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Handedness: Individual and Developmental Differences in the Control of Bimanual Movement

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Various handedness measures were used to investigate the relationship between hand preference and actual performance by the left and right hands (bimanual actirity, unimanual speed and dexterity, unimanual strength). The primary task was the Critical Angle Board, a simultaneous bimanual copying task. Subjects with a strong hand preference (either right or left) showed less interference from controlateral activity of the nondominant hand than ambidextrous subjects Overall, speed and dexterity of the nondominant hand relative to the dominant hand was greater in older subjects, while preference for the dominant hand in right handers increased with age.

Psychologists and educators have entertained many hypotheses about the psychological importance of individual differences in hand preference. Handedness definitions vary, but regardless of the classificatory criteria used, little attention has been paid to the relationship between stated hand preference and actual performance by the left and right hands. In early research, the hand used for writing was considered "dominant," and hand usage for other kinds of unimanual or bimanual activities was ignored. More recently, hand preference has been determined by gusestionnaires on which subjects indicate the direction and strength of hand preference for a variety of manual activities such as throwing, threading a needle, unscrewing a lid, etc. (Annett, 1970; Coren and Porac, 1978; Oldfield, 1971). With the advent of such measures, the definition of handedness has been expanded, and might read as follows: the relative preference of one hand over the other across a broad range of unimanual and bimanual activities involving both fine and gross motor movements.

The present study explores handedness as it relates to bimanual, simultaneous performance of a copying task. It is suggested that concurrent bimanual activity can be used to assess the extent to which one hand predominates in controlling the activity of the other, and may reflect underlying patterns of neurological organization involving the bilateral control of manual movements. The primary task is an old one: the Critical Angle Board, introduced by Van Riper (1935) to study the relationship between handedness and simultaneous bimanual activity. In this task, subjects are asked to copy a pattern concurrently with both hands, using an apparatus that allows the experimenter to vary the angle from which each hand's plane of movement diverges from the subject's frontal plae. Specifically, the copying task is begun in the subject's frontal plane (at zero degrees), and the disparity between movement planes is increased in ten-degree increments to a maximum of 90 degrees, where both planes parallel the subject's sagittal plane. The 90 degree condition is identical to copying a design simultaneously on the front and back sides of a vertical board that bisects the subject's axis of bilateral symmetry. The dependent measure of interest is the extent to which the activity of one hand mirrors that of the other.

In Van Riper's (1935) original study, strongly right-handed subjects mirrored with the left hand only; strongly left-handed subjects mirrored with the right hand only; and ambidextrous subjects either did not mirror at all or mirrored only at angles close to the 90 degree perpendicular. Critical Angle Board results from the present study are compared to Van Riper's original findings and to performance on other measures of unimanual and bimanual activity and preference. The relationships between performance on the Critical Angle Board and tasks of manual dexterity, coordination, strength, speed, and preference are examined in an effort to determine the extent to which stated hand preference, motor skill, and mirroring performance tap similar or different dimensions of handedness. Sex and age effects are also analyzed.

