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The Purposeful Use of an Object in the Development of Skill with a Prosthesis

Hon Keung Yuen
Western Michigan University

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THE PURPOSEFUL USE OF AN OBJECT IN THE DEVELOPMENT OF SKILL WITH A PROSTHESIS

by

Hon Keung Yuen

A Thesis
Submitted to the
Faculty of The Graduate College
in partial fulfillment of the
requirements for the
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Department of Occupational Therapy

Western Michigan University
Kalamazoo, Michigan
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THE PURPOSEFUL USE OF AN OBJECT IN THE DEVELOPMENT OF SKILL WITH A PROSTHESIS

Hon Keung Yuen, M.S.
Western Michigan University, 1988

Theoretically, perceptual information from the interaction with an object and its surfaces (an affordance) facilitates the development of motor skill. This study investigated the use of an affordance in learning control of flexion and extension of an above-elbow training prosthesis. Fifty-two male college students were randomly assigned to two training procedures: two, 1.5-minute periods of a joining dots activity with a flashlight attached to the hook of the prosthesis (affordance group), and practice moving the prosthesis at the elbow joint (no-affordance group) for the same amount of time. To assess generalization of skill to a different task, each subject traced a continuous line through a maze with a pen attached to the hook. deviations from the line were measured. Data analysis using a Mann-Whitney U test revealed that subjects in the affordance group traced significantly better than subjects in the no-affordance group ($p < .025$).
ACKNOWLEDGEMENTS

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Hon Keung Yuen
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The purposeful use of an object in the development of skill with a prosthesis

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CHAPTER I

INTRODUCTION

Several recent studies (Kircher, 1984; Miller & Nelson, 1987; Steinbeck, 1986; Yoder, Nelson, & Smith, 1987) have been done to illustrate how added-purpose or dual-purpose activities can sustain interest or influence affect more than pure exercise. These studies demonstrate that added purpose through occupation can indeed increase motivation. However, occupational therapy through the purposeful use of objects has other goals in addition to increasing motivation. For example, one of the goals of occupational therapy in physical rehabilitation is to promote motor skill.

Gliner (1985) suggested that exercise does not provide the purposeful use of objects needed by the individual to learn appropriate movement strategies. Purposeful activity, which involves active manipulation of objects, should be superior to exercise in learning certain motor tasks. Gliner (1985), therefore, questioned the effectiveness of relying on objectless exercise as the basis for therapeutic intervention. Fidler and Fidler (1978) asserted that purposeful activity provides the action-learning experience essential for skill acquisition. King (1978) also maintained that adaptive
responses can best be organized through active involvement in doing an activity rather than exercise. Her argument is that, in purposeful activity, attention is directed toward the object instead of the movement, and that this pattern of attention is typical of the naturalistic processes of motor skill development.

Gliner (1985) specifically mentioned prosthetic training as an area in which the special benefits of purposeful activity in developing motor skill should be clear. Traditionally, the initial phase of prosthetic training, known as control training, is to use exercise to teach the client to actively operate the control cable in different positions (Fisher, 1983). In addition, several authors have claimed that only when the amputee can perform the control motions easily and gracefully with a minimum of awkwardness, is he or she ready to proceed to the training of using different daily objects (Aylesworth, 1952; Jampol & Leavy, 1954). However, it is possible that the purposeful use of objects in learning a motor task may be desirable even in the initial stages of prosthetic training.

