Pantomime comprehension and ideomotor apraxia

LESLIE J GONZALEZ ROTH, KENNETH M HEILMAN, ROBERT T WATSON

From the Department of Neurology, College of Medicine, University of Florida, and Veterans Administration Medical Center, Gainesville, Florida, USA

SUMMARY In a prior study it was shown that apraxic patients with posterior infarctions that included the parietal lobe could not discriminate between gestures. In this study these observations were replicated using a nonverbal paradigm in which the subjects did not have to discriminate between gestures, but instead had to comprehend their meaning. Pantomimed acts on videotape were shown to six apraxic-aphasic patients, seven nonapraxic-aphasic patients, and six normal subjects. Four drawings were also shown, one of which matched the pantomime (for example, if the pantomime was of hammering, one drawing was of a nail and three were foils). Subjects responded by pushing a button corresponding to the desired picture. The apraxics made more errors than the aphasics or controls.

Apraxia, a disorder of skilled movement, is best described by a process of exclusion. It is not caused by weakness, sensory loss, abnormality of tone or posture, extrapyramidal disease, ataxia, intellectual deterioration, or poor comprehension.¹ Patients with ideomotor apraxia cannot perform skilled limb movements on command, but improve with imitation and further improve with actual object use.

Liepmann² proposed that the junction area between dominant parietal and occipital lobes contains visuokinesthetic motor engrams that programme the motor areas to produce skilled motor acts. Specifically, these visuokinesthetic motor engrams guide the sequencing and timing of motor movements and direct the movement of body parts within space. When these engrams are destroyed or disconnected from motor areas, ideomotor apraxia results.

Apraxia resulting from destruction of the area of visuokinesthetic motor engrams is distinguishable

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Address for reprint requests: Leslie J Gonzalez Roth, Ph.D., Box J236, Department of Neurology, J. Hillis Miller Health Center, University of Florida, Gainesville, FL 32610, USA.

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from apraxia induced by disconnection of this area from the motor association cortex.³ Although patients with either lesion have difficulty performing gestures, they can be differentiated on the basis of gesture discrimination. Specifically, it was found that ideomotor apraxic patients with posterior lesions had a gestural discrimination deficit, whereas anterior apraxics did not. The patients were asked to distinguish well performed from poorly performed gestures. For example, the poorly performed gesture for flipping a coin was an upward extension of the thumb followed by the fist traversing upward (a sequencing error). In contrast to those with posterior lesions (destructive), the apraxic patients with anterior lesions (disconnective) could appropriately distinguish well performed from poorly performed gestures.

Because ideomotor apraxic patients with lesions that are thought to destroy the visuokinesthetic motor engrams have difficulty identifying the unique gestural features necessary to distinguish one hand movement from another, they could also have difficulty comprehending the meaning of gestures. In a previous study³ patients were also presented trials in which semantic foils were presented and required comprehension for accurate performance. For example, one requested gesture was hammering; the semantic foils were the use of a key and of a saw. On this task, the performance of apraxic patients with posterior lesions was also poorer than that of other patient groups. A gesture comprehension deficit, however, may not be the sole explanation for these findings. First, because our task

involved a verbal stimulus, its processing could have been impaired by aphasia. Second, because apraxic patients had difficulty distinguishing gestural features, a task in which they chose from among several gestural alternatives may have proved exceptionally difficult. Last, the apraxics may have suffered from retroactive or proactive interference—that is, the foil gestures may have interfered with recognition of the correct gesture. Therefore, in the present study, we were interested in whether apraxic patients with posterior lesions could attach meaning to gestures when the stimuli were not presented verbally and the response did not involve distinguishing among several gestural alternatives. In addition we tested a patient (described in greater detail elsewhere)⁴ who displayed apraxia from a partial callosal disconnection syndrome resulting from an ischemic event. Based upon our previous gesture discrimination study,³ we predicted that unlike apraxics with posterior lesions, she would normally comprehend gesturally presented information.