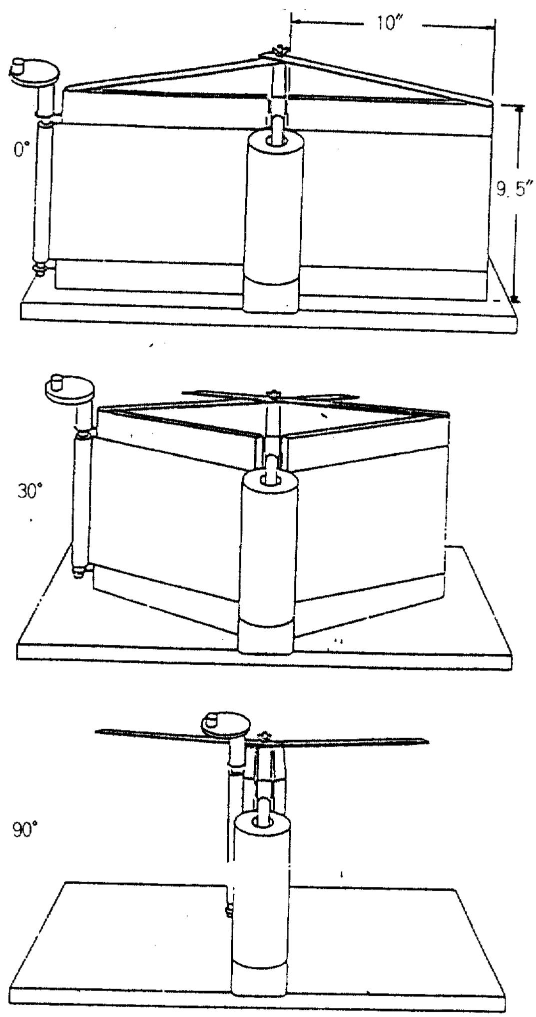

Figure 1. Critical Angle Board at 0°, and 30°, 90°

Method

Subjects. Subjects were participants in a study of twins and their families, and they ranged in age from three to sixty-three years. Families were recruited through the Northwest Mothers-of-Twins Clubs. After an initial mail contact, interested families returned a postcard and were recontacted for scheduling of a visit to the Universitv of Washington in Seattle. Sixty-six families participated, and all family members age four or above were assessed on a battery of perceptual, cognitive, and motor tests that lasted for about three and a half hours. Only two subjects younger than four -- a pair of precocious three-year-old twins -- participated in the study. The number of subjects with valid data varied across measures and ranged from 308 to 343. The results of the cognitive testing and of tasks measuring hemispheric asymmetries of verbal and nonverbal processing will be reported elsewhere.

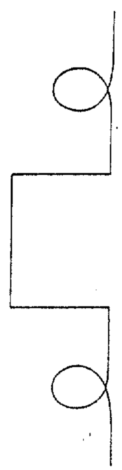

Figure 2. Pattern Copies on Critical Angle Board

Handedness Measures.

Critical Angle Board. The Critical Angle Board consisted of two writing boards that could be varied from a position parallel with the subject's chest surface (Oards forming a straight line) to a position perpendicular to the subject's chest (boards back-to-back and parallel to each other). Figure 1 illustrates the board at zero degrees, 30 degrees, and 90 degrees. A pattern (see Figure 2) was displayed on the wall immediately in front of the subjects, and the subject was asked to copy the pattern as simultaneously with both hands. Subjects were urged to copy the pattern as quickly as they could, and were not allowed to see their hands while doing so. Each subject copied the same pattern for ten trials, and the angle by which each hand diverged from the frontal plane was increased by ten degrees with each successive trial (i.e., the angle between the hands was decreased by 20 degrees) so that in the first trial the boards were in the zero degree position, and in the last trial they were in the 90 degree position. When a subject's right- or left-handed copy of the pattern was a mirror-image reversal of the prototype for two consecutive trials, the angle at which mirror copying first occurred was scored as the critical angle for that hand. The critical angle could range from zero degrees (both planes in the subject's frontal plane) to 90 degrees (both planes in the subject's sagittal plane).

Simultaneous Number writing. This is one of the items from the Harris Tests of Lateral Dominance (Harris, 1957). Subjects were asked to write the numbers from 1 to 12, starting at the top of a blank sheet of paper and continuing down the page vertically as quickly as possible, using both hands at the same time. Subjects were not allowed to see their hands during writing. The number of mirror-image reversals with each hand was recorded.

Unimanual Strength. Subjects were given three trials per hand, right and left hand alternately, with a hand dynamometer. Separate dynamometers were used for children and adults, and the dynamometer was adjusted to each subject's hand size. The best score (in kilograms of pressure) for each hand was recorded.

Tapping Speed. Unimanual tapping speed was recorded separately for each hand when subjects tapped on a metal square with a metal tipped stylus. After a brief practice period, subjects were instructed to tap as rapidly as possible for twelve seconds. The number of taps was automatically recorded with a Lafayette Instruments electric counter.

Grooved Pegboard. The Grooved Pegboard tests visual-motor coordination and dexterity. It consists of 25 small holes with randomly oriented slots. Pegs with a key on one side must be rotated to match the hole before or during insertion. Subjects were instructed to pick up the pegs one at a time, using only one hand, and place them in the slotted holes as rapidly as possible without dropping any. The subject first used the dominant hand, and then repeated the task with the nondominant hand. Time to complete the task was recorded separately for each hand.

