Measuring Hand Movements

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ABSTRACT: Hand movements were classified into speech illustrators, body manipulators, and actions which convey precise symbolic information. The behavioral code noted whether the action involved the left, right, or both hands, and the manipulator code also included the part of the body manipulated. The application of this code to videotapes of conversations provided data to examine a number of methodological issues. Reliability was inspected in a number of ways; each showed high intercoder agreement. Little redundancy was found among the various hand measures, although scores for the frequency of an activity and for the duration of an activity were highly intercorrelated for most classes of hand actions. An economical method for coding hand activity was compared with the standard, more time-consuming method. Similar results were obtained, although the economical method appeared to be more vulnerable to measurement error.

Two different but related methods have been used for studying nonverbal behavior (facial and bodily movement): direct measurement of behavior and observers' inferences based on viewing a sample of behavior. Suppose the question under study is whether body movement varies with emotional arousal, and the investigator has two samples of behavior, one when the persons were known to be low in arousal and another when the persons were known to be high in arousal. Direct measurement might entail counting various aspects of body movement (hand, leg, posture, etc.) to determine whether the incidence differed in the low- and high-arousal samples. The other approach to the question would involve showing groups of observers both samples without identifying which was which, to see if the

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observers could infer the level of arousal from viewing the body movement.

Some questions can be addressed by only one of these methods. For example, if the issue is whether people are able to tell arousal level from body movement, observers' inferences must be gathered. If the question is whether hand-to-body movements more than hand-in-space movements vary with arousal, direct measurement of these these two methods, their relative advantages, disadvantages, and overlap has been discussed elsewhere (Ekman, 1973; Ekman & Friesen, 1968, 1974; Ekman, Friesen, & Ellsworth, 1972, Chap. 6). Two aspects of nonverbal behavior have been the principal foci of direct measurement—facial expression and hand movement. Alternative methods for measuring facial expression have been reviewed recently (Ekman & Friesen, 1976). Here we report on a number of methodological issues regarding the direct measurement of hand movements.

In the late 1960s a number of different but related classifications of hand movements were reported (Ekman & Friesen, 1958, 1969; Freedman & Hoffman, 1967; Mahl, 1968; Rosenfeld, 1966). Although using different terminology, and based on different theoretical rationales, all investigators distinguished hand-to-hand and hand-to-body movement from hand movements that appeared to be more speech related, typically involving the hands moving in space. Our own scheme and that of Wiener, Devoe, Rubinow, and Geller (1972) also distinguished a third class of hand movements, what we termed emblems or symbolic gestures, in which the hand movement has a very specific semantic referent known by all members of a social group.

This report considers the reliability of our hand measurement procedure, the intercorrelations among our different measures of hand activity and among different scores for each measure, and a new technique for more rapidly measuring hand movements. While we focus only on our own threefold classification of hand movements, (emblems, illustrators, and manipulators), the methodological issues discussed have relevance to the other schemes for distinguishing among hand movements since there is so much overlap among the hand movement classifications.

THE HAND MOVEMENT CODE

The following definitions of each class of hand activity are excerpted from the coder's manual (Friesen & Ekman, Note 1).

> The purpose of this code is to locate each and every time either or both hands engage in an act. . . . A hand act is defined as movements in the hand which can be coded as either an illustrator, manipulator, or emblem. As will become clear, these three classes include all hand movement except for those times when the hand moves simply to establish a new position of rest. . . .
>
> Any time the hand is in motion, that motion is a hand act. You must locate the frame when the hand first begins to move and the point at which the hand first touches or assumes a new rest location in order to establish the unit of behavior you are going to code. You must then grossly classify whether the act is an emblem, an illustrator, or a manipulator . . . You are to code what is happening with the left and right hand separately. However, there are acts which involve both hands acting in unison, and therefore, these acts are to be coded as bilateral acts. . . .

Inspection of the material to which the hand code was applied showed that the only emblem (symbolic act) that occurred with sufficient frequency to code was a shrug. Therefore the shrug emblem was the only one defined by the manual:

> The shrug has a very specific configurational definition. Prototypically, it is performed with both hands: there is a smooth motion upward and outward laterally with a twisting of the palm of the hand from faced down at the beginning of the act to faced upward at the apex (point of maximum excursion) of the act. With minimal pause at the apex, the hands are returned to the rest position by simply reversing the direction and twist of the hands.

