

Acceptability of a Functional-Cosmetic Artificial Hand for Young Children, Part II

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IN THE study of the APRL-Sierra No. 1 right hand, which preceded that of the left, the results of comparative performance testing indicated that there was little difference between the hand and the hook on the various test activities. Statements of children participating in the study—and of their parents—indicated a relatively high level of performance with the experimental hand, but advantages and disadvantages were not clearly defined.

These results appeared to be at variance with past clinical impressions, which indicated

that a hand was a significantly less functional terminal device than a hook. Hence, in the Left-Hand Study the performance tests were repeated to check the results of the earlier study. An attempt was also made to delineate more completely the relative usefulness of the two devices by obtaining data concerning their effectiveness in a wide variety of activities.

PERFORMANCE TESTS

As indicated in Part I of this two-part series of articles, the child amputees participating in these studies were required to make four visits to the clinics servicing them, during a period of five months. The first visit was a screening session to select suitable candidates; on the second visit the child was fitted with the experimental hand; the third visit, two months after the fitting, was for the purpose of making evaluative comparisons between the old and the new terminal devices; and the purpose of the fourth visit, four months after the fitting, was to make a final evaluation.

A prosthetic performance test, utilizing the old terminal device, was given the child on the second visit. On the third visit the same performance test was administered, utilizing first the APRL-Sierra hand and then the old terminal device. The prosthetic performance test required the child to perform six activities, upon each of which he was timed and rated. The activities were:

¹ Part I appeared in the Spring 1964 issue of *Artificial Limbs*. Both Part I and Part II are based upon *Acceptability of a Functional-Cosmetic Hand for Young Children*, published by Child Prosthetic Studies, Research Division, College of Engineering, New York University, New York, N.Y., in January 1964 (1). Part I covered the history and purposes of the study, a description of the experimental hand (APRL-Sierra No. 1 hand), a description of the sample used in the studies, an account of the reactions of the children, their parents, and others to the hand, observations of classroom behavior during the period, and prescription considerations. Part II covers the children's performance of standard tasks with the hand and its functional capabilities and limitations. The studies reported were conducted under the auspices of the Subcommittee on Child Prosthetics Problems of the Committee on Prosthetics Research and Development, National Academy of Sciences—National Research Council, 2101 Constitution Ave., N.W., Washington, D.C. 20418. The research was sponsored by the Children's Bureau of the Department of Health, Education, and Welfare under a special grant.

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1. Unscrewing and reassembling five small plastic barrels ("Kitty in the Kegs") (Fig. 1)

2. Drying a wet cup, saucer, and dinner plate, using a dish towel (Fig. 2).

3. Putting on a shirt or dress—as appropriate—and shoes and socks (Fig. 3).



Fig 1 "Kitty in the Kegs," a set of small plastic barrels, one inside the other. A picture of a kitten is in the innermost barrel



Fig. 4. "Loony Links." The child is asked to assemble a jointed doll and stand it on its feet, using a preassembled doll as a model



Fig. 2. Drying dishes.



Fig. 5. Cutting and pasting.



Fig. 3. Pulling on clothes.



Fig. 6. Eating ice cream.

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4. Assembling a jointed doll ("Loony Links") (Fig. 4).
5. Cutting out a printed figure and pasting it to a piece of paper (Fig. 5).
6. Eating ice cream from a paper cup, using a metal spoon (Fig. 6).

Typically, the test was administered by an occupational therapist. The rating scale employed ranged downward from a score of 5 for performance approximating that of a non-amputee to 1 for performance in which the terminal device was not used, in accordance with the following subjective criteria:

- | Rating | Criteria |
|--------|---|
| 5 | A nearly normal bilateral performance in which the terminal device seems essential; that is, it is used to perform active functions in addition to and more advanced than holding, such as grasp and transportation and manipulation of the object. |
| 4 | A bilateral pattern in which the terminal device is a significant aid in grasping or hooking. |
| 3 | The terminal device is used for occasional grasping only, alternating with passive use. |
| 2 | The terminal device is used passively for pushing, weighting, or support, but not for grasp. |
| 1 | The terminal device is not used, although the elbow and forearm may be used as an aid. Ratings of 1.5, 2.5, 3.5, and 4.5 were interpolated to indicate performance whose quality was between two categories. |

Each child's performances with hook and hand were compared on the basis of best scores obtained while utilizing each device. In the Left-Hand Study performance times with each device were also obtained. The

comparative data are presented in Tables 1, 2, and 3.