Minnesota Manual Dexterity Test. This test was designed to measure speed of simple, rapid, hand-eye coordination in unimanual motor movements. The Lafayette Instruments apparatus consisted of a shallow 37.5-inches by 13.5-inches rectangular box. Inside the box was a 36-inch by 12-inch sheet of fiber board with a 15 by 4 matrix of 1.5-inch diameter holes. A 1.5-inch diameter round block, red on one side, black on the other side, rested in each hole. At the beginning of each trial all blocks were either red- or black-side-up. After a practice period, the subject was told to begin with either the left or right hand (randomly determined) and, working as quickly as possible with only one hand, to turn all the blocks over to the other color. The time required to turn over all the blocks was recorded to the nearest tenth of a second for each hand.

Oldfield's Edinburgh Inventory. The Oldfield Inventory is a measure of hand preference. Subjects were asked to indicate the direction and strength of hand preference for ten activities. In the present study, all subjects aged fourteen and older filled out the standard questionnaire. Subjects younger than fourteen were individually assessed on each questionnaire item, and were asked to act out each activity. For example, subjects drew, wrote, cut with scissors, and pretended to brush their teeth. The individually tested subjects were also asked if they always used the same hand, and if they indicated some inconsistency in hand preference for a particular task, they were asked to demonstrate for the experimenter.

Results

Measures of the right and left hands' relative strength, speed, independence, dexterity, and preference were calculated as quotients, ranging from −100 to +100. In all cases, −100 means left hand superiority in strengh, speed, independence (i.e., left hand mirrors less), dexterity, and preference.

Critical Angle Board:(R−L)/(R−L)×100, where R is the critical angle for the right hand (the angle at which the right hand begins to mirror the left hand). and L is the critical angle for the left hand. The range of R and L scores was zero degrees to 90 degrees when mirroring occurred. For purpose of correlational analyses only, a score of 100 degrees was assigned to a hand if no mirroring occurred for that hand across the entire zero degree fo 90 degree range. Such an instance represented the extreme in independence of manual control, since it reflected a hand's imperviousness to confusion and error induced by the other hand's. concurrent competing motor activity

Simultaneous Number Writing: (L−R)/(L+R) ×100, where L is the number of mirror responses with the left hand, and R is the number of mirror responses with the right hand. L−R was used rather than R−L because a mirror response was assumed to reflect less independence in the control of this (number-writing) motor activity. The possible range of mirror responses for each hand was zero to twelve.

Hand Dynamometer: (R−L)/(R+L) ×100, where R is the kilograms of pressure (grip strength) for the right hand's best trial, and L is the kilograms of pressure for the best left-hand trial. The range of right-hand scores was 3 to 90 kg., and of left-hand scores was 3 to 92 kg.

Tapping: (R−L)/(R+L) × 100, where R is the number of right-hand taps and L is the number of left-hand taps. The range of right-hand scores was 12 to 122, and of left-hand scores was 8 to 113.

Grooved Pegboard: (L−R)/(L+R) × 100, where L is the time taken to place all the pegs correctly with the left hand, and R is the time for the right hand. With this (and the following) timed measure, L−R was used because a longer time presumably indicates lower dexterity, and all quotients were referenced to a common standard in which positive ratios reflected right-handed superiority and negative ratios reflected left-handed supertority.

Minnesota Manual Dexterity: (L−R)/(L+R) × 100, where L is the time taken to turn over all the pegs with the left hand and R is the time for the right hand. The range of left-hand times was 45.0 seconds to 327.8 seconds, and of right-hand times was 44.1 seconds to 296.2 seconds.

Hand Preference: (R−L)/(R+L) × 100, where R is the number of questionnaire items checked (out of 10) for the right hand, and L is the number of items checked for the left hand.

The quotient means and standard deviations for all measures are presented in Table 1 for all subjects and for males and females separately. Significant sex differences were found only for Hand Preference and Simultaneous Number Writing. Males had significantly higher quotients than females on both of these measures, reflecting stronger preference for the right hand and greater motor independence of the right hand in the fact of competing homologous activity.

In order to compare the present findings with those of Van Riper (1935), subjects were divided into four groups according to hand preference quotients (HPQ). The four groups were: strong left-handers (−100 ≤ HPQ (−50), ambidextrous left-handers (−50 ≤ HPQ 〈 0), ambidextrous right-handers (0 〈 HPQ 〈 80), and strong right-handers (80 〈 HPQ ≤ 100). Criteria for forming handedness groups were determined on the basis of overall score distributions. Requiring a