Gliner (1985), in his critical analysis of the current body of knowledge on motor skill acquisition, related what has been called the "ecological approach" to the use of purposeful activities in occupational therapy.
The term "ecological approach" was coined by J. J. Gibson (1966). One of the essential features of the ecological approach is the explanation of motor control through the individual's interaction with affordances. Affordances are invariant combination of the properties of substances and their surfaces taken with reference to an individual (J. J. Gibson, 1982). In other words, an affordance is an object that provides perceptual feedback on how to engage in or "do" an activity; for example, a graspable object, like a dowel, affords a grasping activity. According to J. J. Gibson's ecological approach, affordances must be perceived to be acted upon, and the individual must proprioceive himself/herself to coordinate the component movements and postures in order to do the action (J. J. Gibson, 1982). The perceived information of an object, either through direct contact with the object or through visual perception, will allow the individual to adjust one's body parts relative to the component's properties. For example, to trace through a maze with a pen, the healthy individual has to coordinate several body parts: the trunk, the scapula, the shoulder, the forearm, the wrist, and each of the joints within the hand. In order to keep the pen marks on the path, some of these body parts must be stabilized while others are moved. The equation changes at different points along the path. The
pen and the paper, with its marks, afford the changing complexes of movements. In general, affordances provide the contexts in which an individual adapts to his environment. Theoretically, affordances not only guide movement but also enhance the development of motor skill. For the initial stage of motor learning, Gentile (1987) emphasized the importance of action-oriented movement and objectives set through the interaction between performer and the environment. This is in contrast to focusing on the details of movement. Without an affordance, it is difficult for the performer to regulate the changes needed to meet the demands of the environment. Mark (1987) cited several studies that have been done to demonstrate that the intrinsic optical information from an affordance guides an individual in predicting the feasibility of an action to be performed. Arbib (1980) further elaborated on the concept of affordance and proposed a possible relation between visual schemas and motor schemas for reaching and grasping. Arbib (1980) and J. J. Gibson (1982) suggested that affordances provide the visual proprioception needed by the individual in discerning the properties of these affordances. These properties include size, shape, texture, rigidity, and so on, all of which can guide the individual to control the movement. The perception of an affordance may be innate, or learned (E.
J. Gibson et al., 1987).

A recent related study demonstrated how perception of an affordance can guide appropriate movement. Warren and Whang (1987) measured the degrees of shoulder rotation of a group of college students when they passed through apertures of varied width. They found that the mean absolute angle of shoulder rotation increased markedly as the width of the aperture decreased.

The ecological approach, which emphasizes the development and use of strategies through use of objects, is consistent with the underlying theoretical constructs in occupational therapy (Gliner, 1985). Based on the concepts of the ecological approach, this study investigated if provision of an added affordance is effective in skill learning. The motor skill under study was flexion/extension of an above-elbow prosthesis training arm. This motion is controlled by flexion and extension of the shoulder supporting the prosthesis. To attain an adequate sample, normal college students wearing a prosthetic training arm were studied. To provide an additional affordance, a flashlight was inserted into the terminal device in the experimental group; the subjects in this group were asked to join dots with the beam from the flashlight. The control group was asked to practice moving the forearm component of the prosthesis (i.e,
exercise) without any additional affordance to provide visual cues. It was hypothesized that the group with the added input from the affordance of a flashlight and a piece of paper with dots on it would score significantly higher on a subsequent tracing maze activity designed to test skill in regulating the movement of the forearm of the prosthesis.
CHAPTER II

METHOD

Subjects

Fifty-two right-handed, healthy, male college students, from a Michigan public university, who were not occupational therapy students, with no previous experience in using any type of upper limb prosthesis device, volunteered to participate. Their age ranged from 18 to 29 with a mean of 21.5. To minimize the variation of the height of the working level, each subject’s height was between 1.7 m to 1.9 m with a mean of 1.8 m. To ensure proper fitting of the prosthesis, the weight of each subject was between 61.4 kg and 93.2 kg with a mean of 77 kg.

Apparatus

The prosthetic device was a standard above-elbow training arm manufactured by Wright & Filippis, Inc., Rochester Hills, Michigan, and it was equipped with a farmer’s hook. The prosthesis has an adaptive sleeve attached to the arm piece so that it can be put on the normal arm of a non-amputee. The mechanism of the cable control of this training prosthesis is the same as the
standard above-elbow prosthesis for amputees. For the purpose of this study, the locking mechanism of the cable, which permits opening of the terminal device, was permanently unlocked. Therefore, the only possible mechanical movement of the training prosthesis was elbow flexion and extension through flexion and extension of the corresponding shoulder supporting the prosthesis. Stump socks were used as padding on the subjects' arms, as necessary, to ensure proper fitting of the prosthesis.

Used in the experimental condition was a piece of A3 paper 43 cm x 28 cm. It was dotted with 30 small blue paper discs 6 mm in diameter, made with a hole punch and glued on (see Appendix F). The testing maze was composed of four rows of a continuous zigzag line drawn on a piece of A4 typing paper. The average length of each row is 13.5 cm with a space of 1.3 to 2.5 cm between each row and with one small step along each row (see Appendix E). The maze was drawn at 30 degrees deviating from the vertical and then photocopied. The maze was taped to a blackboard which was inclined by 10 degrees from the vertical. The degree of deviation of the maze from the vertical and the inclination of the blackboard were determined by a pilot study to provide the maximum range of contact between the ball-point pen and the maze with minimum trunk movement and maximum elbow flexion-extension during tracing.
Procedure

