

# The Effects of Origami on the Improvement of Hand Dexterity

This study was carried out to investigate the effects of making an origami crane on the improvement of hand dexterity. Subjects composed of 20 normal adult males were randomly assigned to experimental and control groups of 10 people respectively. For the experimental group, a training of making an origami crane was conducted for 40 to 50 minutes a day during a 4-week training period. The control group was made to engage in everyday activities as usual. For pre and post assessment, Groove Pegboard test, Purdue Pegboard Test, and Jebsen Hand Function Test were used. The results on the effects of making an origami crane showed that there was a statistically significant difference in both the Grooved Pegboard test and Purdue Pegboard test ( $p < .05$ ). In the Jebsen hand function Test, a significant difference was found in handwriting and building pieces of chess ( $p < .05$ ), but there was no statistically significant difference in comparison with the right hand during the average performance of picking up small stuffs. The activity of making an origami crane for normal adults was confirmed to be helpful to improve the hand dexterity. Accordingly, making an origami crane is suggested to be an effective way to improve the hand dexterity.

Key words: *Handicrafts; Making an origami Crane; Hand Dexterity.*

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## INTRODUCTION

Humans actively perform activities necessary for daily living using their hands according to their will. Activities are necessary for humans to live healthy and the use of the hands serves the role of a medium that connects humans with environments. The hands are used to make various movements such as making things and attempting to hold something while stretching out the hands while being complicatedly manipulated. Handicrafts that are made by the hands have been developed to induce hand movements. Today, they provide leisure skills and are sometimes used as therapeutic tools.

All handicrafts require problem-solving, physical abilities, orientation, and the permanency of perception. For this reason, handicrafts have been used as a clinical tool since the establishment of the profession of operation therapy. Handicrafts are applied to leather crafts, beadwork, metal craft, mosaic, artwork, thread-crafts, paper crafts, and computer. Among them, paper crafts refer to those handicrafts

of making shapes by cutting or folding paper. Among paper crafts, origami enables anybody regardless of age or sex to make flowers, animals, plants, dolls, mobiles, and frames anytime anywhere. In particular, it greatly helps growing youths in their wholesome leisure activities and brain development as creative artwork making and provides elderly persons with opportunities to obtain pleasure by making toys for children and to have confidence in success(1).

Origami is an active movements that we can easily perform, which is considered to have all variables for the improvement of hand function.

Our every day life is lived by utilizing various tools through the movements of our arms. Arm movements comprises reaching, manipulation, carrying, and releasing. Manipulations are divided into five basic types: finger to palm, palm to finger, shift, simple rotation, and complex rotation. All skills require the ability to control the arch on the palm. Finger to palm and palm to finger are described as moving objects linearly. This pattern maintains objects to be unceasingly in contact with the pads of

the fingers and the thumb. Shifts are involved when moving an object straightly on the surface of the fingers to rearrange the object on the pads on the fingers.

The hand can make diverse forms of movements. The hand not only is a part that can make the most accurate movements but also has functions to perceive the textures, weights, and stiffness of objects. Most operations are performed using the hand and the hand is recognized as the most important body part that determines the performance of operations(2).

Hand skills are the most important element for interactions with environments and the hand plays great roles during activities through contact. The hand is used to play, work, and perform self control activities such as activities of daily living through contact with the outside(3).

Good operant hand functions mean the ability of the arm, the hand, and the fingers to integrate accuracy and speed with delicately coordinated movements and are essential and important functions in daily living.

The activities of daily living such as origami, writing, carrot chopping, and letter writing on the mobile phone require functions that need coordination between the eyes and the hand. The coordination between the eyes and the hand is skilled and precise movements made using the eyes, the arm, the hand, and the fingers in combination(4). In particular, the movement or operational ability to pick up objects using the thumb and the index finger requires quite high coordination(5). This coordination is also called a control system for neurological joint actions(6).

Maintaining this function is important for independent living as people get older. The operational ability which is one of the elements of hand functions, that is, dexterity or coordinated movement skill has long been regarded as an important element of hand function(7).