Table 1
Means and Standard Deviations for All Laterality Measures

	Males			Females			Total Sample		
	$\overline{X}$	SD	(N)	$\overline{X}$	SD	(N)	$\overline{X}$	SD	(N)
Hand Preference*	63.7	55.59	(166)	50.7	70.17	(177)	57.0	63.78	(343)
Critical Angle Board	13.6	50.33	(148)	13.5	52.05	(161)	13.6	51.15	(309)
Simultaneous Number Writing	56.4	62.40	(152)	42.5	68.29	(166)	49.1	65.81	(318)
Hand Dynamometer	3.2	6.52	(162)	3.5	6.30	(174)	3.4	6.40	(336)
Tapping	4.5	8.24	(163)	3.6	7.54	(175)	4.0	7.88	(338)
Grooved Pegboard	4.4	8.86	(163)	4.9	9.56	(173)	4.7	9.22	(336)
Minnesota Manual Dexterity	1.8	5.77	(163)	1.7	6.77	(173)	1.8	6.29	(336)

* Males significantly higher(more right-handed) than females for Hand Preference($t = 1.90, p < .05$), and Simultaneous Number Writing($t = 1.90, p < .05$).

score of 80 or above for the strong right-handed group insured inclusion of individuals who used the right hand exclusively, and also permitted a "left" response for a single item(such as "hand at top of a broom"). A single response that deviated from total right hand preference was not deemed sufficient cause to classify a subject as ambidextrous. As is obvious from Table 2, the majority of subjects were strong right-handers with perfect or near-perfect right-hand preference scores. The distribution of left-handers was not so sharply skewed in faror of strong left-handers, and −50 was used as the cut-off score so that each handedness group would contain at least 20 subjects. The distribution of subjects across groups is presented in Table 2.

Table 2
Distribution of Subjects in Hand Preference Groups
According to Hand Preference Quotient(HPQ) on Oldfield Questionnaire

Handedness Group	Hand Preference Quotient (HPQ)	N
Strong Lefthanders	(−100≦HPQ−50)	40
Ambidextrous Lefthanders	(−50≦HPQ≦0)	21
Ambidextrous Righthanders	(0<HPQ<80)	64
Strong Righthanders	(80≦HPQ≦100)	183

For performance on the Critical Angle Board, Table 3 presents frequencies and percentages of subjects in each hand preference group who mirrored (in at least two consecutive trials) with the dominant and nondominant hands. More than 80 percent of subjectsin all handedness groups mirrored with the nondominant hand. In addition, more than 40% of subjects in all groups mirrored with the dominant hand. The incidence of nondominant-hand mirroring was significantly greater than dominant-hand mirroring within all hand preference groups [z(strong left) = 5.74; p⟨.001; z (ambidextrous left) = 2.58, p⟨.01; z

Table 3
Frequencies and Percentages of Mirroring on Critical Angle Board

Handedness Group	Mirrored with Nondominant Hand	Mirrored with Dominant Hand
Strong Lefthanders	33/40 (82.5%)	17/40 (42.5%)
Ambidextrous Lefthanders	18/21 (85.7%)	13/21 (61.9%)
Ambidextrous Righthanders	55/64 (85.9%)	32/64 (50.0%)
Strong Righthanders	157/183 (85.8%)	77/183 (42.1%)

(ambidextrous right) = 6.67, p⟨.001; z(strong right) = 13.09, p⟨.001]. The strong left-handed and strong right-handed groups did not differ significantly in frequency of mirroring with the dominant hand (z =.09, p = n.s.). Similarly, the ambidextrous right-handed and ambidextrous left-handed groups did not differ significantly in frequency of dominant-hand mirroring (z = 1.57, p = n.s.). Therefore, the two strong handedness groups were combined, as were the two ambidextrous groups. A comparison between these newly defined groups (strong handedness versus ambidextrous) revealed significant differences (z = 2.70, p ⟨.01). Subjects with a strong hand preference (either right or left) were significantly less likely to mirror with the dominant hand than more ambidextrous subjects.

The mean angles of the first of two

consecutive mirrorings are presented in Table 4. For subjects who mirrored, there were no significant differences between strong and ambidextrous handedness groups in the angle of first mirroring. These results did not confirm Van Riper's (1935) finding of differences in angle of first mirroring with the nondominant hand. For all handedness groups the nondominant hand mirrored before the dominant one(i.e., mirrored at a smaller angle), but the difference between the hands was significant only for the strong right-handers ($t = 3.23$, $p < .01$).

