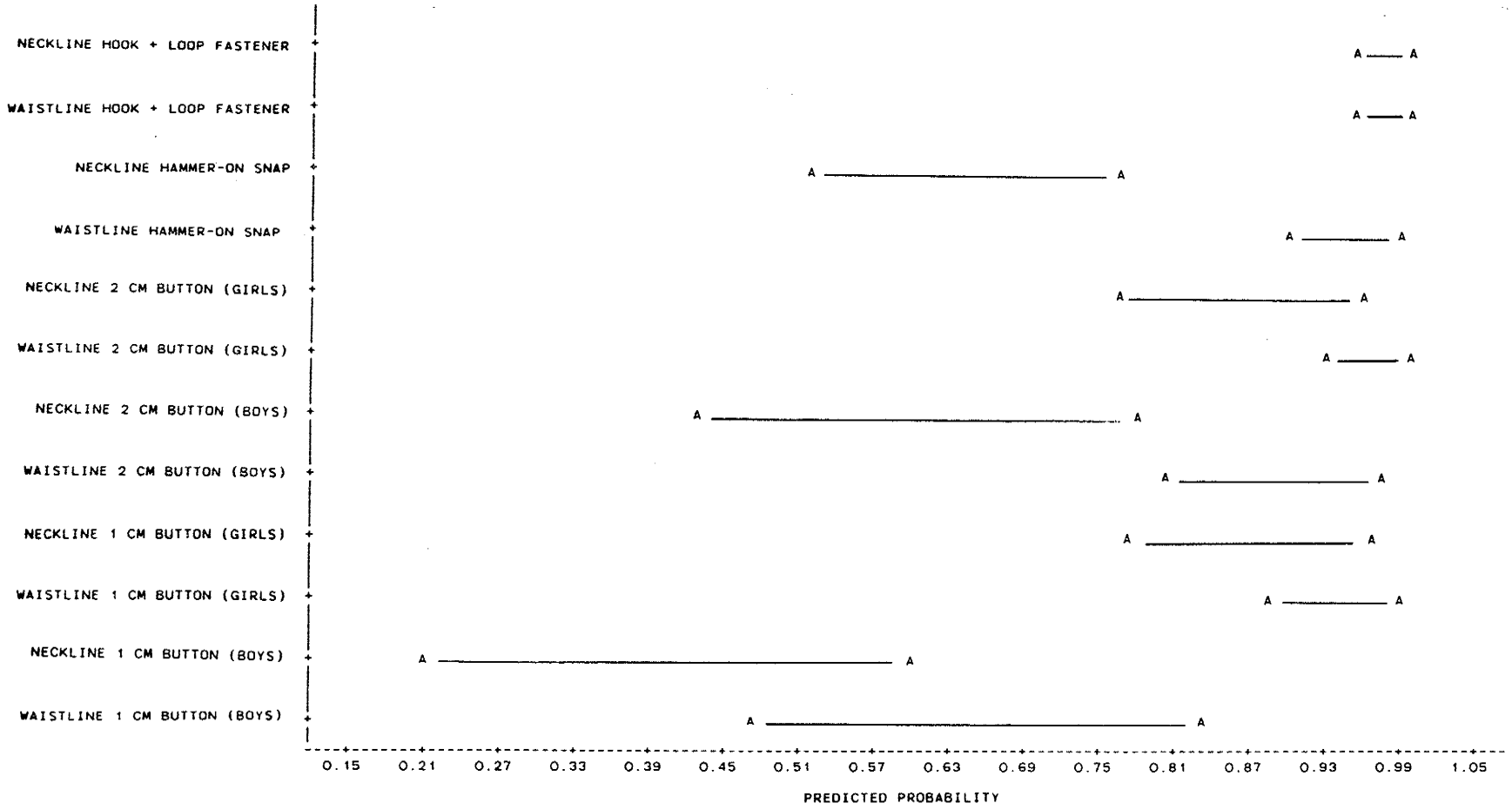

Figure 83

Confidence Intervals for Predicted Probabilities of 48 Month Old Children
Closing and Opening Waistline and Neckline Fasteners