TABLE 1. COMPARATIVE MEAN PERFORMANCE RATINGS, HOOK VS. HANDS, RIGHT- AND LEFT-HAND STUDIES

Activity	Right Hand (N = 32)		Left Hand (N = 36)	
	Hook	Hand	Hook	Hand
Kitty in the Kegs	4.23	4.05	4.42	4.00
Dry Dishes	4.06	3.62	4.19	3.60
Put on Clothes	3.45	2.77	3.83	2.94
Loony Links	3.87	3.75	4.01	3.46
Cut and Paste	3.58	2.87	3.95	3.03
Eat Ice Cream	3.16	2.72	3.35	2.68

There are obvious limitations to these data, in that the tests may have differed with individual children (the type of clothing donned, for example), and there were undoubtedly differences in the frames of reference employed by different therapists in rating a given performance. Since the data themselves are of doubtful precision, the application of tests of statistical precision is not indicated. Within these limitations, however, there is evidence that:

1. Mean performance ratings in all activities were higher for the hook (Table 1), which clearly appeared to be the better device functionally. Its superiority was most evident in the test activities of "Put on Clothes" and "Cut and Paste." The smallest differences in mean ratings were found in the "Kitty in the Kegs" and "Loony Links" tests. Both of these latter activities involve the grasping of objects for

TABLE 2. COMPARATIVE EFFECTIVENESS OF PERFORMANCE, HOOKS VS. HANDS, RIGHT- AND LEFT-HAND STUDIES

Activity	Better Performance						Hook and Hand Equal			Could Not Do or Not Reported
	Hook			Hand			Right	Left	Total	
	Right	Left	Total	Right	Left	Total				
Kitty in the Kegs	7	17	24	2	1	3	23	18	41	0
Dry Dishes	13	16	29	5	2	7	14	17	31	1
Put on Clothes	16	23	39	2	0	2	13	12	25	2
Loony Links	6	19	25	4	0	4	22	17	39	0
Cut and Paste	16	24	40	4	4	8	12	6	18	2
Eat Ice Cream	15	17	32	3	2	5	14	16	30	1
Totals			189			29			184	

TABLE 3. COMPARATIVE SPEED OF PERFORMANCE, HOOKS VS. HANDS, LEFT-HAND STUDY

Activity	Better Performance		Hook and Hand Equal	Could Not Do, or Not Reported
	Hook	Hand		
Kitty in the Kegs	25	8	3	0
Dry Dishes	26	7	2	1
Put on Clothes	23	10	1	2
Loony Links	24	6	6	0
Cut and Paste	17	3	15	1
Eat Ice Cream	26	9	1	0

which the active fingers and thumb of the hand are relatively well adapted.

2. In a total of 408 hook- and hand-performance comparisons shown in Table 2 (68 children performing 6 activities with each device), hook performance was rated as superior in almost half the instances (189 times). Interestingly enough, however, hook and hand performances were rated as equal almost as frequently (184 times), although hand performance was considered better in only a relatively insignificant number of cases (29). In this tabulation of the data also, the superiority of the hook appears less marked in the same two test items—"Kitty in the Kegs" and "Loony Links."

3. The comparative time data (Table 3) indicate that in the majority of instances hook performance was faster as well as more effective than hand performance, although again the results are by no means unanimous.