Table 4
Mean Angle of First Mirroring for Subjects Who Mirrored

Hand Preference Group	Mirroring Angle for Nondominant Hand		Mirroring Angle for Dominant Hand	
	$\bar{X}$	N	$\bar{X}$	N
Strong Lefthanded	40.3°	33	47.1°	17
Ambidextrous Lefthanded	40.6°	18	48.5°	13
Ambidextrous Righthanded	44.7°	55	51.0°	32
Strong Righthanded	45.8°	157	59.2°	77

Table 5
Correlations of Critical Angle Board Performance With Other Manual Measures

	All Subjects		Males		Females	
	r	(N)	r	(N)	r	(N)
Hand Preference	.39***	(308)	.30***	(147)	.46***	(161)
Simultaneous Number Writing	.37***	(301)	.26***	(143)	.47***	(158)
Hand Dynamometer	.24***	(307)	.13	(147)	.35***	(160)
Tapping Speed	.24***	(309)	.23**	(148)	.26***	(161)
Grooved Pegboard	.24***	(309)	.16*	(148)	.31***	(161)
Minnesota Manual Dexterity	.32***	(309)	.23**	(148)	.39***	(161)

* $p < .05$ ** $p < .01$ *** $p < .001$

Correlations between Critical Angle Board performance and performance on the other manual tasks are presented in Table 5. Overall, the correlations of Critical Angle Board scores with other manual measures were moderate, the strongest relationships being with Hand Preference ($r = .39$) and Simultaneous Number Writing ($r = .37$). The correlations of Critical Angle Board performance with other manual measures were higher for females than males for all measures, but the differences between male and female correlations were statistically significant only for Simultaneous Number Writing ($z = 2.09$, $p < .05$) and Hand Dynamometer ($z = 2.03$, $p < .05$). When the other manual tasks were correlated with each other, females again were found to have higher intercorrelations among tasks than males. This trend may reflect greater consistency of hand usage and skill across tasks for females than for males.

When scores on the manual tasks were correlated with age, the results shown in Table 6 were obtained. Overall, the

Table 6
Correlations With Age For All Manual Measures

	Male						Female						Total					
	All		R		L		All		R		L		All		R		L	
	r	N	r	N	r	N	r	N	r	N	r	N	r	N	r	N	r	N
HP	.06	(166)	.16*	(143)	-.02	(23)	.00	(177)	.26***	(135)	-.15	(42)	.03	(343)	.18***	(278)	-.10	(65)
CAP	-.08	(148)	-.12	(127)	.00	(21)	-.03	(161)	-.04	(121)	-.03	(40)	-.06	(309)	-.09	(248)	-.01	(61)
SNW	-.02	(152)	.02	(130)	-.44*	(22)	-.08	(166)	-.07	(125)	-.16	(41)	-.04	(318)	-.02	(255)	-.26*	(63)
HD	.10	(162)	.09	(141)	.16	(21)	-.03	(174)	.08	(132)	-.33*	(42)	.04	(336)	.08	(273)	-.17	(63)
T	-.02	(163)	-.06	(141)	.24	(22)	-.12	(175)	-.28***	(133)	.25	(42)	-.06	(338)	-.15**	(274)	.24*	(64)
GP	-.22**	(163)	-.29***	(141)	.12	(22)	-.11	(173)	-.28***	(131)	.31*	(42)	-.16***	(336)	-.29***	(272)	.25*	(64)
MMD	-.09	(163)	-.10	(141)	-.08	(22)	-.03	(173)	-.13	(131)	.24	(42)	-.06	(336)	-.12*	(272)	.14	(64)

HP – Hand Preference
CAP – Critical Angle Board
SNW – Simultaneous Number Writing
HD – Hand Dynamo meter
T – Tapping
GP – Grooved Pegboard
MMD – Minnesota Manual Dexterity

* $p<.05$
** $p<.01$
*** $p<.001$

strongest age correlations were with Grooved Pegboard scores, for which right-handers had negative correlations and left-handers had positive correlations. The same trend of increasing relative proficiency of the nondominant hand with age was evident for Tapping scores and, to a lesser extent, for Minnesota Manual Dexterity scores for females. For all right-handed subjects, age was positively and significantly correlated with strength of right-hand preference. Other than Critical Angle Board, the only task involving concurrent activity of both hands was Simultaneous Number Writing, for which older left-handers showed relatively more mirroring by the nondominant (right) hand than younger left-handers.