Variations in this action were also described in the coder's manual.

> *Illustrators* are hand movements which follow the rhythm or content of speech. However, you will not be listening to what is being said, and will not be able to see the face of the person you are coding. There will be no way for you to know if the person is speaking. You must therefore recognize an illustrator by where and how it occurs. Almost all illustrators are movements of the hand (occasionally only fingers) out into space. However, illustrators must be distinguished from shrugs, changes of rest position, or manipulators in which the hand moves through space to get to the site of the manipulation. If all these can be ruled out, it is safe to conclude that the movement of the hand in space was an illustrator.

The coder's manual also explained how to distinguish those illustrators which involve touching the body from manipulators.

> *Manipulators* are of two kinds: self manipulators and object manipulators. Self manipulators are movements which occur against or on the body. The hand may move to the face to rub or squeeze the cheek. One finger may scratch the palm of the same hand to which it belongs. Wherever they occur on the body, the hand may engage in various actions, such as scratches, picks, squeezes, or wringing.

While a number of these manipulator actions were defined in the coder's manual, low frequency of occurrence dictated dropping distinctions among type of manipulator action from the analyses.

> Object manipulators are similar actions, but involve rubbing, playing, manipulating a nonanimate object, such as part of a chair, a microphone cord, piece of clothing, a pen or pencil, etc. Once you have determined that the movement of the hand is a manipulator, and you have located the beginning and end of the action, you must determine what part of the body is being manipulated, or that it is an object which is being manipulated. . . . You are to distinguish only three basic areas of the body where the manipulator may occur: the face, the hands, and the legs.

The coder's manual included seven locations within the facial area, but the frequency of occurrence for these separate locations was so low that the distinctions have been dropped in all of the results reported below. "If the manipulator is located on any other body part than those three, the location is coded as 'other.'"

Preliminary analyses of the results of coding 32 interviews revealed that the correlation across interviews between frequency and duration scores was above .90 for shrugs and for illustrators but not for manipulators. Inspection of the distribution of frequency and duration scores for the manipulator actions revealed that there were many brief manipulators (under 2 seconds) and many much longer. The latter would contribute to a high score on the duration score but add little to frequency counts, thereby eroding the correlation between frequency and duration scores. Independently, Freedman, Blass, Rifkin, and Quitkin (1973) made a distinction between short and long manipulators in their analysis of hand-to-hand manipulations. On both of these bases we decided to distinguish brief from long manipulators (using a 2-second cutoff) in our analyses.

Five subscores were available for illustrators, shrug emblems, and manipulators: right, left, unilateral (right plus left), bilateral, and total. For manipulators there were additional subscores for location (face, hands, legs, objects, other) and for brief or long.

RELIABILITY OF HAND CODING

Materials Coded

The code was applied to video records gathered in an experimental situation. Student nurses were subjects in two standardized interviews. In the *honest interview* the subjects watched a short nature film designed to elicit pleasant feelings, and the subjects were instructed to describe their feelings frankly. In the *deception interview* subjects saw a film intended to elicit negative affect and were instructed to conceal negative feelings and convince the interviewer they had seen another pleasant film. The interviews were 2 to 4 minutes in length. Results on both direct measurement and observers' judgments of these video records have been reported elsewhere (Ekman & Friesen, 1974; Ekman, Friesen & Scherer, 1976; Ekman Friesen, O'Sullivan, & Scherer, in press; Ekman, Bratessani, O'Sullivan, & Friesen, 1979). Fourteen interviews, seven honest and seven deception, were coded by four independent persons. Their coding provides the data for all the analyses of reliability.

Agreement About the Major Classes of Activity

The first set of analyses sought to determine whether coders agreed as to whether there was any hand movement at all; if so, whether it was a shrug, illustrator, or manipulator. Two different methods that provide related but different information about reliability were used. The first method assessed agreement about the classes of activity occurring at a moment in time by sampling once each second (1 out of every 60 video frames) throughout the interview. Agreements or disagreements were tallied in a 5 × 5 matrix (illustrator, shrug, manipulator, rest position, no action) across the 14 interviews. This tally was done separately for the two hands and summed in one matrix. One such matrix was generated for each possible pairing of the four coders.