It is interesting to note (Tables 1 and 2) that in the Left-Hand Study the performance ratings more clearly reflected the functional superiority of the hook than was the case in the tests with the right hand. For example, only seven children of 32 were rated as performing the "Kitty in the Kegs" test better with the hook in the Right-Hand Study. In contrast, 17 of 36 children had better ratings utilizing the hook in this activity in the Left-Hand Study. A similar marked difference in comparative ratings is evident in the "Loony Links" task. In the other test activities, the differences diminished until in the "Eat Ice Cream" item the right- and left-hand data are almost identical.

The reasons for these differences are not clear. The subjectivity of the rating scale may, of course, have been a consideration. However, since the trend of the data is consistent, that is, favoring higher comparative hook ratings

in the Left-Hand Study, it would appear that other than chance factors are operative.

Handedness might possibly be a factor, but unfortunately data on this variable were not obtained in the study. It is also possible that in the earlier Right-Hand Study the raters were affected by a "halo" factor which had diminished by the time of the later Left-Hand Study.

FUNCTIONAL PREFERENCES

In studying child and parent opinions concerning the function provided by the No. 1 hand in comparison to that available in standard hooks, the task is complicated by the strong emotional factors involved. In many instances the excellent acceptance of hand appearance clearly tended to influence the answers to questions concerning its function. In interpreting the responses of children and their parents, therefore, it must be borne in mind that the hand was almost three times as heavy as the hook previously worn by the children; and although operating forces to initiate opening were only somewhat higher than for the hook, the forces required to obtain full opening were significantly higher—two factors which should make use of the hand more difficult.⁴ Pertinent comparative data are presented in Table 4.

Thus, when children report, as some do, that the hand is lighter and easier to operate

TABLE 4. WEIGHT AND OPERATING FORCES OF HAND AND HOOK

Terminal Device	Pinch (lbs.)	Weight (grams)	Operating Forces	
			To Initiate Opening (lbs.)	To Open Fully (lbs.)
No. 1 Hand	2	170-173	4 ± 1	9 ± 1
Dorrance 10X Hook				
2 Rubber Bands	2	62	3	3.5
3 Rubber Bands	3	63	4	5.75

⁴ Actual pinch forces in the hooks worn by children in the study were not obtained. However, recommended forces for the age group are: below-elbow, 3-1/2 lb.; above-elbow, 3 lb.

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than the previously worn hook, the data must be questioned. Nevertheless, conservative interpretation of the available information does provide insight not only into hand usage but also into terminal-device function in general.

The presentation which follows is based primarily on data from the Left-Hand Study, but these are supplemented where appropriate by evidence from the preceding Right-Hand Study.

All 39 children and parents in the Left-Hand Study were asked, "With which terminal device is the child able to perform more activities?" The answers were:

	Hook	Hand	No Preference
Children	18	14	7
Parents	16	9	14

However, two children and two parents in the no-preference category added statements which suggested that the hook provided more function and that their no-preference choice was motivated by a balance between hook function and the cosmetic appeal of the hand either to the child or to the parent.

Furthermore, some children who rated the function of the hand as better than that of the hook made comments indicating the reverse. Joseph: "The hand is heavier and harder." Robin: "The hand can do a couple of things but not too many things." Linda: "The hand is heavier and harder but I like the way it works." The therapist said that this girl's answer was motivated by a strong desire to keep the hand.

However, several children who preferred the function of the hand were able to back up their choice by specific examples. Susan, a young above-elbow amputee, said the hand was easier to don, better for washing dishes, for holding paper, and to pick things up. Rodney, also an above-elbow amputee with an unfitted paraxial hemimelia (ulnar) on the contralateral (right) side, said the hand was heavier but easier to operate. His therapist said the hand did not afford Rodney greater function but he was much more eager to use it. This greater enthusiasm was also noted in Susan, the above-elbow amputee

previously mentioned. The greater motivation to use the hand on the part of both these youngsters may have actually resulted in a higher level of functioning!

