Concordance of Handedness Between Teacher and Student Facilitates Learning Manual Skills

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Abstract:
Eighty-six left- and right-handed male and female adults received demonstrations of the manual actions involved in tying three different knots from either left- or right-handed female instructors. Learning was greatly facilitated by concordance of handedness between teacher and student, Sex of subject had no effect, nor were any interaction effects significant. Therefore, it is conceivable that observation learning of manual skill, which accompanied the hominid evolution of tool-use and tool-making skills, could have provided selective pressure for concordance (the right-bias) in human handedness.

Article:
Handedness, or limb-use preference, is a general characteristic of mammals, particularly of those that use their forelimbs in ways other than locomotion (Walker, 1980). However, humans are distinct among mammals in manifesting an uneven distribution of handedness. The majority (usually about 90%) of the people in every culture are right-handed (Annett, 1978). Thus, only humans have a right-hand bias in hand-use preference.

Of the many theories proposed to explain the prevalence of right-handedness (Harris, 1980), none addresses the question of what function this bias could serve. What is the advantage to the individual if his or her handedness is the same as that of the majority of people? Since the right-bias in handedness distribution is an ancient characteristic in the hominid lineage (Coren & Porac,1977; Spennemann, 1984; Steklis & Hamad, 1976) and may have been a product of the same evolutionary selection pressures by which humans evolved, the right-bias should be associated with traits that are specifically human.

Tool-use and manufacture are traits strongly tied to the evolution of humans (Oakley, 1072). Since tool-working requires extensive manual skill, and since handedness, or differences of proficiency between the hands in the execution of manual skills, is a common characteristic of primates, handedness must have been an important skill factor in the early evolution of tool-use and manufacture (Falk, 1980; Frost, 1980).

Traditions of tool-type and mode of manufacture are distinct characteristics of current and past human societies that imply social transmission of the manual skills employed in tool-working (Oakley,]972). Since tool traditions are evident early in the evolution of hominids (Falk, 1980; Frost, 1980; Oakley, 1972), the social transmission of tool-working skills likely occurred without verbal mediation, relying instead on observational learning. Therefore, the functional significance of the bias in human handedness distribution may reside in the way in which handedness affects the observational learning of manual skills.

The present study addresses the question of whether a concordant handedness relation between demonstrator (teacher) and observer (student) would facilitate observational learning of manual skills. The manual skills that were learned were those used in tying three different knots. Knot-tying skills involve the use of both hands, but each hand performs quite different actions and the handedness of the individaul determines which hand performs which actions. Moreover, these actions are quite simple and well within the skill range of each hand.

The subjects were 86 students attending a local university, of whom 33 were male (eight left-handers, 25 right-handers) and 53 female (24 left-handers, 29 right-handers). Handedness was assessed by an adaptation of the Annett handedness questionnaire (Briggs & Nebes, 1975). Only consistent right-handed (scores greater than 15) and consistent left-handed (scores less than —15) subjects were included in the study. A much greater proportion of female than male left-handed volunteers met the criterion for consistent left-handedness. A one-meter rope was used to tie three knots: a sheepshank knot, a mountain climbing non-slip knot (butterfly), and a "magic" slip-knot.

Demonstrations of knot-tying were presented to each subject, individually, by either a right- or left-handed teacher. The subjects were divided into four groups by sex and whether or not the teacher and student had the same handedness. The two teachers were female college students (one of whom was left-handed, the other right-handed) who had practiced tying each knot until they were equally proficient, as determined by their speed in tying (not faster than 15 seconds nor slower than 20 seconds) without any errors. To keep each demonstration for a subject consistent, the demonstrations were timed by a stopwatch to fit this 15-20 second duration.

Each teacher taught equal numbers of male and female subjects and the left-handed subjects were equally divided between teachers. After completing the questionnaire, the subjects were told that they would be shown how to tie three different knots, one at a time. The six possible orders of presentation of the three knots were counterbalanced across groups and the sex of the subject. For each knot the subjects were told that they would receive five demonstrations of how the knot is tied but that they would receive no verbal instructions. Subjects were not informed about the teacher's handedness or the specific purpose of the study.

The subjects were instructed to stand alongside the teacher during a demonstration, but were free to choose the right or left side and sometimes they changed sides between demonstrations. After each demonstration, the subjects had 90 seconds to tie the knot. They were told that they could request another demonstration before the end of the 90 seconds but that the trial would be scored as lasting 90 seconds and ending in failure. Each 90-second trial was followed by another until the fifth trial. The number of knots learned and the total time (up to 450 seconds) across trials was recorded for each subject. When a subject successfully tied a knot, the time taken was added across trials to score the time taken to learn to tie that knot.

Almost all (97%) subjects learned to tie at least one knot and 37% learned to tie all three knots. Significantly more subjects (90%) learned to tie two or more knots when their handedness was concordant with that of their teacher than when their handedness was discordant with that of their teacher (50%, x2 = 12.8, d.f. = 1, P < 0.01).