Major functions of the hand are grabbing, releasing, and reaching and dexterity which is the ability to handle objects mainly using the hand and grip strength which is necessary to hold things using the entire hand are important measures that reflect hand functions(8). Motions that can be said to be hand functions can be largely divided into grip motions which are clenching one's fist, pinch motions which are gently pickling up various objects, and hook motions which are lifting up objects and smooth hand movements can be made through the harmony of these motions(9).

General methods of evaluating hand functions

include the range of motion of hand joints, edema, manual muscle testing, sensory testing, dexterity testing, physical ability assessment, grip strength measurement, and functional independent measure(9, 10, 11). Evaluation methods using testing tools include box and block test, Jebsen hand function test, nine-hole pegboard test, O'connor test, Grooved pegboard test, and Purdue pegboard test(9, 12, 13, 14, 15).

The grooved pegboard test is an operant dexterity test that requires a little more complicated visuomotor cooperation ability than other dexterity tests and is used as an objective tool in neurological tests and visuomotor cooperation ability tests(14, 16, 17).

The evaluation tool Jebsen hand function test which is the most widely used as hand function tests is an evaluation method designed by Jebsen et al. in 1959, which has seven sub-tests and is an objective evaluation tool that includes hand functions that are the most frequently used in standardized daily living determined from 300 males and females aged between 20 years and 94 years(18).

Therefore, in this study, origami crane folding activities that correspond to paper crafts will be implemented and the effects of origami crane folding on hand dexterity will be examined using the aforementioned tools to present the meaning of origami crane folding.

## METHODS

### Subjects and Period

The subjects of this study were 20 male students in their 20s with no problem in hand functions selected between June 8 and 29, 2012 from among those who were in attendance at G University located in Gyeongsangbuk-do. According to the results of preliminary interviews, all the subjects were right-handers. Therefore, the right hand was identified as the major hand and the left hand was identified as the non-major hand to conduct the study.

### Measuring Instruments and Methods

In this study, preliminary/expost evaluations were conducted using Groove pegboard test and Purdue pegboard test which are instruments standardized to evaluate hand skills and hand lettering, small object picking up, and chess piece piling up among Jebsen hand function test items. As a task for the study, the subjects were instructed to fold 20 origami cranes for

approximately 40~50 minutes every day.

### Jebsen hand function test

The hand function test used in this study was conducted on the hand with dysmyotonia as designed by Jesen et al.(19). The test has seven submethods: hand lettering, card turning, chess piece piling up, small object picking up, eating imitation, light can moving, and heavy can moving. Among the seven items, only three items necessary for origami crane folding were applied. The item hand lettering was measured by measuring the time spent to write a letter from the time when the tester said 'Start' showing the front side of a card that had been selected by the tester from among four card and had been maintained upside down. The item small object picking up was measured by measuring the time from the moment of 'Start' to the time when the sound of the fall of the last object was heard. The item chess piece piling up was measured by measuring the time from the moment of 'Start' to the moment at which the fourth chess piece came into contact with the third chess piece.

### Grooved pegboard test

The Grooved Pegboard for hand dexterity evaluation was developed by Dr. Ronald Trites at Royal Ottawa Hospital in Ontario, Canada for neuropsychiatric tests. This instrument is composed of a board with 25 key-hole shaped grooves and 25 key shaped pins. In this study, a grooved pegboard was presented approximately 5cm away from the end of the table at the center of the subject. The subject began to put pegs into the grooved as soon as the tester's command 'Start' was heard using his major hand and the time from the beginning to the moment at which the last peg was put into the Pegboard was measured. Thereafter, the time for the same process underwent using the subject's non-major hand was measured. This test conducted using the major hand first followed by the non-major hand was repeated three times and the average value was used.

### Purdue pegboard test

This test was developed by industrial psychologist Tiffin as an evaluation tool for large scaled movements of the hand and the arm and hand dexterity. The test-retest reliability of this test conducted once was shown to be 0.60~0.79. Purdue pegboard test is composed of five sub-tests; major hand, non-major hand, both hand, and assembly tests. In this study,

the right hand(major hand), left hand(non-major hand), and both hand tests were conducted for 30 seconds each and the assembly test was conducted for 60 seconds and average values of the values measure during the tests were used for scores.