Table 1 shows one of the six matrices generated for the pairing of the four coders. Agreement between the two coders is shown in the

Table 1

Matrix of Agreement on Coding of Major Classifications of Hand Movements

Coder B	Coder A				
	Shrug	Illustrator	Manipulator	Rest Position	No Action
Shrug	16	5	0	0	2
Illustrator	5	380	14	2	17
Manipulator	6	46	964	133	421
Rest Position	0	10	7	48	7
No Action	1	58	249	74	2727

diagonal cells. In this matrix, and in each of the other five matrices, the most common disagreement was over the occurrence of a manipulator vs. no action. Inspection of the data showed that such disagreement pertained primarily to brief manipulators that were hand-to-hand or hand-to-leg. When the manipulator was of long duration or when it involved a hand-to-face action, agreement was quite high.

A percent agreement figure was derived by dividing the number of entries in the diagonal cells by the total number of entries in the matrix. For Table 1 the two coders agreed on 80% of the sampling points compared. The percent agreement for the other five pairings of coders ranged from 80% to 88%. The mean across all six pairings was 83% agreement. Table 1 shows that the majority of the agreements occurred when both coders identified no action. While it is important that such a decision be reliable, to include such agreements in an overall index of reliability could conceal instances in which both coders see an action but disagree about what class of action it is. Percent agreement figures were recalculated dropping the no-action columns and rows from the matrices. These figures were quite high (mean 94% agreement, range from 86% to 96%) showing that coders did agree about the type of action when they both observed a hand movement.

Kappa correlation coefficients (Cohen, 1968) were calculated utilizing the data in the matrices. The coefficients were all significant beyond the .001 level of confidence, when the no-action columns and rows were included and also when no action was excluded. The mean kappa coefficient across the six matrices was .70 when no action was included and .82 when no action was excluded.

The *second* method of evaluating the reliability of the major

classification of hand movements utilized rank-order correlations. These rhos were calculated across the 14 interviews, utilizing the scores provided by each pairing of coders on the frequency and on the duration of a class of hand activity in each interview. With four coders, there were again six coder pairings, providing data for six rhos for each code category: illustrators, shrugs, and manipulators. The rhos calculated utilizing frequency scores were generally the same as those calculated using duration scores and only the frequency score rhos are reported.

The average rho between pairs of coders for shrugs was .85, with a range from .76 to .93. For illustrators the average rho between pairs of coders was .98, with the range from .97 to .99. For manipulators the average rho between pairs of coders was .88, with the range from .82 to .96.

To summarize, two methods of evaluating reliability were employed: (1) comparisons between two coders once every second throughout their scoring of the 14 interviews, from which percent agreement and kappa coefficients were derived; (2) summations of the frequency and duration of each type of action for each interview made by each coder, from which rhos were performed for each pair of coders across the 14 interviews for each type of action. High reliability was found by both methods for the major classificatory decision about whether an action was an illustrator, shrug, or manipulator.

Agreement About the Minor Classifications of Hand Activity

All actions were coded for each hand separately and also when the two hands acted in common. Therefore, it was possible to look at agreement about illustrators, shrugs, and manipulators for the right hand, left hand, their combination in a unilateral category, and for bilateral activity where both hands acted in unison performing the same type of action. Rhos were calculated across the 14 interviews utilizing the scores provided by each pair of coders for each minor classification. With four coders there were again six pairings providing data for rhos using frequency scores and six pairings for rhos using duration scores for each subclassification.

Table 2 shows the mean across the six rhos based on frequency scores alone, since the rhos using duration score were comparable. Reliability on each of these minor classifications of hand activity was high with the exception of bilateral shrugs, where the mean rho was .68. Inspection of the correlations for each of the six pairings of

Table 2

Mean Rhos on Minor Classifications of Hand Actions Using Frequency Scores

	Right	Left	Unilateral (right + left)	Bilateral	Total
Shrugs	.84	.83	.84	.68	.85
Illustrators	.93	.89	.91	.98	.99
All Manipulators	.83	.81	.86	.74	.88

the four coders revealed that one coder was often deviant. Five of the 90 rhos that were the basis for the mean rhos reported in Table 2 were below .70; four of these five low correlations involved this one particular coder. When the mean correlation for bilateral shrugs was calculated across the pairings of the other three persons, it was .79. It seems reasonable then to conclude that adequate reliability has been demonstrated for the minor classifications of shrugs, illustrators, and manipulators in terms of handedness. (The rest of the data analyses excluded the deviant coder and used the coding of three persons.)

