Language dominance and gesture hand preferences

Debra Stephens
The University of Chicago
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In general, adults gesture only when speaking, and with one hand more than with the other (Kimura, 1973a, b; McNeill & Levy, 1982; Sousa-Poza, Rohrberg & Mercure, 1979). Kimura (1973a) observed the hand motions of right-handed adults during speech, nonverbal vocalization (humming), and during the silent performance of a verbal and a nonverbal task. A subject's hands were empty throughout a session. She found that most of the hand movements were classifiable either as self-touching (e.g., pushing back hair, adjusting eye glasses) or as "free movements--any motion of the limb which did not result in touching of the body or coming to rest (p. 46)." Self-touching occurred frequently during all activities, while free movements (which we shall hence-forth call gestures) were limited almost exclusively to the speaking condition. Moreover, subjects displayed no hand preference in self-touching, but a right-hand predominance in gesturing.

Kimura (1973b) recorded gestures of both right-and left-handers during spontaneous speech. A subject was classified as sinistral or dextral if he or she wrote and performed at least six of seven other common activities (e.g., combining hair, striking a match) with the given hand. Language dominance was inferred from left- or right-ear superiority in the perception of words presented in a dichotic listening task. Right-handers with inferred left hemisphere language, as well as left-handers with inferred right language, gestured primarily with the dominant hand, which is opposite and presumably controlled by the hemisphere dominant for speech. Sinistrals with inferred left hemisphere language gestured about equally often with either hand. Since all the left-handers demonstrated a strong left hand preference in performing other activities, the difference between the two groups may reflect discrepant organization of expressive language functions, with greater bilateral representation in the subjects who displayed no hand preference in gesturing. Although the dichotic test indicates left dominance in this group, it is, as Kimura points out, primarily a perceptual task; and studies of brain-damaged populations suggest that left-handers are more likely than right-handers to have diffusely organized language functions (e.g., Hecáen & Piercy, 1956; Marcie, 1972; Milner, Branch & Rasmussen, 1964).

Our own preliminary observations largely confirm Kimura's findings. We videotaped each of 23 adults narrating an animated cartoon he or she had just seen, to a listener who had not viewed it. Six subjects were participants in a study by McNeill and Levy (1982), the primary purpose of which was not to examine hand preference in gesturing, but to illuminate the ways that speech and various types of gestures represent the speaker's conceptual structures. Four of the six subjects in that investigation reported later, by telephone, that they write and perform other common activities with the right hand, and the other two were self-reported left-handers. Subsequently we analyzed the gestures of an additional six dextrals and 11 sinistrals narrating the same cartoon. We required each of these 17 subjects not only to report his or her preferred hand for performing nine common activities (e.g., brushing teeth, eating with a spoon), but also to pantomime each action, and to write a short phrase. We classified a subject as right- or left-handed on the basis of the hand preferred for writing. All 17 subjects reported that they always write with the same hand. In more than 99% of the cases, reported hand preference for the other nine tasks matched the hand used in pantomiming. Right- and left-hand preferences on a task were scored respectively as 1 and -1, and the absence of a preference received a zero. Thus an overall score of 9 indicates strong dextrality, and a -9 maximum sinistrality.

The subjects were also administered a questionnaire regarding the handedness of immediate family members (parents, grandparents and siblings). Each was assigned an index of familial sinistrality, which we computed using the method described by Levy and Reid (1978, p. 135). Every left-handed or ambidextrous parent or sibling was weighted as 1, and each left-handed or ambidextrous grandparent was assigned a weight of .5. The weights were totaled and divided by the number of family members whose handedness the subject reported. This index did not correlate with gesture hand preference, or with the measure of general hand preference.

We classifed almost every gesture (i.e., more than 80%) of each subject either as "iconic" or as a "beat" in accordance with the criteria devised by McNeill and Levy. An iconic gesture is one which "seems to bear a formal similarity to some aspect of the situation described by the accompanying speech (p. 272)." For example, most of our subjects accompanied a description of a cat climbing up a drainpipe with a gradual upward motion of one hand. In this case both speech and gesture describe the direction of the cat's movement. A beat, on the other hand, is "small and formless, often quickly made (p. 273)." It shows no relation to the speech content but is associated with the discourse structure. Two lines of argument led us to suspect that iconics in particular would be generated by the speech-dominant hemisphere, while beats might be produced by either. First, the former are intimately tied to speech content, while the latter are not. McNeill and Levy postulate that in fact an iconic gesture and the accompanying utterance emerge from a common conceptual representation. Second, iconics involve sequences of movements, while beats are discrete motions. Kimura and Archibald (1974) found that a group of aphasics was impaired in performing manual sequences, but not on tasks requiring single motions. Beats are not only simple and largely devoid of content, but insofar as they are associated with discourse structure, are connected to a function that may involve the whole brain performing in an integrated manner. This is because discourse planning includes an interrelation of global and sequential planning which could draw on the special skills of both sides of the brain.