Fourteen of the 39 children fitted with the No. 1 left hand reported it to be as heavy as or heavier than their hook, and 17 found it hard to open or otherwise more difficult to operate than their hook had been. There seemed to be a significant relationship here with age, as indicated by the fact that of 17 children, ages 3 to 5, eight found the hand heavy, while of 22 children, ages 6 to 10, only six reported that the hand was heavy. Of those who stated that the hand was difficult to operate, ten were in the 4-to-5 age bracket and only five were in the 6-to-10 age group.

A relationship to amputation level was also apparent. The one shoulder-disarticulation amputee found the weight acceptable but the hand too hard to operate. He retained the hand, nevertheless, for cosmetic reasons. Of the five above-elbow amputees, four found the hand heavy and difficult to operate, and the remaining child rejected it after less than two months' wear. In contrast to these negative reports, two above-elbow amputees, only 5 years old, were among those who were most highly motivated to use the prostheses with the hand device.

The combination of youth and a higher level of amputation made the use of the hand much too difficult for the youngest child in the study, an elbow-disarticulation case who was barely 4 years old when fitted. Consequently, at the conclusion of the study he was wearing the hand only for special occasions. Of the four wrist-disarticulation amputees, the two 4-year-olds found the hand a little heavy and difficult to operate, while two 8-year-olds advised that both weight and operating forces were satisfactory.

SPECIFIC TYPES OF GRASP

In the Right-Hand Study a general comparison of the functional qualities of hand and hook, based on child and parent opinions, had yielded indecisive results. Therefore, in the Left-Hand Study children and parents were requested to rate the suitability of both the old terminal device (hook) and the No. 1



Fig. 7. Carrying a school bag.

hand, not only for grasping objects in general but also for eleven specific types of grasp or activity areas. Explanatory comments concerning terminal device use for each specific function were also solicited.

The eleven activity areas were:

1. Carrying objects, such as school bags, purses, lunch pails, etc.
2. Grasping or picking up very small elongated objects, such as pins, paper clips, etc.
3. Grasping or picking up small elongated objects, such as pencils, scissors, etc.
4. Grasping paper.
5. Grasping or holding soft objects, such as sandwiches, toothpaste tubes, etc.
6. Grasping or holding a drinking glass.
7. Using silverware while eating.
8. Grasping large bulky objects, such as paste jars, books, balls, etc.
9. Grasping objects such as bicycle handles, swing chains or ropes, etc.
10. Putting on clothes, such as shirts, blouses, etc.
11. Putting on shoes and socks.

Many of these areas involve the performance of a number of discrete activities. Hence, the data obtained not only provide bases for

comparison of hand and hook functions but also supply considerable general information concerning the activities of children with upper-extremity prostheses. Since this information may be of significance to clinic personnel, especially to therapists and to persons concerned with the development of devices for children with arm amputations, the data relating to each of the activity areas are presented in some detail (Fig. 7).

Carrying objects, such as school bags, purses, lunch pails, etc.

	Satisfactory	Unsatisfactory	Does Not Use	Not Reported
Children				
Hook	32	0	6	1
Hand	21	4	8	6
Parents				
Hook	34	0	3	2
Hand	34	1	2	2

Approximately four-fifths of the children reported the hook as satisfactory for carrying objects with handles, while only half found the hand satisfactory. Parents, on the other hand, believed the hook and hand functioned about equally well for holding these objects. Where difficulty was experienced with the hand, it was usually because the objects carried were too heavy for the amount of "Bac-Loc" provided. Illustrative comments follow. Betsy: "The hand doesn't let me hold heavy things." Linda's mother: "Buckets, lunch pails, and anything of metal or plastic that is heavy slip from her grasp." Gabriel's mother: "The hand is satisfactory provided the handle is not too thick and the object not too heavy."

Grasping or picking up very small elongated objects, such as pins, paper clips, etc.