There were no further minor classifications for the shrugs or illustrators, but for manipulators there were further classifications in terms of locations (face, hands, legs, objects, other) and duration (long vs. brief). The mean rhos across all pairings of three coders were .91 for hands, .97 for face, .74 for legs, .80 for other, .84 for brief and .88 for long manipulators. There were insufficient data (occur-

Table 3

Mean Rhos of Two-Way Minor Classifications of Manipulators

Duration x Location			Duration x Handedness			Location x Handedness		
Brief	Hands	.86	Brief	Right	.76	Hands	Right	.78
	Face	.88		Left	.86		Left	.85
	Legs	.81		Unilateral	.86		Unilateral	.86
	Other	Insufficient Data		Bilateral	.52		Bilateral	.92
Long	Hands	.90	Long	Right	.91	Face	Right	.93
	Face	.89		Left	.88		Left	.95
	Legs	.82		Unilateral	.89			
	Others	.88		Bilateral	.67			

rences in less than half the interviews) to estimate reliability for object manipulators.

Table 3 presents the mean rhos for the two-way subclassifications: duration (brief/long) by location; brief/long by handedness; location by handedness. There were insufficient data to estimate reliability for any handedness classifications for the *leg* and *other* locations, for some of the handedness classifications for the *face*, and for the *brief-other* category.

Most of the correlations indicated high reliability. The only low rho was .52 for brief bilateral manipulators. Such actions represented less than 10% of the manipulators coded by any coder.

Three-way classifications of manipulators (locations × handedness × brief vs. long) would provide 40 more hand measures. There were insufficient data to estimate reliability when all three subclassifications were considered except for hand-to-hand actions. All rhos reached acceptable levels of reliability (between .72 and .86).

To summarize, acceptable levels of reliability were obtained for all but one of the minor classifications of hand movements when a type of activity occurred often enough to estimate reliability. The exception was that reliability was consistently low for brief bilateral manipulators. These actions were fairly rare, constituting less than 10% of all manipulators coded. In general, adequate reliability has been demonstrated for both minor and major classifications of hand movements.

REDUNDANCY AMONG MEASURES

The distinctions among hand movements were presumed (Ekman & Friesen, 1969) to measure psychologically different phenomena. Yet some of these measures might be so redundant that they could be discarded. Intercorrelations among measures were calculated to search for such instances of high redundancy.

The coding of 62 interviews was utilized. Each had been scored by more than one coder to study reliability, (the coding of 14 of these interviews was the subject of the reliability analyses reported earlier). For the intercorrelational data analyses the scores produced by one of the coders was selected in a randomized fashion for each interview.

Rather than calculating correlations among measures across all 62 interviews, correlations were calculated separately for each of four subsets: (1) honest and (2) deception interviews recorded with 16 student nurses in 1970 and (3) honest and (4) deception interviews

recorded with 15 student nurses in 1974. By this means it was possible to determine whether a correlation between two measures was consistent across two samples of persons (the 1970 and the 1974 subjects) or across two types of interviews (honest and deception).

Rank-order correlations were calculated among almost all of the measures. Not examined were relationships among measures which by their definition could not be independent. For example, right and left actions were combined for the unilateral score; therefore, the correlation between right and unilateral or between left and unilateral was not examined. The rhos were calculated separately utilizing the frequency scores and the duration scores.

Since the purpose was to determine whether there was sufficient redundancy among any pair of measures to suggest eliminating one of them, a stringent criterion for redundancy was set. A correlation significant at the .01% level ($N = 15$, rho $\geq .64$ and $N = 16$, rho $\geq .06$) had to be observed in the coding of at least two of the four interview samples. Although hundreds of correlations were calculated no such instance was found. Most of the rhos did not even reach the 5% significance level, and those that did were not replicated across the different samples.