Discussion

While the finding that at least 80% of subjects in all handedness groups mirrored with the nondominant hand was consistent with Van Riper's (1935) results, the occurrence of mirroring by the dominant hand was not. The high incidence of such mirroring (at least 40% in all handedness groups) is clearly discrepant with earlier work.

The general pattern of mirroring across handedness groups was not surprising, and can be regarded as an overt demonstration of what one would predict if the classification "ambidextrous" has any behavioral validity. While all handedness groups showed significantly more mirroring with the nondominant hand, both ambidextrous right- and left-handers were significantly more likely to mirror with the dominant hand than were subjects with a strong (right or left) hand preference. As assessed by this task, ambidexterity may reflect less "consistency" for the side — left or right — that dominates concurrent bimanual motor activity. Note that the two hands do not function independently in ambidextrous subjects. In fact, ambidextrous subjects showed more overall mirroring, or interference from contralateral activity, than subjects with a strong hand preference. Therefore, while it is possible that ambidextrous subjects are more flexible about which side controls fine motor movements, it is also possible that the control of such movements is only loosely specified. Such lack of specification could lead to interference in the execution of complex bimanual tasks in which movements are identical rather than complementary.

Van Riper's (1935) difference in angle of first mirroring between subjects with strong versus weak hand preferences was not replicated in the present study. To the contrary, if one considers incidence of mirroring in addition to angle of first mirroring, one is even less inclined to conclude that ambidextrous subjects can maintain greater independence of the hands than subjects with strong hand preferences.

It is clear from the pattern of correlations between Critical Angle Board performance and the other manual measures that "handedness" may not be as unidimensional and clear-cut as is often assumed. Most of the correlations, although statistically significant, were only moderate, and the highest correlations were with Hand Preference and Simultaneous Number Writing. This finding is not surprising, since Hand Preference was the most general handedness measure, and Simultaneous Number Writing was the task that most closely resembled the Critical Angle Board task. In both bimanual tasks it was necessary to produce identical configurations concurrently with both hands without the aid of visual feedback. Mirroring responses were scored as errors. The low correlations obtained between the bimanual Critical Angle Board task and the unimanual tasks may reflect a difference in the kinds of feedback and organization necessary to control rapid bimanual activity versus unimanual strength, tapping speed, or dexterity.

Although the same pattern of correlations was observed for males and females, the correlations among manual measures were considerably weaker in males. The correlations of Critical Angle Board scores with scores on other measures were consistently lower for males than females. This sex difference in the cross-task consistency of hand usage, manual skill, and control of one hand's activity by that of the other may reflect greater male ambidexterity in overt manual performance (as opposed to self-reports of preference). This result is particularly interesting in light of the finding that, using Hand Preference scores alone, males in the present sample would be classified as less ambidextrous than females.

One of the clearest conclusions to emerge from the age correlations was that patterns of age differences in handedness varied according to the measure of handedness. The measures used in the present study can be divided into four categories; (1) measures of bimanual activity (Critical Angle Board and Simultaneous Numbers): (2) measures of unimanual speed and dexterity (Grooved Pegboard and Tapping for fine motor manipulations; Minnesota Manual Dexterity for grosser motor movements); (3) measure of unimanual strength (hand dynamometer); and (4) hand preference measure (Oldfield Inventory). Although preference for the dominant hand may increase with age, a change in preference does not necessarily reflect changes in the relative skill or speed of the two hands. Overall, speed and dexterity of the nondominant hand relative to the dominant hand was greater in older subjects.

Finally, it is necessary to address the question of the functional significance of mirroring under conditions of bimanual competition. Does mirroring tap an underlying organization of the nervous system related to the initiation and control of coordinated bimanual motor activity? Of all motor measures used in the present study, the two mirroring tasks were least likely to be highly practiced and also least likely to be affected by cultural biases about handedness. Mirroring occurred as an unintentional lapse in an effort to control the hands independently.

In everyday bimanual activity the hands complement rather than directly mimic each other. Usually one hand does fine manipulations while the other anchors the material being worked on (as in sewing, writing, drawing, or unscrewing the lid of a jar). Alternately, both hands perform mirror symmetrical movements, relative to the sagittal plane, that are approximately in phase with one another (as in clapping or swimming the breast stroke) or approximately 180 degrees out of phase with one another (as in running,swimming the backstroke, or beating on a bass drum). In order for both hands to copy the same pattern (as with the Critical Angel Board) or write the same numbers (as with Simultaneous Writing) without mirroring, the motor/muscle commands to each hand must not mirror each other. That is, they must be defined in a non-homologous manner. Given symmetrically identical initial joint angle configurations in both arms, a movement to the right will involve activation of a given set of muscles in one arm and a non-identical (non-homologous) set of muscles in the other arm. Hence, the inhibition of mirroring may require overriding a strong predisposition to homologous movements when performing bimanual tasks.