	Satisfactory	Unsatisfactory	Does Not Use	Not Reported
Children				
Hook	23	4	9	3
Hand	15	13	6	5
Parents				
Hook	20	11	6	2
Hand	12	16	10	1

More than half the subjects and parents rated the hook as satisfactory for picking up very small objects. The hand was considered adequate for this function by only about a third of the children and parents. Some children pointed out that the hand was satis-



Fig. 8. Holding a safety pin.

factory for holding very small objects but not for picking them up (Fig. 8). One parent suggested that the child's vision was blocked by the rest of the hand, another that the floating fingers were in the way. Some of the illustrative remarks are quoted. John: "Nails but not pins." Susanne: "I have to hold the object in the other hand to pick it up." Danny's mother: "Too much effort and concentration."

Grasping or picking up small objects, such as pencils, scissors, etc.

	Satis- factory	Unsatis- factory	Does Not Use	Not Re- ported
Children				
Hook	30	1	4	4
Hand	26	7	2	4
Parents				
Hook	32	2	4	1
Hand	28	6	4	1



Fig. 9. Holding a pencil.

Three-fourths of the children and parents considered the hook satisfactory for this function, while a slightly smaller proportion also found the hand satisfactory. The objects given particular attention within this category of use were scissors, pencils, crayons, hammers, and put-together toys.

It was apparently impossible to cut with ordinary scissors held in either a hook or an artificial hand. Thus, unilateral amputees held scissors in their good hand, while bilaterally involved children could not use them at all unless the scissors were especially modified.

Concerning pencils, the reports were mixed, with some children rating the hook better for picking up and holding pencils, but with more subjects preferring the hand (Fig. 9). Some illustrative comments follow. Jeff: "I can hold a pencil better with the hook." Danny: "The hand holds a pencil better for sharpening." Rand}-: "I can pick up pencils easier with the hand."

Only one or two of the children with unilateral amputations made reference to writing with the prosthesis, although this was, of course, necessary for bilateral amputees. In general, the hook was favored for writing. Gail: "I can write better with a hook." Randy's teacher: "He is more secure doing written work when he wears hooks." (Randy is a bilateral upper-extremity amputee.)

There were only two references to hammers, one favoring each terminal device.

Concerning put-together toys there were two statements, both favoring the hook.



Fig. 10. Grasping paper.

In summary, scissors appeared to be difficult, if not impossible, to grasp with either hook or hand, pencils somewhat easier to handle with the hand, and put-together toys easier with the hook, and possibly writing also.

	<i>Grasping paper</i>			
	Satisfactory	Unsatisfactory	Does Not Use	Not Reported
Children				
Hook	37	0	1	1
Hand	30	4	1	4
Parents				
Hook	34	1	2	2
Hand	34	2	1	2

Nearly all children rated both the hook and hand as satisfactory, with only four rating the hand as unsatisfactory (Fig. 10). Almost all the parents considered both devices satisfactory.

The comments indicated that grasping paper was not one function but several, each calling for a different application of the terminal device. Involved were such tasks as holding paper for cutting with scissors, holding paper on a desk for writing, picking up paper, selecting one sheet from many, holding playing cards for card games, etc.

Two children cited holding paper to cut with scissors to explain their rating of the hook as satisfactory, but in both cases they considered the hand also suitable for this purpose. The therapist of a third child (Susan) felt that the hand was less helpful: "When cutting paper, Susan usually places the paper in the

hook. With the hand she seldom places the paper in the hand; it seems to crush the paper and hold it in an awkward position." Susan herself regarded both devices as satisfactory for grasping paper.

The hand was considered better for holding paper on a table or desk while writing (Fig. 11). Sean's mother: "With the hook the paper tends to slip—resulting in ragged print." Danny: "The hand holds down paper better for writing." Gail's mother: "School paperwork seems to be neater with the hand because the paper doesn't slip."

Several remarks seemed to indicate that the hand was better for picking up paper, but one bilateral amputee mentioned difficulty in selecting one sheet from many.

Concerning holding playing cards for various games, Susan's therapist made the following comment: "Playing card games is an activity which is performed better with the hand. It is in a better holding position and the cards come out easier when she is taking them from the hand."