Thus, the analyses did not provide the basis for eliminating any of the hand measures because of consistently high intercorrelations among measures.

REDUNDANCY BETWEEN SCORES

The procedure used in this study for coding hand movements generated two scores for each measure: frequency and duration. The correlations between frequency and duration scores were examined to determine if they were sufficiently redundant to justify eliminating one of them. Again, rather than calculating these rhos across the coding of all 62 interviews, the rhos between frequency and duration scores were calculated separately for each of the four interview samples. By this means it again was possible not only to examine the magnitude of the correlation, but also whether it replicated across two samples of persons and two different types of interview.

The frequency and duration scores were so highly intercorrelated for shrug measures (from .94 to .99) and for illustrator measures (from .95 to .99) that the two scores can be considered interchangeable. As was expected this was not so for the measure of all ma-

nipulators, which disregarded whether the action was brief or long. The mean rho between frequency and duration scores across the scoring of all four interviews was .68, the range was from .56 to .96.

Earlier in this report when the distinction between brief and long manipulators was introduced, preliminary findings of a low correlation between frequency and duration scores were mentioned as one justification for the distinction. Another rationale for the distinction was that brief manipulators look quite different from long ones. In a brief action the manipulator seems to accomplish something—picking, scratching, hair rearranging, etc. Long manipulators seem to have no such distinct purpose. It is hard to characterize or describe these actions. Most often the long manipulator involves a small, continuous movement, e.g., one hand touching the other or playing with a pencil. The preliminary analysis found that many manipulators occured in less than 2 seconds; many took considerably more than 2 seconds. It is these latter long actions that would degrade the correlation between frequency and duration scores, since they could contribute very little to a frequency score while heavily loading a duration score.

Segregating brief and long actions enhanced the rhos between frequency and duration scores: for brief manipulators the mean rho was .87; for long manipulators the mean rho was .86. The correlations between frequency and duration scores for each of the other manipulator measures were above .90 except for three categories: long unilateral manipulators, .89; long right-handed manipulators, .87; long hand-to-hand manipulators, .89. Segregating brief from long manipulators did not enhance the rhos between frequency and duration scores for the face manipulators, the leg manipulators, or the "other" manipulators. The benefit was only for the hand-to-hand manipulators, where there were many long actions.

These analyses have shown that frequency and duration scores are highly redundant. In many types of investigation either score could be eliminated. Eliminating duration scores would save an enormous amount of time in the coding of hand behavior. Most time is spent in determining exactly when a movement begins and ends. Counting the frequency of occurrence of the class of movements could be done much more quickly.

Before considering an economical coding procedure of this sort, let us describe the kind of investigation that may still require the time-consuming operations involved in obtaining precise beginning and end points, even if duration scores are not needed. If the research is focused on the moment-to-moment interrelationship between a

type of hand movement and some other activity, then precise location of each such hand movement will be required. For example, if the study was to determine whether there is a change in pitch level when a person illustrates, the precise beginning and ending point of each illustrator would need to be determined. A related question, i.e., whether people who show a decrease in illustrators from one time period to another will also increase their pitch level, can be studied without precise location of beginning or ending points. All that is needed is a single score to represent the amount of illustrating for each sample. (Such a study was reported in Ekman, Friesen & Scherer, 1976.) Yet, if it is proposed that long illustrators will be accompanied by an increased pitch level while short illustrators occur with decreased pitch, then each illustrator must be classified as short or long and this might require precise location of begin and end points.

ECONOMICAL CODING FOR FREQUENCY SCORES

A study was conducted utilizing a much more economical coding procedure that furnished only frequency scores. The purpose was to determine whether such a procedure was reliable and whether it would yield the same findings as those provided by standard scoring. Two persons experienced with the standard hand coding, coded 13 interviews (7 honest, 6 deception) using the more economical frequency-only coding procedure. They were instructed simply to tally each occurrence of each of a prescribed list of hand actions (see Table 4). The coder was allowed to stop the videotape machine in order to pause long enough to make tally marks, but slow motion or repeated viewing (essential for coding duration) was discouraged. However, a coder was allowed to view each interview twice, if necessary.