Each of the 52 subjects was randomly assigned beforehand to one of the two types of training. The principal investigator recruited subjects on campus to participate, without knowing to which group the subjects would be assigned. After entering the test room, each subject was given written instructions on the rules for manipulation of the prosthesis, posture, and duration (see Appendix B). The affordance group instructions were: "The purpose of this study is to see how well you can learn to control the movement of the mechanical arm at the elbow joint steadily and accurately by focusing on learning to control the movement of the light beam from the flashlight." The no-affordance group instructions were: "The purpose of this study is to see how well you can learn to control the movement of the mechanical arm at the elbow joint steadily and accurately by focusing on the movement of the mechanical arm."

After subjects read through the instructions, they were then assisted in putting the training prosthesis on the dominant (right) arm. The forearm component of the prosthesis was internally rotated to 10 degrees, and the forearm component of the prosthesis was next to the sound forearm rather than on top of it to prevent the subject
from directly supporting the forearm component. Subjects were instructed on how to lift up and lower the forearm component of the prosthesis by flexing and extending the right shoulder for five successful trials as practice. Afterwards, the principal investigator left the room. There were four occupational therapy students who served as research assistants in the administration of the procedures. Each administered an approximately equal number of experimental (affordance) and control (no-affordance) group sessions. Each research assistant was trained to follow a carefully typewritten protocol. The use of research assistants on this way permitted the principal investigator to be blind to group assignment when administering the test.

For the experimental group, the single research assistant attached flashlight to the hook, and taped dotted paper on a wall, 100 cm above the floor. For the control group, a flashlight was also attached to the hook but with the light source pointing in the non-functional direction toward the base of the hook (this equated the conditions in terms of weight). Each subject in the control group stood on a mat with two foot print cutouts on it; the mat was placed in the middle of the test room of 430 cm x 260 cm with no objects immediately in front of the subject.
Subjects were verbally reminded to keep the body upright in standing position and to use the right shoulder action to operate the forearm component (Appendix D). The experimental group was told, "Use the light beam from the flashlight to join the dots in your own way, but be as accurate as possible." Verbally, the control group was told, "Practice lifting up and lowering down of the forearm component of the mechanical arm in your own way, but be as steady as possible." Subjects were also shown the limits of the range of movement at the elbow joint of the prosthesis. Each subject was allowed to have two, 1.5 minute long training periods with a break of about 10 seconds in between. During the break, the research assistant corrected the subject if errors were made, for example, using too much arm movement other than flexion and extension of the shoulder.

After the two training periods, a break of about 30 seconds between the training phase and the testing phase was allowed to eliminate the possibility of fatigue, and to provide sufficient time for the research assistant to take the flashlight off the hook. During the break, the subjects were given instructions similar to the previous ones to remind them about the rules and posture that they had to observe (Appendix C). Practice moving the prosthesis during the break was discouraged. Once the
research assistant restored the setting back to its original state, the principal investigator came back into the test room to begin the testing phase of the experiment when the subject would be required to trace the maze.

Measurement was then made from the floor to the elbow of the prosthesis. This information was used for the adjustment of the height of the maze relative to the subjects. Subjects were then told to stand on the footprint cutouts on a floor mat that was placed next to the blackboard. A trial to trace over the first row of the maze with the tip of the ball-point pen covered by its cap was used to make a minor adjustment (within ± 2 degrees), if necessary, on the degree of internal rotation of the prosthesis. Subjects were requested to make a continuous mark on the maze. Subjects of both groups were told to start the tracing activity whenever they wanted, but they were timed covertly.

Measurements

Proficiency in controlling the movement of the prosthesis was measured by the lack of deviation from the traced line. A graph paper transparency with squares of approximately 1 mm$^2$ size was placed on top of the testing maze. Each square partially or completely between the tracing line and the original maze line was counted. A
low score indicates better motor skill. The principal investigator scored all mazes while being blind to the condition of each subject. Two research assistants each independently rescored half of the mazes (it should be noted that the scoring system involved no marking or alteration of the maze). Interrater reliability was calculated by dividing each subject's smaller score by his larger score, and by taking the mean of these percentages. The interrater reliability was 87.9%.