Shown in Table 1 is the index of general hand preference, for the 17 subjects from whom these data were obtained. In addition, for each of the 23 subjects, Table 1 displays the number of surface grammatical clauses in the narration. We define a

clause as any linguistic unit containing precisely one subject and predicate, either of which might not be explicitly stated, but inferred from context. Finally, the numbers of iconics and beats performed with the left, right, and both hands, respectively, are presented. As shown in Table 1, seven of our ten dextrals made iconic gestures primarily with the right hand or with both hands, and much less frequently with the left hand alone. Two of the other three performed iconics with the right hand almost exclusively, while the remaining right-hander showed a predominance of left-handed iconics. The pattern for beats is more complicated: five subjects show a right hand preference, four a left-hand one, and one performed mostly two-handed beats.

As Table 1 indicates, three of the 13 sinistrals produced more iconics with the right hand, than with the left or both. Four performed a greater number of two-handed than left- or right-handed iconics, and the remaining six left-handers displayed a left hand preference. Most sinistral individuals showed the same preference in making beats, as in producing iconics, though the numbers of beats are rather small in many cases.

For tasks other than gesturing, all right-handers received scores indicating strong dextrality. The variation in the scores for left-handers prompted us to compute the correlation between this index and the respective percentages of left-, right- and two-handed iconics and beats, for this group alone. As the hand preference score decreases, signifying an increase in strength of left hand preference, the percentage of left-handed iconics rises ($r = -.67$, $df = 11$, $p<.05$), and the percentage of two-handed iconics decreases ($r = .64$, $df = 11$, $p<.05$). No significant correlations were found for beats.

For each subject, we divided the total number of iconics, the total number of beats, and the sum of both, by the number of clauses in the narration, thus obtaining measures of the rate at which the two types of gestures were produced, separately and in combination. Right- and left-handers produced iconics at about the same rate, but the former performed, on the average, one beat for every four clauses, while the latter made one beat for every six clauses.

We also wished to determine if hand preference for iconics was associated with aspects of the gestures themselves. First, we checked to see if direction of lateral motion varied with gesture hand. Most subjects used the left and right hands about equally often to gesture either to the left or to the right. Interestingly, though, subjects usually reproduced actions in the direction they were performed in the cartoon, from the watcher's perspective. Thus a gesture depicting a cat running to the subject's right was likely to involve a rightward hand motion.

Second, we searched for systematic differences in the meanings of iconics performed with the preferred versus the non-preferred hand. Here we noted whether the action depicted in the gesture was that of a major or minor character, and if major, whether the active pursuer (the cat) or the pursued (a bird). We hypothesized that the preferred gesture hand would portray the cat's actions, and that the other hand would depict those of the bird and of the minor characters. However, either hand was equally likely to describe the actions of any character.

In addition, we examined the speech accompanying iconic gestures of the preferred and non-preferred hands. We suspected that iconics produced by the non-preferred hand might appear with dependent clauses, passives, and information not central to the narrative; while the preferred hand would perform iconics accompanying independent clauses, active verbs and statements about important events in the story. Again we uncovered no systematic variations.

Two major findings thus emerge from our observations of the production of iconics and beats. First, in dextrals, preferential gesturing with the right hand consistently occurs for iconics, which are very closely associated with speech content, but not for beats, which bear no formal relation to what is being said. This result is consistent with the finding of Sousa-Poza et al. (1979), that 25 of 28 right-handed males displayed a right hand preference in producing "representational" gestures, but no asymmetry for "non-representational" ones. Since iconic gestures, as mentioned previously, involve motor sequences, whereas beats are discrete movements, it is possible that the dominant hand performs more iconics than the non-dominant, simply because it possesses greater motor skill; but a contribution of speech laterality cannot be ruled out on the basis of these data.