While this procedure could be utilized for all of the hand measure classifications, in this initial study only an abbreviated list was used. However, it did include the classification of duration (brief/long) for two manipulator categories. Coding an interview took about one-fifteenth of the time typically spent using the standard method. If all of the hand measure categories had been included on the frequency-only checklist, the time spent would have increased but would probably still be less than one-fifth of the time required for standard coding.

Intercoder Reliability

Rhos between the two independent coders were calculated for each of the measures included in their list, across their coding of 13 interviews. Table 4 shows that reliability was high, similar to what was reported earlier for the standard coding method. Intercoder reliability for the economical method was lowest for the brief manipulators, as was so for the standard method.

Validity—Correlation with Standard Coding

Rhos between economical and standard coding of 30 interviews provided one type of validity data. Would scores obtained by the economical method be highly correlated with scores obtained by the more costly standard method of coding hand behavior? Rhos were calculated separately for the coding of the honest and the deception interviews. Table 5 shows that the economical method yielded similar rankings to the standard method for most of the hand measures. The correlations for shrugs, illustrators, manipulators, and face manipulators were quite high. The rhos for the remaining manipulator subclassifications were significant, but many were only moderate. The one nonsignificant correlation in the table is not interpretable since the range of scores was quite restricted.

Table 4

Rhos between two coders measurement of 13 interviews using the economical, frequency only coding procedure.

Shrugs	.83
Illustrators	.94
All Manipulators	.98
Face Manipulators	.88
Hand-to-Hand	.94
Brief	.74
Long	.94
Non-Face and Non-Hand Manipulators	.92
Brief	.86
Long	.88

Table 5

Rhos between standard coding and new, economical, frequency only coding procedure on 30 interviews.

	Fifteen Honest Interviews	Fifteen Deception Interviews
Shrugs	.91	.84
Illustrators	.90	.75
Manipulators	.85	.77
Face Manipulators	.82	.97
Hand-to-Hand Manipulators	.69	.75
Brief	.67	.63
Long	.67	.71
Non-Face and Non-Hand Manipulators	.79	.85
Brief	.66	.35*
Long	.78	.85

*Not Significant

Validity—Correlation with Other Data

Another way to compare the economical method of hand coding with the standard method was to see if the two would generate comparable substantive findings. The substantive area examined was the correlation between hand-activity measures and observers' global judgments about affect and personality. The question asked was whether the economical method would duplicate correlations between hand activity and observers' judgments that were found by using the standard hand-coding method.

In other research (Ekman, Friesen, & Scherer, 1976; Ekman, Friesen, O'Sullivan, & Scherer, in press) 30 interviews were shown to observers who judged the person shown in each interview on 14 bipolar 7-point scales (e.g., expressive-unexpressive, dominant-submissive, calm-agitated, etc.). Separate groups of observers were shown the full audiovideo recording of each interview or just the body, without hearing the sound or seeing the face.

Since 14 scales were rated by two groups of observers (audiovideo or body only) who judged two types of interviews (honest and deception) a total of 56 rhos could be calculated between observers' judgments and each hand measure. Ten hand measures were

coded in both the economical and standard methods (listed in Table 4), so that 560 rhos were calculated using each of the two methods. We set as a criterion that a correlation between standard hand coding and judgments had to reach at least the 1% level (rho $\geq .64$, $N=15$) before checking to see if the relationship was duplicated with the economical method.

For three of the hand measures—shrugs, manipulators, and face manipulators—there were no such correlations with observers' judgments. Among the other seven measures there were 36 correlations with observers' judgments that were at or beyond the 1% level. Of these correlations, 34 also reached significance when the economical method scores were used. Six were at the 1% level; the other 28 met the 5% level.

Thus, when a strong correlation between hand scores and observers' judgments was found with the standard method, a strong or moderate correlation also was found using the economical method. However, the coefficient was consistently larger when the standard method scores were correlated with observers' judgments.

While the economical method appears promising, more research is needed to establish that intercoder reliability will remain high when more measurement categories are added to the list and to determine if the correlation with standard scoring can be improved for some of the manipulator subclassifications. More data showing whether comparable substantive findings can be obtained with the two methods are also needed.

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