### Data Analysis

The collected data were analyzed through computerized statistics processes using the SPSS 12.0 Windows program. To examine the effects of origami crane folding on the improvement of hand dexterity functional scales were evaluated before and after the implementation of experiments. To examine whether the subjects' hand dexterity was improved, the initial values and later evaluated values were compared using paired t-tests. To test significance, significance level  $\alpha$  was set to .05.

## RESULTS

### Comparison of Grooved Pegboard Test Scores between before and after the Performance of Origami Crane Folding Activities

After the subjects performed origami crane folding activities, grooved pegboard tests showed results as shown in Table 1. The preliminary and ex post evaluations of the right hand showed values of 57.53 and 49.43 respectively and the difference of 8.09 points was statistically significant( $p < .05$ ).

The preliminary and ex post evaluations of the left hand showed values of 62.70 and 53.93 respectively indicating time reduction and the difference of 8.77 points was statistically significant( $p < .05$ ).

**Table 1.** Difference in hand dexterity between before and after the experiment in grooved pegboard tests

(Unit : sec.)				
Division	M $\pm$ SD	M	t	sig
Right hand(before)	57.53 $\pm$ 6.79	8.09	5.84	.00*
Right hand(after)	49.43 $\pm$ 4.95			
Left hand(before)	62.70 $\pm$ 9.05	8.74	5.13	.00*
Left hand(after)	53.95 $\pm$ 6.22			

\* $p < .05$

**Comparison of Purdue Pegboard Test Scores between before and after the Performance of Origami Crane Folding Activities**

**Comparison between the right hand and the left hand**

The differences between the right hand and the left hand after performing origami crane folding activities were as shown in Table 2. The average of the right hand was shown to be 15,9 pieces in the preliminary test and 18,0 pieces in the expost test and the difference of -2,1 points was statistically significant( $p < .05$ ).

The average of the left hand was shown to be 15 pieces in the preliminary test and 16,8 pieces in the expost test indicating that the dexterity of both hands was improved and the difference of -1,85 points was statistically significant( $p < .05$ ).

**Table 2.** Comparison of right hand and left hand scores in purdue pegboard tests between before and after experiment (Unit : sec)

Division	M±SD	M	t	sig
Right hand(before)	15,9±1,9	-2,1	-4,97	.000*
Right hand(after)	18,0±4,9			
Left hand(before)	15,0±2,1	-1,85	-3,6	.002*
Left hand(after)	16,8±1,7			

\* $p < .05$

**Comparison of both hands' scores in purdue pegboard tests between before and after experiment**

The purdue pegboard test scores before and after finger movements using origami crane folding were as shown in Table 3. The average score of both hands was 12,1 pieces in the preliminary test and 12,4 pieces in the expost test indicating an increase in the average number of pieces but the difference of -.35 was not statistically significant( $p > .05$ ).

**Table 3.** Comparison of both hands' purdue pegboard test scores between before and after experiments (Unit : piece)

Division	M±SD	M	t	sig
Both hands(before)	12,1±1,9			
Both hands(after)	12,4±1,3	-.35	-1,32	.201

\* $p < .05$

**Comparison of purdue pegboard assembly scores**

Differences in assembly scores between before and after finger movements using origami crane folding were as shown in Table 4. The average number of assembled pegs was 38,7 in the preliminary test and 40,8 in the expost test indicating an increase in the number and the difference of -.54 point was statistically significant( $p < .05$ ).

**Table 4.** Comparison of the number of pegs in purdue pegboard tests between before and after experiment (Unit : piece)

Division	M±SD	M	t	sig
Pre-test	38,7±0,8			
Expost test	40,8±0,8	-.54	-2,83	.011*

\* $p < .05$

**Comparison of Jebsen Hand Function Test Scores between before and after Performing Origami Crane Folding Activities**

**Comparison of hand lettering test scores between before and after experiment**

Changes in hand lettering test scores between before and after origami crane folding activities are as shown in Table 5. The average score of the right hand was 7,1 in the preliminary test and 6,3 in the expost test and the difference of ,83 was statistically significant( $p < .05$ ). The average score of the left hand was 20,5 in the preliminary test and 17,2 in the expost test indicating the improvement of the dexterity of both hands and the difference of 3,2 points was statistically significant( $p < .05$ ).