Second, for our sinistrals, strength of hand preference on other tasks correlates with hand asymmetry in the production of iconics but not of beats. The fact that many of Kimura's strong left-handers exhibited no gesture hand preference is impossible to evaluate without knowledge of what types of gestures her subjects produced.

We are now conducting an experiment to determine the strength of association between each of several indices of handedness as well as language dominance, and hand preference in the production of iconics and beats. To elicit large numbers of both types of gesture, we require each subject to view a feature-length film, which he then narrates to a listener who has not seen it. Two measures of dominance for receptive language function--a reading test developed by Levy and Reid, and a dichotic listening task--are administered to the narrators.

Unfortunately, we know of no non-intrusive measure of the lateralization of expressive speech. For most right-handers we can safely assume that the left hemisphere is dominant, and has primary control of the right hand. However, we cannot make the same assumptions concerning either hemisphere in sinistrals. Levy and Reid suggested that left-handers who write with an inverted posture (with the hand above the line of writing) control fine movements of the writing hand via ipsilateral motor pathways (p. 136). Smith and Moscovitch (1979) found some support for this theory, but it has not been established as fact. Therefore, we cannot say which hemisphere controls the preferred gesture hand in a left inverter.

Despite these unresolved issues, we can ascertain which hand probably is controlled by the speech dominant hemisphere in the performance of at least some activities. Numerous researchers have found that if a right-handed subject is required to tap a key with one finger or hand, in isolation and concurrently with speaking, the right hand, but not the left, shows a decrement in tapping rate when the subject is speaking (e.g., Kinsbourne & Cook, 1971; Lomas & Kimura, 1976; McFarland & Ashton, 1975; see Kinsbourne & Hicks, 1978, for a review). Kinsbourne and Hicks (1978)

interpreted this result to indicate that the speech center or a nearby area also controls the right hand in its performance of the manual activity, and when a limited area subserves two competing functions, a decrement will be observed in the performance of at least one activity. In our study, subjects are required to tap silently and when reading aloud for comprehension. Hellige and Longstreth (1981) found that for dextrals, reading concurrent with unimanual tapping produces a greater decrement in right hand than in left hand tapping rate, and that the maximal rate reduction occurs when subjects read aloud with the expectation of a comprehension test afterward.

Finally, we assess the hand preference of each subject in the performance of a number of common tasks, and measure his skill on a peg-moving test which involves sequencing of hand and arm movements (Annett, 1970).

One observer will classify every gesture, and a second one will classify the gestures occurring during a brief segment of each filming session, so that reliability may be computed. Hand preference in the production of each type of gesture will be correlated with the indices of language dominance and general hand preference and skill. Results will be available by the time of the conference.

Table 1

Gesture hand predominance in relation to handedness and strength of general hand preference

Subject	Hand Pref. Strength	N Clauses in Nar.	Hand of Gesture: Iconic Left	Iconic Right	Iconic Both	Beat Left	Beat Right	Beat Both
Right-handers			N	N	N	N	N	N
C.	-	130	9	33	26	6	18	14
L.	-	98	4	21	24	22	1	17
S.	-	101	2	24	25	4	7	11
K.C.	9	133	3	23	20	0	1	5
E.O.	9	131	10	27	39	30	14	3
T.S.	7	222	21	75	41	0	32	0
D.	-	90	4	14	6	21	2	5
M.N.	9	126	1	26	1	1	4	1
D.H.	9	191.	3	77	4	0	27	1
V.F.	9	71	16	3	8	19	5	5
Left-handers								
V.G.	-6	141	9	37	10	5	6	3
M.V.	-3	114	9	22	10	0	6	5
S.M.	-1	92	7	27	25	12	7	12
V.	-	149	6	13	27	8	6	17
D.R.	3	228	10	23	57	3	3	8
J.B.	-5	175	26	24	33	4	2	6
A.B.	0	115	14	4	25	6	1	10
D.S.	-9	62	15	2	10	3	2	10
D.G.	-9	202	49	27	18	31	27	9
C.C.	-3	114	28	21	18	7	0	2
J.	-	134	21	11	15	41	3	7
K.C.	-5	130	11	6	11	4	0	5
E.B.	-3	86	11	9	4	8	1	2

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