Grasping or holding soft objects, such as sandwiches, toothpaste tubes, etc.

	Satisfactory	Unsatisfactory	Does Not Use	Not Reported
	Children			
Hook	20	9	9	1
Hand	13	10	12	4
Parents				
Hook	21	10	5	3
Hand	24	9	5	1

Half the children rated the hook as satisfactory, but the number dropped to a third for the hand. Half the parents considered the hook as suitable and a slightly greater number rated the hand as adequate. More children than parents reported that neither device was used for grasping soft objects.

Picking up and holding a tube of toothpaste apparently presented no problem, but difficulties arose with sandwiches, cookies, candy bars, marshmallows, grapes, or raw eggs, all of which were usually held in the sound hand. The majority of the children experienced difficulty in holding the soft objects with either device. Debra: "The hand squashes it and I can't eat it—the hand squashes the sandwich." Joseph: "The hook might squash them;

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Grasping or holding a drinking glass

	Satis- fau- tory	Unsatis- fau- tory	Does Not Use	Not Re- ported
Children				
Hook	8	8	18	5
Hand	7	12	16	4
Parents				
Hook	13	8	13	5
Hand	12	11	15	1



Fig. 11- Holding paper while writing.



Fig 12 Grasping a sandwich.

the hand can pick it up but I'll smash it." There were some children who made comments favoring the hand. Danny: "With the hand I can get a sandwich better without squeezing it" (Fig. 12). Mother of Randy (triple amputee): "Eating sandwiches is a treat which I was unable to do with hooks." However, a larger number preferred the hook for this purpose.



Fig 13. Grasping a paper cup.

Less than a fourth of the subjects rated either hook or hand as satisfactory for holding a drinking glass. The parents were slightly more positive, a third of them rating both hook and hand as suitable. Several of the children who gave a rating of satisfactory explained that they would use a terminal device only to hold a glass by the rim when filling it with water or to carry it while setting the table.

Comparisons between hook and hand were few. Some children stated that the hand did not open wide enough for available glasses or that the glass slipped. Two others, however, stated that the hand had a better grip and

did not slip. Small opening and slippage were problems also reported with hooks. The general impression is that even children who rated a terminal device as satisfactory for holding a drinking glass were merely claiming they could hold a glass as a special feat, not as a commonly used skill (Fig. 13).

Using silverware while eating

	Satis- factory	Unsatis- factory	Does Not Use	Not Re- ported
Children				
Hook	13	2	22	2
Hand	15	2	19	3
Parents				
Hook	19	3	14	3
Hand	21	2	16	0

Approximately a third of the children and half of the parents rated both hook and hand as satisfactory for holding silverware, while half of the children and a third of the parents indicated that neither device was used for the purpose. The slight differences favored the hand. With the exception of three bilateral arm amputees, the children who answered this question were left-arm amputees. It appears likely that they used the terminal device only for holding a fork while cutting meat (Fig. 14), although one or two held a spoon in the terminal device also. Many children, even some who regarded a terminal device as satisfactory, reported that the parents usually cut their meat for them.



Fig. 14. Holding a fork.

Particular mention was made of problems of slippage, of difficulty of positioning, the better appearance of the hand performance, and the need for practice.

Grasping large bulky objects, such as paste jars, books, balls, etc.

	Satis- factory	Unsatis- factory	Does Not Use	Not Re- ported
Children				
Hook	30	4	2	3
Hand	18	12	3	6
Parents				
Hook	32	2	2	3
Hand	28	6	4	1



Fig. 15. Holding a large ball.

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Fig. 16. Holding a doll.

Three-fourths of the children rated the hook as satisfactory, but only half found the hand so. The same proportion of parents rated both hand and hook as satisfactory.

The intention of the question was to determine whether the smaller opening provided by the hand was a disadvantage in actual use. The specifications of the No. 1 hand require that a minimum full opening of 2 in. be attainable with the thumb in the wide opening position, but most hands exceeded the specification to a maximum of approximately 2-3/8 in. However, there were indications that several children utilized the small, 1-1/2 in. opening only and did not bother to change the thumb position. A Dorrance 10X hook, by comparison, provided a 3-in. opening and the Dorrance 99X hook a 3-1/2 in. opening.