**Table 5.** Comparison of Jebsen hand function test : hand lettering scores between before and after experiment (Unit : sec)

Division	M±SD	M	t	sig
Right hand(before)	7,1±0,9			
Right hand(after)	6,3±0,9	.83	3,92	.001*
Left hand(before)	20,5±5,9			
Left hand(after)	17,2±4,8	3,27	4,17	.001*

\* $p < .05$

### Comparison of small object picking up test scores between before and after experiment

Differences in small object picking up test scores before and after performing origami crane folding activities were as shown in Table 6. The average time of the right hand was 5.3 sec. in the preliminary test and 5.1 sec. in the expost test and the average time of the left hand was 5.6 sec. in the preliminary test and 5.3 sec. in the expost test. Therefore, the average time was shortened in both hands. Whereas the difference .20 point of the right hand between before and after experiment was not statistically significant( $p > .05$ ), the difference .30 point of the left hand between before and after experiment was statistically significant( $p < .05$ ).

**Table 6.** Comparison of Jebsen hand function test : small object picking up test scores between before and after experiment (Unit : sec)

Division	M±SD	M	t	sig
Right hand(before)	5.3±0.5	.20	1.44	.165
Right hand(after)	5.1±0.3			
Left hand(before)	5.6±0.6	.3	4.17	.001*
Left hand(after)	5.3±0.4			

\* $p < .05$

### Comparison of chess piece piling up test scores between before and after experiment

Changes in chess piece piling up test scores after performing origami crane folding activities were as shown in Table 7. The average time of the right hand was 3.4 sec. in the preliminary test and 3.2 sec. in the expost test and the difference .15 point was statistically significant( $p < .05$ ). The average time of the left hand was 3.6 sec. in the preliminary test and 3.4

**Table 7.** Comparison of Jebsen hand function test : chess piece piling up test scores between before and after experiment (Unit : sec)

Division	M±SD	M	t	sig
Right hand(before)	3.4±0.5	.15	2.8	.012*
Right hand(after)	3.2±0.4			
Left hand(before)	3.6±0.4	.14	3.4	.003*
Left hand(after)	3.4±0.3			

\* $p < .05$

sec. in the expost test indicating that the dexterity of both hands was improved and the difference .2 point was statistically significant( $p < .05$ ).

## DISCUSSION

Thus far hand functions have been mainly evaluated and treated with focus on how the forms of static grips occur. However, from the beginning of the 1990s, attention to the functional movements of the hand necessary for performing works has gradually increased and thus studies on the ability of the hand to handling things have been actively conducted(3).

The dexterity, coordinated movements, muscle strength, and senses of the upper extremities are essential abilities for performing tasks. Standardized hand function evaluation tools and functional tests include coordination and agility that are necessary for performing standardized tasks. Dexterity is defined as finely coordinated movements in handling objects with the arm, the hand, and the fingers swiftly(20). Dexterity is very closely related to daily living and is frequently used as an indicator of rehabilitation.

Dexterity is largely divided into the dexterity of the entire hand and the dexterity of each finger. The dexterity of the entire hand is required for minute and accurate hand movements when the hands move asymmetrically for tasks, for instance, knitting, sewing, and fast cutting. Finger dexterity is required for movements of different fingers such as piano playing and keyboard entry(21). Dexterity is required for finger, wrist, forearm, and elbow movements and requires the functions and motor control of both hands. However, it can be modified by anybody depending on his/her level of abilities. It is used to evaluate mental health including cognitive functions, orientation senses, spatial actions, and frustration tolerance and it is necessary for activities of daily living of both normal persons and disabled persons.