Methods

Subjects

Three groups—apraxic-aphasic (six subjects), nonapraxic-aphasic (seven subjects), and normal controls (six subjects)—were studied. All subjects were right-handed, and the nonapraxic-aphasic and apraxic-aphasic groups did not differ in overall severity of aphasia or in comprehension specifically as measured by the Western Aphasia Battery.⁵ See the table for individual biographical data.

The 13 brain-damaged subjects were divided into two groups based on their performance on the Florida Apraxia Screening Test (FAST),⁶ a test of gestural production ability. Subjects who scored 9 or below on the FAST were

classified as apraxic, and those who scored 10–15 were considered nonapraxic. In all cases the performance on the FAST was consistent with the clinical evaluation of the patient. All subjects in the apraxic-aphasic group and six in the nonapraxic-aphasic group had unilateral infarctions of the left hemisphere. One patient in the nonapraxic-aphasic group had a focal disturbance caused by multiple sclerosis. Data were confirmed in 12 of 13 cases by electroencephalogram, brain scan, computed tomogram (CT), or biopsy (the patient with multiple sclerosis).

The patient with a callosal lesion was a 43-year-old right-handed woman who had left-handed apraxia to command and imitation and with object usage, though she performed normally with the right hand. She also had apraxic agraphia of the left hand but could type well with that hand. In performing the gestures on the FAST, first with the right hand then with the left, she was accurate on 14 of 15 trials with the right hand and on three of 15 with the left. Gesture discrimination was tested in the same manner as that previously reported.³ Briefly, the patient was shown a super 8-mm film on which a performer produced 32 trials of three separate pantomimed acts. She was asked to choose which of the three acts of each trial best represented the gesture requested. On 16 of the trials the foils were well produced gestures unrelated to the requested gesture (for example, foils for using a key were hammering and smoking). On the remaining 16 trials, foils were poorly performed movements similar to the requested gesture. The patient performed this task flawlessly. A CT scan (fig 1) showed infarction of the corpus callosum from the junction of the genu and body extending to the posterior one fourth to one fifth of the body. No cortical lesions were present. At the time of the present examination (10 months after onset), her neurological examination was normal except for severe ideomotor apraxia isolated to the left hand.

The normal controls were patients hospitalised at our institution who did not have central nervous system disorder.

Table Patient biographical data

Group*	Age (yr)	Years of education	Months after onset	Aphasia quotient†	Auditory comprehension‡	Apraxia score	Lesion location
A	64	9	1	83.4	7.5	3	Parietal
A	72	12	1	18.0	9.25	4	Frontoparietal
A	55	14	6	13.7	6.35	5	Frontoparietal
A	65	9	2	77.4	8.90	4	Parietal
A	58	10	1	86.4	9.10	2	Parietal
A	62	16	10	22.2	7.90	5	Frontoparietal
B	43	8	1	14.9	7.45	11	Frontoparietal
B	48	18	51	92.2	10.0	12	Frontal
B	52	9	1	20.5	9.40	13	Frontal
B	30	16	1	56.8	8.20	11	Frontal
B	49	16	15	63.5	6.35	13	Parietal
B	49	12	14	19.8	9.90	14	Frontoparietal
B	65	14	1	83.8	9.75	15	Frontoparietal
C	60	12	—	—	—	—	—
C	55	8	—	—	—	—	—
C	55	10	—	—	—	—	—
C	63	14	—	—	—	—	—
C	50	13.5	—	—	—	—	—
C	71	16	—	—	—	—	—

* Group: A = aphasic-apraxic, B = aphasic-nonapraxic, C = normal.

† Aphasia quotient: as measured by the Western Aphasia Battery.

‡ Auditory comprehension: as measured by the Western Aphasia Battery.

Fig 1 Computed tomogram of patient with callosal apraxia.

Procedure

All subjects were individually tested by the same examiner in a quiet room without interruption. The subjects sat in front of a video monitor and watched an actress perform a pantomime. A response page containing four pictures lay before the subject (fig 2), who was asked to indicate which of the four pictures "went with the gesture". There were 30 trials on this task.

Fig 2 Response page of the gesture comprehension test.