Data Analysis

A preliminary analysis showed that the data indicating motor skill were positively skewed (mean deviation scores were well above median scores). Therefore, a non-parametric Mann-Whitney U test was used to test the research hypothesis.
CHAPTER III

RESULTS

Results of the Mann-Whitney U test indicated that the affordance group scored significantly lower than the no-affordance group, \( U=225.5, p=0.01975, 1\text{-tailed} \). The mean and median of the affordance group were 662.23 and 624.00 respectively, with an SD of 158.44. The mean and median of the no-affordance group were 859.50 and 736.00 respectively, with an SD of 375.59.

The mean time spent tracing the testing maze was 90.92 for the affordance group and 84.69 for the no-affordance group. This difference was not statistically different \((p=0.58)\). The deviation and time data are displayed in Table 1.
Table 1
Subjects' Age, Weight, Height, Duration of Test, and Amount of Deviation from the Original Maze Line in Affordance and No-affordance Groups.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Affordance</th>
<th>No-affordance</th>
</tr>
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<tbody>
<tr>
<td>Age</td>
<td>M</td>
<td>21.70</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>3.07</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>M</td>
<td>77.17</td>
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<tr>
<td></td>
<td>SD</td>
<td>8.89</td>
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<tr>
<td>Height (m)</td>
<td>M</td>
<td>1.81</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>.04</td>
</tr>
<tr>
<td>Duration of test (sec)</td>
<td>M</td>
<td>90.92*</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>41.20</td>
</tr>
<tr>
<td>Score (number of graph squares away from the original line)</td>
<td>M</td>
<td>662.23</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>158.44</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>624.00</td>
</tr>
<tr>
<td></td>
<td>Mean Rank</td>
<td>22.17**</td>
</tr>
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</table>

*not significantly different from the no-affordance group, p=.58.

**significantly lower than the no-affordance group, U=225.5, p=.01975.

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CHAPTER IV

DISCUSSION

Results indicated that subjects in the affordance group learned to control the flexion and extension of the prosthesis at the elbow joint better after engaging in an activity in which more affordance was provided than in the control condition. This study suggests the importance of purposeful use of objects (the provision of more affordance) in the development of motor skill with a prosthesis.

This provides a new area of research for occupational therapists to explore the potential use of purposeful activity in motor skill training. Clinically, occupational therapists are urged to consider the use of objects in the training of motor skill rather than just practicing the required movement, as in a no-object exercise, in order to train clients in a particular motor skill.

This study also confirms the theoretical suggestions that provision of additional affordance can enhance the development of motor skill. The development of neuromuscular coordination through the purposeful use of objects has been theoretically explored by Turvey and his colleagues (Tuller, Fitch & Turvey, 1982). Through
engaging in purposeful activity, an individual may learn how to link the many degree of freedom in the movement of different joints into a coordinative unit, so as to perform the trained skill proficiently (Tuller, Fitch & Turvey, 1982). This study demonstrated that subjects learned to coordinate different muscle groups around the shoulder joint through engaging in a joining dots activity in order to steadily control the movement of the prosthesis.

The design of this study also demonstrates the ability of subjects to transfer or generalize the learned skill to a somewhat different activity. During the learning phase, subjects in either group were told not to touch the hook of the prosthesis to any object. On the other hand, in the testing phase, subjects were requested to trace along the maze with a pen attached to the hook. The friction between the tip of the ball-pen and the paper made a different demand on the neuromuscular adjustment for the subjects. This frictional force involved the transfer of skill acquired in the learning phase to the testing phase.

A merit of the design of this study was that the principal investigator was blind throughout the whole research process as to training group assignment. This prevented the possibility of conscious or even unconscious
bias by the principal investigator.

The present study only explored one of the components of affordance as addressed by J. J. Gibson, namely visual perception. J. J. Gibson (1982) proposed that an affordance is any object that can provide any sort of information to an individual engaged in an activity. Future research in other sensory modalities tapped in the purposeful use/manipulation of objects is needed.

For control purposes, this study only investigated a single movement. Future study may explore coordinated, sequential movement patterns. This would be possible with the training prosthesis.

Results of this study should not be generalized to any disability group. Research on amputee clients and other disability groups that require the use of adaptive devices, such as mobile arm supports or permanent orthoses, are essential. Wheelchair mobility training such as learning to wheelie is a specific area that needs to be explored. For example, a common practice for wheelchair training is to tilt the wheelchair by pulling the driving-wheel backward. The client has to learn how to maintain this balancing position for a while. Based on the results of this study, it may be more effective learning to balance a wheelchair in tilt position by providing more affordance to the clients, so that he or
she receives additional information from other senses.