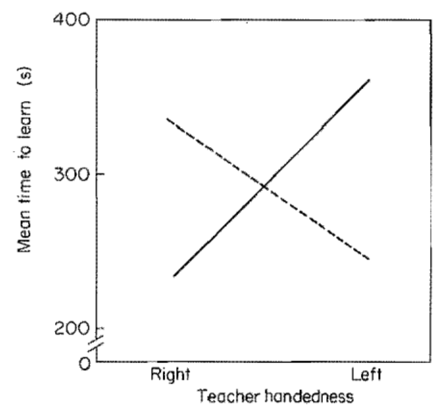
The time taken to learn to tie each knot was examined in a 2x2x3 analysis of variance design representing the teacher-student handedness relation, the sex of the subject, and the three knots as repeated measures. There was no significant difference between sexes in learning time and no significant interaction effects. The discordant handedness group (i =- 348.5,S.D. = 87.5) took significantly longer to learn (F = l4,2, df= 1,82,P<0.00)) than the concordant handedness group (X = 279•4, S.D. = 80•2). There was a significant main 134.2) and butterfly (Tx = 30O.7, S.D. = 133.8) knots were learned faster (Tukey's test, P < 0.01 than the sheepshank knot (x = 349•6, S.D. = 110•2).

Although the proportion of left-handed subjects is too small and unbalanced in its sex ratio to more than tentative conclusions, the effect of student or teacher right-and left-handedness on learning time was examined by analysis of variance of scores on the magic knot, chosen because 74% of the students learned to tie it and its scores had the lowest coefficient of skew (-0.23).

Handedness of teacher (F=2•d.f.= l,82,) >0.05) and handedness o[student (}r= 0.1,d.f= 1,82P>0.10) had no significant effect nn learning time. Left- and right-handed teachers demonstrated the knot-tying skills equally well and left- and right-handed students learned equally well. However, the interaction between teacher and student handedness was significant (F = 14.7,d.f = 1, 82,P<0-001). As Figure 1 indicates, right handed students learned significantly faster from a right handed teacher (5c=234.7,S.D.= 132.7) than from a left-handed teacher = 358.8, S.D. =))7.2, Tukey test, P < 0.05). Similarly, left-handed students learned significantly faster from a left-handed (x = 245.3, S.D. = 114.2) than from a right-handed teacher =383.3`8.D.=l30.0,P<0.01).Thus, concordance of handedness between teacher and student, whether left-handed or right-handed, was the relevant factor in facilitating learning.

Left-handers are often t d as being l awkward, and slow to learn. However, this may be because of the extra burden discordance of handedness places on the left-handed learner in a right-handed world. Figure 1 shows that right-handers may be equally slow to learn if their teacher is .

Figure 1. Mean time taken to learn to tie the "magic" knot for right-handed (solid line) and left-handed students taught by either a right- or left-handed teacher.



The results indicate that regardless of the sex of the subjects, observational learning of manual skills is significantly enhanced when the student and teacher are concordant in handedness. It is likely that in the discordant condition, manual skill learning requires a transformation (or an additional step during information processing) by the observer that is not necessitated when handedness is concordant. Since the manual actions, and even the interlimb sequences of action, involved in tying knots are common, well-rehearsed skills, it is unlikely that the disruption occurs in the motor programming phase. Also, observation of the manual actions during knot-tying seems not to require any special cognitive skills and, if so, surely left-handers would have acquired special enabling strategies for learning from right-handers. Yet, discordant handedness is just as disruptive for left-handed as for right-handed students. Thus, identification of the point during learning at which such a transformation must occur requires further analysis.

Pre-hominids were probably evenly distributed in their handedness (Annett, 1978; Walker, 1980). As tool-working skills evolved as an important component of hominid evolution, the social transmission of these skills would have depended on observational learning. It would have been advantageous for individuals to be concordant in handedness because this would greatly facilitate the observational learning involved in the social transmission of tool-working manual skills. Therefore, it is conceivable that facilitation of observational learning for manual skills may be an important factor in the selection pressure favoring a population bias in human hand-use preference.

The advantage provided by the concordance in handedness raises the question of why any individuals in the population are discordant. Although some have argued that left-handedness is a consequence of neural pathology (Satz, 1972), left-handedness is likely a normal form of variability for most individuals (Hardyck & Petrinovich, 1977). The maintenance of distinctly different behavioral types (polyethism), like the maintenance of polymorphism in a population, usually means that the minority type has associated characteristics that are relatively more advantageous in selected aspects of the population's ecology. Therefore, left-handedness may be maintainted because its associated characteristics are adapted to conditions somewhat different from those for right-handedness (Hardyck & Petrinovich, 1977; Mebert & Michel, 1980).

The right-bias in handedness is thought by some to be an incidental consequence of left hemisphere dominance in the control of speech (Annett, 1975). However, the present results suggest that the predominance of a ri ht-hand preference in humans could have evolved separately as a means of facilitating the social transmission of tool-working skills before the evolution of instrumental speech skills. Speech, then, would have evolved within a neurobehavioral context that already encouraged a population bias for right-handedness as well as for a left hemisphere advantage in processing language-like sounds (Heffner & Heffner, 1984).

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