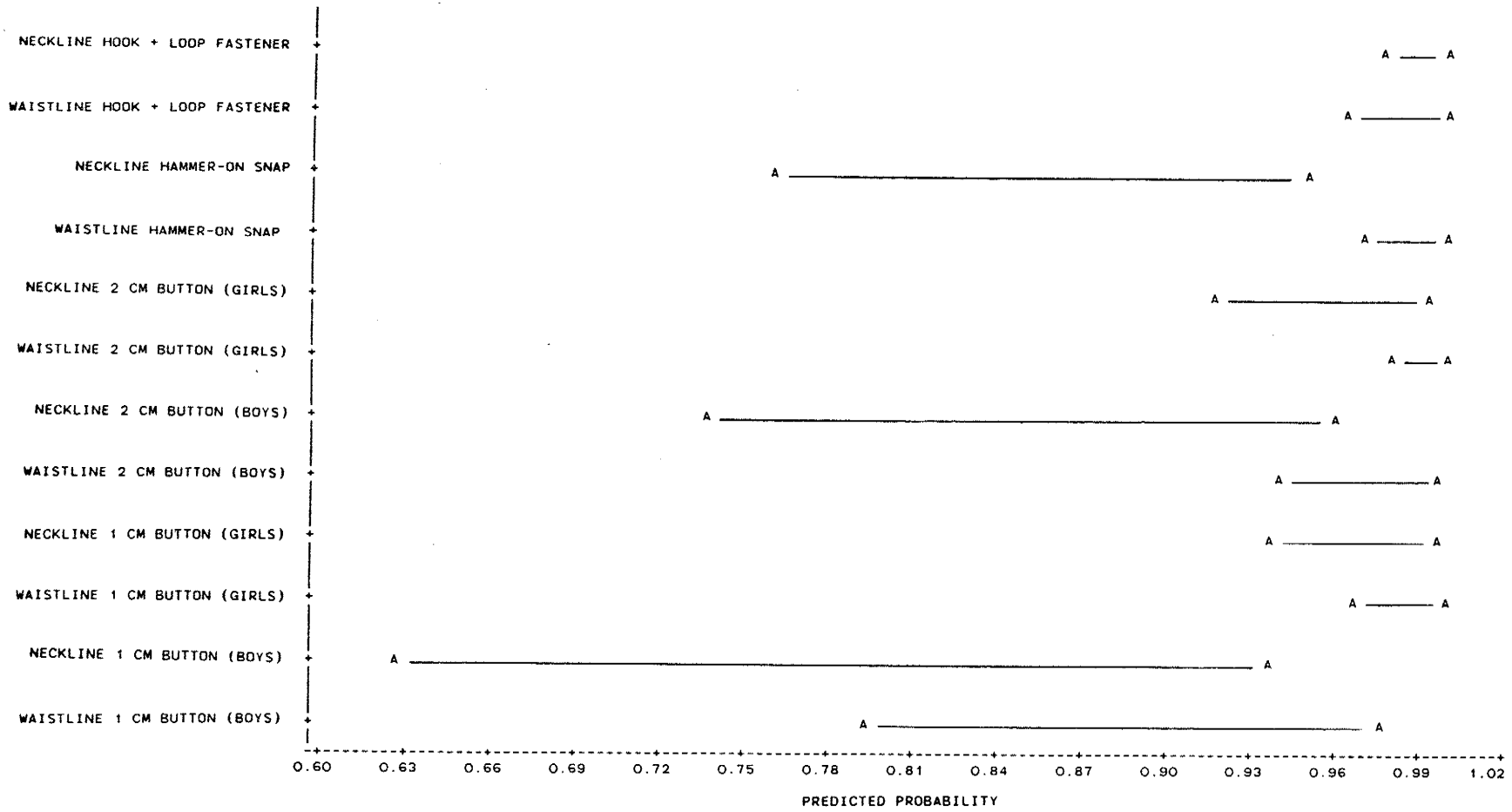

Figure 84

Confidence Intervals for Predicted Probabilities of 54 Month Old Children
Closing and Opening Waistline and Neckline Fasteners

Appendix S

EXISTENCE OF SIGNIFICANT DIFFERENCES IN CONFIDENCE INTERVALS FOR MANIPULATING WAISTLINE AND NECKLINE FASTENERS

Table 46

Existence of Significant Differences in Confidence Intervals for Predicted Probabilities of Manipulating Waistline and Neckline Fasteners

Age in Months	Fasteners			
	1 cm Buttons	2 cm Buttons	Hammer-on Snaps	Hook and Loop Fasteners
24	NS	NS	NS	NS
30	NS	NS	NS	NS
36	NS	NS	S	NS
42	NS	S for boys NS for girls	S	NS
48	NS	S for boys NS for girls	S	NS
54	NS	NS	S	NS

Note. "NS" means there is no significant difference and "S" means that there is a significant difference.