Although most simple motor skills cannot be tested in normal college students, it may be feasible to study such skills in hemiplegic, or cerebral palsied, or spinal-cord-injured clients. Another interesting issue related to clinical practice is discovering the optimal amount of affordance for a client when learning a particular task. An occupational therapist needs to be able to assess or evaluate this optimal amount in order give a client maximum facilitation when learning a new motor skill, without simultaneously distracting or confusing him. For example, in driver education for clients with neurological deficiency, too much sensory stimulation from the environment may actually distract the client from concentrating on the visual or auditory cues that are essential to learn a particular skill. Structuring the environment and adjusting the optimal amount of affordance provided to a particular client in order to facilitate learning a motor skill is a special challenge for the occupational therapy clinician.
Appendix A

Letter of Informed Consent
The information on this questionnaire will be kept confidential.

Age___________

Height____ft____in

Weight_______lb

Do you have any experience in using an upper limb prosthetic device? Yes / No.

Do you have any health problems in your right arm or back? Yes / No.

Hand dominant-----R / L.

Dear Volunteer,

I, Hon Keung Yuen, am a graduate student of occupational therapy at Western Michigan University. Participation in this project will contribute to the knowledge of prosthetic device training.

The information collected in this study will be coded so that no one will be able to identify you in any way. You are free to stop participating in the study whenever you wish without penalty; participation is voluntary. There are no special risks or benefits to you through participation in this study. Discomfort in wearing the device is not expected, but you are encouraged to stop participation in the unlikely event of feeling any discomfort.

Any questions you have about this study will be answered promptly.

INFORMED CONSENT FORM

I do not have any previous experience in using an upper limb prosthetic device. I understand that participation in and cessation of the activity is totally controlled by myself. I have read and understood all the above information. All of my questions have been answered and I agree to participate.

Signature of Volunteer ___________________________ Date ___________
Appendix B

Information Sheet A for the Subjects in Affordance and No-affordance Groups
We would like you to wear a mechanical arm. The purpose is to learn how to control the movement of the mechanical arm at the ELBOW JOINT STEADILY and ACCURATELY by using a flashlight attached to the hook of the mechanical arm. The idea is to learn how to move the elbow by focusing on learning to control the light from the flashlight. Afterwards, we would like to see how well you can learn to control the movement of the mechanical arm.

Please observe the following rules when doing the activity:

(1) Keep your BODY UPRIGHT.

(2) Use your RIGHT SHOULDER MOVEMENT ONLY (Please RELAX YOUR LEFT SHOULDER).

(3) Keep the rest of your body, except for your right shoulder, as still as possible when moving the arm.

(4) There will be two periods for you to learn how to use the arm with the flashlight, each will be 1.5 minutes long separated by a 10-second break. I will tell you when to begin and when to stop. MOVE THE ARM ONLY WHEN YOU ARE TOLD.

(5) Please DO NOT TOUCH THE PAPER WITH THE FLASH LIGHT when doing the activity.

(6) Please DO NOT USE YOUR LEFT HAND IN ANY WAY.

(7) Please CONCENTRATE when doing the activity.

Please feel free to ask questions. Thank you for your cooperation.
We would like you to wear a mechanical arm. The purpose is to learn how to control the movement of the mechanical arm at the ELBOW JOINT STEADILY and ACCURATELY by practice moving it. The idea is to learn how to move the elbow by focusing on learning to control the movement of the mechanical arm. We would like to see how well you can learn to control the movement of the mechanical arm.

Please observe the following rules when practicing:

(1) Keep your BODY UPRIGHT.

(2) Use your RIGHT SHOULDER MOVEMENT ONLY (Please RELAX YOUR LEFT SHOULDER).

(3) Keep the rest of your body, except for your right shoulder, as still as possible when moving the arm.

(4) There will be two periods for you to learn how to use the arm through practicing, each will be 1.5 minutes long separated by a 10-second break. I will tell you when to begin and when to stop. MOVE THE ARM ONLY WHEN YOU ARE TOLD.

(5) Please DO NOT LET THE HOOK TO TOUCH ANY THING when practicing.

(6) Please DO NOT USE YOUR LEFT HAND IN ANY WAY.

(7) Please CONCENTRATE when practicing.

Please feel free to ask questions. Thank you for your cooperation.
Appendix C

Information Sheet B for the Subjects
There are several rules we would like you to observe when doing the tracing activity:

(1) Please MAKE A SMOOTH CONTINUOUS LINE when tracing through the maze, and try NOT TO LIFT THE PEN OFF THE PAPER.