A number of children and parents specifically mentioned holding baseball bats, balls, paste jars, books, boxes, dolls, and a see-saw. Curtis: "With the hand, I can hold the bat better when I play ball." Glenda's mother: "Bats the ball using both hands now." Comments indicated that the hook was superior for

throwing balls, but the hand was satisfactory for catching them in two-handed fashion. In general, though, the children found it difficult to grasp balls with either the hook or the hand (Fig. 15). The hook was somewhat better for holding paste jars. Books, boxes, paper cups, and dolls (Fig. 16) were better held with the hook, but one boy said riding a see-saw was easier with the hand.

Grasping objects such as bicycle handles, swing chains or ropes, etc.

	Satisfactory	Unsatisfactory	Does Not Use	Not Reported
Children				
Hook	34	1	2	2
Hand	24	3	7	5
Parents				
Hook	36	1	1	1
Hand	33	2	2	2



Fig. 17. Holding a bicycle handle.

Most children and parents rated the hook as suitable, but some children stated that the hand was unsatisfactory or not used for these activities. Confusion may have existed because of the separate uses; several of the children played on swings but did not ride a bicycle or tricycle. The hook was more often preferred for holding a swing chain, but preference was evenly divided for riding a bicycle (Fig. 17). Several parents felt that the hand grasp appeared more natural. There was concern about the danger of tearing the glove or breaking the thumb of the hand on a swing chain. Other activities mentioned under this heading were climbing monkey bars and holding a jump rope, a broom and a hoe, or a bow for archery.



Fig. 18. Putting on shoes and socks.

Putting on clothes, such as shirt, blouse, etc.

	Satisfactory	Unsatisfactory	Does Not Use	Not Reported
Children				
Hook	27	1	8	3
Hand	21	3	9	6
Parents				
Hook	29	2	6	2
Hand	30	1	7	1

factory (Fig. 18). A fourth of the children stated that they did not use either device to put on shoes and socks, and the number who did not tie shoelaces with prostheses was undoubtedly much higher. Timothy, for example, said that he did not know how to tie shoelaces and that his mother dressed him, but he and his mother rated both devices as suitable for putting on shoes. Another reason given for parental assistance was that the child consumed too much time in dressing himself.

CONCLUSIONS

In spite of the wide differences in the opinions expressed by the children and parents participating in the study, it was apparent that:

Putting on shoes and socks

	Satisfactory	Unsatisfactory	Does Not Use	Not Reported
Children				
Hook	24	3	9	3
Hand	19	3	11	6
Parents				
Hook	29	3	6	1
Hand	28	3	7	1

Two-thirds of the children and the parents rated the hook as satisfactory, but less than half of the former considered the hand satis-

1. The APRL-Sierra No 1 hand was heavier and in most instances more difficult to operate than the previously worn hook, but for the majority of subjects in the sample these were not serious drawbacks. Those with shoulder-disarticulation amputations and to a lesser extent some of the younger children and above-elbow amputees were most likely to have difficulty with weight and operating forces. It is obvious, of course, that if the hand were lighter and had a more efficient operating ratio, it would be more acceptable to all.

2. The hand provided somewhat less pinch force than most of the hooks and a less precise grasp. The majority of children reported that they could perform more activities better with the hook; however, many could also specify a number of activities that were

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performed better with the hand. The latter was preferred somewhat more often for tasks such as picking up a pencil, grasping paper, and holding silverware for eating. The majority of the children and their parents considered the hand as "adequate" to "very satisfactory" for a wide range of activities.

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LITERATURE

CITED

1. Fishman, Sidney, and Hector W. Kay, *Acceptability of a functional-cosmetic artificial hand for young children*, Child Prosthetic Studies, Research Division, College of Engineering, New York University, January 1964.