To examine hand dexterity in daily living, Jeong measured the dexterity of the paretic side hands and the non-paretic hands of hemiplegia children using the grooved pegboard test which is a dexterity test tool and the results showed that the dexterity of both hands were improved(2). A study that examined the time for normal persons to perform tasks using the right hand and the time to perform the same tasks using the left hand reported that the major hand performed tasks faster than the non-major hand in all age groups(13) and a study that compared normal

children's major hands and non-major hands also reported that major hands were faster(23). In this study too, normal persons' major hands performed dexterity requiring tasks significantly faster than their non-major hands. Given these results, the difference in dexterity between the major hand and the non-major hand is considered to have affected the results of studies that applied crafts activities to normal persons or disabled persons.

The standard dexterity test scores of males aged 20 ~29 years in Purdue pegboard test are 16.1 pieces for the major hand and 14.6 pieces for the non-major hand and the scores obtained in this study were 18.0 pieces for the major hand and 16.8 pieces for non-major hand. The differences were statistically significant( $p < .05$ ). The standard dexterity score for both hand is 12.8 pieces and the score obtained in this study was 12.4. This difference was not statistically significant. The average score of assembly increased from 38.7 pieces in the preliminary study to 40.8 pieces in the ex post test indicating that the dexterity of both hands was improved. Kim conducted tests separately in males and females in different age groups to compare the dexterity of the major hand with that of the non-major hand and showed that the major hand performed dexterity requiring tasks faster than the non-major hand(13). The difference in dexterity between the major hand and the non-major hand was shown to be significant even in people in their 20s which is considered attributable to differences made through training.

In the case of Jebsen hand function test, Kim and Jebsen et al. calculated standard values for normal persons through studies with normal persons(19, 22). Jeong reported that myotonia patients did not show any increase in the speed of chess piece piling up or small object picking up after experiment while showing increases in the speed of hand lettering, card turning, and eating imitation(24) and Sonl et al. advised that the unaffected hands of traumatic brain injury patients showed improvement in all seven items the affected hands showed improvement in chess piece piling up and small object picking up(25). In this study, experiments conducted with normal persons to examine dexterity showed improved dexterity in hand lettering, small object picking up, and chess piece piling up.

In this study, it could be seen that diverse sensory stimulations using both hands such as picking up training and gripping training not only increased finger and hand muscle strength but also improved dexterity with functional and fine hand movements and affected changes in hand function related

behaviors. Hand functions necessary in daily living can be developed through continuous repetition and sufficient plays.

Limitations of this study include the short experimental period not sufficient for the generalization of the results, the fact that the subjects could not be supervised to ensure that they folded origami cranes, and the fact that the subjects were limited to students of a certain university so that the study results cannot be generalized.

## CONCLUSION

In this study, experiments were conducted with 20 healthy male university students in their 20s to examine the effects of origami crane folding on the improvement of hand dexterity and the study results are as follows.

1. After performing origami crane folding, the average time to conduct groove pegboard tests was shortened than before the performance for both hands( $p < .05$ ).
2. After performing origami crane folding, the average number of pieces in Purdue pegboard test increased than before the performance for both the right hand and the left hand( $p < .05$ ). Although the average number of pieces in Purdue pegboard tests for the dexterity of both hands increased, the difference was not significant( $p > .05$ ). After performing origami crane folding, the average number of pieces in assembly tests increased compared to that before the performance( $p < .05$ ).
3. After performing origami crane folding, the average time to perform hand lettering or chess piece piling up under Jebsen hand function test was shortened than before the performance for both hands( $p < .05$ ) and the average time to perform small object picking up did not change for the right hand( $p > .05$ ) but was shortened than before the performance for the left hand( $p < .05$ ).

In this study, origami crane folding was shown to be effective for the improvement of hand dexterity. After right hand, left hand experiments, it could be seen that hand dexterity was improved in all tests except for both hands in Purdue pegboard tests and the right hand in small object picking up under Jebsen hand function test. However, the results were not sufficient to suggest that small movements such

as origami crane folding should be used for hand dexterity improvement. More studies are considered necessary that can help hand function improvement with small movements based on the results of this study.

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