(2) Keep your BODY UPRIGHT.

(3) Use your RIGHT SHOULDER movement ONLY (Please RELAX YOUR LEFT SHOULDER).

(4) You are ONLY ALLOWED TO MAKE MINOR BODY ADJUSTMENT such as leaning forward or stepping backward when tracing through the maze.

(5) Please stand in the DESIGNED FOOT PRINT AREA throughout the activity.

(6) SPEED IS NOT IMPORTANT.

Please feel free to ask questions. Thank you for your cooperation.
Appendix D

Protocol for the Research Assistants
Please observe the following procedures:

(1) Check the data to see if the subject meets all the criteria for this study, which include age, weight, height, hand dominance, no experience in using upper limb prosthesis before, and no back or shoulder pain.

(2) Hon and the research assistant assist the subject in putting on the prosthesis and teach the subject how to manipulate it. Afterwards, Hon leaves the room.

(4) Insert the flashlight into the hook either with the light source pointing to the tip or to the base of the hook depending on which group the subject has been assigned.

(5) For the flashlight drawing group, please tape the dotted paper on the notice board. For the non-drawing group, please place the mat in the designed area (in the middle of the room).

(6) Remind the subjects of both group "Stand upright, move the prosthesis only in this way."

(7) Tell the subjects in the drawing group

"Use the light beam from the flashlight to join the dots in your own way, but be as accurate as possible."
"The purpose of the joining dots activity with the flashlight is to learn how to control the bending of the arm at the elbow joint."
"By joining the dots, you try to learn how to control this up-and-down movement of the forearm component."

Tell the subjects in the non-drawing group

"Practice lifting up and lowering down of the forearm component of the mechanical arm in your own way, but be as steady as possible."
"By practicing, you try to learn how to control this up-and-down movement of the forearm component."

Note: manipulate the prosthesis to demonstrate
--- the difference between supporting the movement of the mechanical arm and the actual operating the forearm components,
--- the correct way to operate the prosthesis i.e. only flexion and extension of the shoulder, NOT ABDUCTION.
--- the APPROXIMATE RANGE OF THE MECHANICAL FOREARM MOVEMENT.

(8) Remind the subjects in the drawing group "do not touch the paper with the flashlight" and the subjects in the non-drawing group "do not let the hook to touch any thing."

(9) Remind the subject not to move the prosthesis during the break by saying "Please relax and not practice moving the prosthesis during the break." Do not talk except to response to the subject's questioning.

(10) Remind the subjects "Don't start moving the arm until the official starting time."

(11) The subjects are requested to engage two 1.5 minutes sessions of drawing activity or practicing with a break of about 10 seconds in between so as to give some feedbacks to the subjects on their performance. Tell the subjects, "Please stop and have a break." Feedback includes "You are doing fine." If necessary, repeat the instructions to "Keep the body upright" or "Move the arm only in this direction or this range, plus demonstration."

(12) After the training session over:
--- remove the flashlight from the hook
--- remove the dotted paper on the notice board or the mat on the floor
--- give another information sheet for the subjects to read
--- inform Hon to come in the room.

(13) Hon will take over the rest.
Appendix E

Testing Maze
Appendix F

Dotted Paper for the Experimental (Affordance) Group
(reduced by 30%)
Appendix G

Western Michigan University Human Subjects
Institutional Review Board Approval Form
TO: Yuen Hon Keung

FROM: Ellen Page-Robin, Chair

RE: Research Protocol

DATE: December 15, 1987

This letter will serve as confirmation that your research protocol, "Generalizability of three types of training methods in using an upper limb prosthetic device" has been approved by the HSIRB after an expedited review with the following qualifications: 1. We need to know if there is any risk in particular, or discomfort with the use of the prosthetic device. If so, it should be spelled out in the consent form. 2. Will subjects be eliminated who have other disabling conditions other than those requiring a prosthetic device?

Please submit requested information to the HSIRB office. If you have any questions, please contact me at 383-4917.
TO: Yuen Hon Keung  
FROM: Ellen Page-Robin, Chair
RE: Research Protocol
DATE: January 11, 1988

This letter will serve as confirmation that your research protocol, "Generalizability of three types of training methods in using an upper limb prosthetic device" is now complete and has been signed off by the HSIRB.

If you have any questions, please contact me at 383-4917.
BIBLIOGRAPHY