Four buttons, one directly in front of each of the four pictures, were connected to a timer. A spike wave electrical impulse on the audio portion of the videotape activated a digital timer at the onset of the stimulus presentation. The subjects received only the video portion of the tape because the audio was turned off, thus they did not hear the impulse. They indicated their response by pressing the corresponding button and stopping the clock. They were allowed to use the preferred hand but were required to use the same hand consistently. The examiner recorded the time and the picture choice on a score sheet. No baseline reaction times using this apparatus were obtained. No instructions were given by the examiner regarding a preference for speed versus accuracy of the responses.

Results

For group comparisons two measures were used—reaction time and error scores—each of which will be discussed separately. Reaction times for the callosal apraxic patient were not obtained, and her performance was excluded from the group analyses.

Figure 3 summarises each group's error scores on this task. A nonparametric analysis of variance procedure (Kruskal-Wallis) of the error scores showed significant group differences in the number of errors made in identifying the content of the pantomimes ($p < 0.02$). Specifically, Mann Whitney U tests confirmed that in identifying the meaning of pantomimes the apraxic-aphasics made more errors than the normals ($p < 0.0094$). Apraxic-aphasics produced more errors than nonapraxic-aphasics ($p < 0.03$), who produced more errors than normals ($p < 0.005$). The patient with callosal apraxia performed the pantomime comprehension test with 100% accuracy.

Fig 3 The mean number of errors while identifying the meaning of gestures.

Infrequently, the apraxic-aphasic and the nonapraxic-aphasic patients failed to respond to some stimuli because they could not determine an answer satisfactory to them. To avoid skewing the reaction time data, we simply excluded from analysis any instance when the subject failed to respond. In the apraxic-aphasic group, three subjects used the right hand to respond, whereas three used the left hand because of right hemiplegia. In the nonapraxic-aphasic group, three patients used the right hand and four used the left, also because of right hemiplegia. All normal controls used the right hand. Although no baseline reaction time data were obtained, nonparametric analysis of the reaction times of patient responses confirmed the error score

Fig 4 The reaction time to identify the meaning of gestures.

findings (fig 3). That is, a Kruskal-Wallis analysis of variance of the reaction times showed a significant difference among the groups ($p < 0.0084$). Mann Whitney U tests showed that reaction times of apraxic-aphasics were slower than those of nonapraxic-aphasics ($p < 0.01$) and of normals ($p < 0.007$), who did not differ from each other. Therefore, both the error and reaction time analyses were consistent with the conclusion that apraxic-aphasic patients had more than normal difficulty comprehending pantomimes.

Discussion

This study was designed to examine whether right-handed apraxic patients with posterior lesions of the dominant hemisphere could comprehend the meaning of pantomimes. The task involved matching one of four pictures with a video-presented pantomime. Unlike our prior study,³ this task was nonverbal. Also unlike our prior study, which required the subject to discriminate among three pantomimes, this study required subjects to match the pantomime to the appropriate item in a picture. Apraxic patients produced more errors in selecting an appropriately

matched picture. The apraxic-aphasic patients were also slower than nonapraxic-aphasic or normal groups in making that selection, but because no baseline reaction times were obtained and because the groups differed in the hand used to respond, this information serves only to confirm the error score results.

Although our task was nonverbal, both nonapraxic-aphasic and apraxic-aphasic groups produced more errors than normals. Therefore, this pantomime comprehension deficit still may result from a linguistic deficit (aphasia or asymbolia). The ability to provide a link between gesture and picture may be linguistic in nature, and aphasia may interrupt formation of that association. However, the responses of the nonapraxic-aphasics were as quick as those of the normals and the nonapraxic-aphasics produced fewer errors than the apraxic-aphasics. Because the severity of aphasia was equivalent in the nonapraxic-aphasic and in the apraxic-aphasic groups, it is unlikely that a language deficit accounts for these differences in pantomime comprehension. The observation that our callosally disconnected apraxic patient could completely comprehend pantomimes gives support to the hypothesis that disconnection apraxia, where visuokinesthetic engrams are separated from the motor areas, differs behaviourally from the ideomotor apraxia where the engrams are destroyed. Although both lesions induce a performance deficit, in the latter instance comprehension is defective, whereas in the former instance pantomime comprehension is preserved.

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