The extent to which one hand dominates in controlling such bimanual activity clearly is related to what we call handedness. In this study the ambidextrous subjects showed less consistency in the hand that mirrored than did subjects with a strong hand preference. This could mean that: (a) they have more flexibility in the control of bimanual movement, or (b) the activity of either hand(dominant or nondominant) is more likely to interfere with what the other hand is trying to do. It would be interesting to investigate hand preference and mirroring in individuals who routinely do bimanual activities in which mirroring would clearly be a liability. Playing the piano or typing exemplify such activities. In order to do either activity effectively, the tendency to mirror would have to be suppressed. An excess of strongly right- or left-handed pianists, for example, might support the finding in the present study that subjects with a strong hand preference were, overall, less likely to experience contralateral manual interference. An understdanding of the extent to which such interference varies with age, sex, and handedness might enhance our knowledge about individual differences in the acquisition of complex bimanual skills.

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양손동작 통제에서의 개인차와 연령차

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본 연구에서는 피험자의 손 사용에 대한 선호도와 실제 두 손의 수행과의 관계를 알아보기 위하여 다양한 과제들을 실시하였다. 과제들은 대략 다음의 4종류로 나눌 수 있다.

(1) 양손 동시 활동 과제들, (2) 각 손의 수행 속도와 기술의 측정 과제들, (3) 각 손의 힘(강도) 측정 과제, (4) 다양한 활동에서의 손 사용에 관한 질문지이다.

주과제는 양손 동시 활동 과제로서 피험자가 하나의 간단한 시각 패턴(본문 Figure 2)을 두손으로 동시에 똑같이 복사하는 것이었다. 첫 시행에서는 양손이 반응하는 종이의 각도가 180°로서 피험자의 가슴과 평행이 되었고 그 후 각 시행마다 중심부에서 양쪽 반응 종이가 동시에 10°씩 뒤로 꺾여져서 마지막 시행에서는 피험자의 가슴과 수직방향이 되었다(본문 Figure 1 참조). 종속변인은 어느 각도에서부터 한쪽 손이 다른쪽 손의 움직임을 따라 반응하여 원래 요구된 반응과 대칭되는 반응이 나타나기 시작하는가였다.

피험자는 손사용에 관한 질문지 점수에 따라 강한 왼손잡이, 약한 왼손잡이, 약한 오른손잡이, 강한 오른손잡이의 4집단으로 나뉘었는데, 약한 손잡이 집단은 흔히 양손잡이로 분류되는 사람들이었다. 집단별로 우세한 손과 우세하지 않은 손에 대칭반응이 나타난 빈도의 백분율을 산출한 결과, 4집단 모두 80% 이상의 피험자가 우세하지 않은 손으로 대칭반응을 하였고, 적어도 40% 이상의 피험자가 우세한 손으로 대칭반응을 하였다. 우세하지 않은 손의 대칭반응은 4집단 사이에 차이가 없었으나, 우세한 손의 대칭반응은 강한 손잡이 집단들보다 약한 손잡이 집단들에서 의의있게 많이 나타났다. 따라서 Van Riper(1935)의 주장과 같이 양손잡이(약한 손잡이) 집단들이 두 손을 독립적으로 사용할 수 있는 것이 아니라, 강한 손잡이 집단들보다 우세한 손의 대칭반응을 더 많이 보임으로써 우세하지 않은 손의 움직임에 의해 방해를 더 많이 받는 것으로 나타났다.

주과제와 다른 과제들과의 상관계수들은 통계적으로는 의의가 있더라도 그리 높은 것은 아니어서 보통 생각하듯이 "handedness"가 단일차원으로 분명히 나타나는 것은 아닌 것 같다. 우세한 손에 대한 선호도는 연령에 따라 증가하는 것으로 나타났으나 이것이 꼭 우세한 손이 우세하지 않은 손보다 기술, 속도, 힘 등에서 훨씬 나아지는 것을 뜻하지는 않았다. 대체로 우세하지 않은 손의 기술과 속도는 연령에 따라 더 나아졌다.