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INFERENCE OF OBJECT USE FROM PANTOMIMED ACTIONS BY APHASICS AND PATIENTS WITH RIGHT HEMISPHERE LESIONS

ABSTRACT. Twenty-four aphasic and fifteen right brain-damaged subjects were compared on their ability to identify the objects whose use was depicted in a series of twenty videotaped pantomimes. Aphasics were inferior to right brain-damaged patients in inferring object use. Success was correlated with Performance IQ, but not with language measures. Analysis of movement features contributing to subjects' choices reveal speed of movement and object weight to be the most robust and hand shape and size to be the most fragile.

1. INTRODUCTION

The ability of aphasic patients to comprehend pantomime and gesture has received considerable attention in the recent literature. The issues addressed have concerned the effects of aphasia on symbolic skills in general and possible correlates of pantomime comprehension in specific components of the language functions of these patients. For example, Duffy et al. (1975) have reported small but significant impairments in pantomime recognition on the part of aphasic subjects, in comparison with normal and right brain damaged controls. The performance of the aphasics was correlated with their scores on auditory word-discrimination and overall severity of their aphasia. The authors interpreted their results to mean that aphasia entailed degradation of symbolic capacity across all modalities, as suggested by Finkelburg (1870). Both the inability to understand symbolic gestures and the verbal semantic impairment may represent just different facets of a general disorder of the *symbolic function*. The finding of a specific impairment of aphasics on tests of comprehension of symbolic gestures was confirmed in the work Gainotti and Ibba (1972), Gainotti and Lemmo (1976), but these authors interpret the results as an example of the disintegration of the abstract set of relations existing between verbal sounds and meaning as initially suggested by Goodglass et al. (1970). They advanced the hypothesis that the linguistic disintegration in aphasia does not affect only verbal expression and comprehension, but also performance on nonverbal tasks, such as the comprehension of symbolic gestures. This would suggest that perhaps the encoding of the meaning of symbolic

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gestures may be a verbally mediated task. However, Varney (1978, 1982) and Seron (1979), found that comprehension of pantomimes correlated only with the reading comprehension of aphasics, but not with their oral language ability.

In the present study, while considering some of the issues examined by prior investigations, we have emphasized the contrastive analysis between the ability of the aphasic and the right hemisphere groups to recognize pantomimes intended as direct representation of actions with specific objects or implements (e.g., combing, sawing, playing the piano), and those in which the features of the object used had to be inferred from the speed, direction and position in space in such a non-specific actions as throwing, pushing, setting down, and from the configuration of the hands – all of which conveyed information as to the size, weight and manipulability of the objects. The first group are referred to as 'easy' items, and the second group as 'difficult' items. We also focused on a comparison between aphasics, in whom semantically based errors might be anticipated, and right brain damaged patients, for whom perceptual errors were considered more likely.

In a post-hoc qualitative analysis we used the pantomime recognition task in order to identify the contribution to recognition of some sensorial apparent features of the actions and inferred features of the objects whose use was pantomimed. Among the physical dimensions which characterized the movements were direction, speed, force, shape and spatial location of the movement. Recognition of object features required inferences concerning the size, shape, weight, and manipulability of the imaginary objects. In this analysis we were interested to learn whether recognition errors may be explained on the basis of a perceptual deficit which implies overlooking the clues given by the physical qualities of the movement.

Two types of actions were pantomimed. In the first class (9 items) were actions which did not have a unique functional relation with the object used. Examples are throwing, pulling, plucking, and setting something down. The identification of the object whose use was pantomimed is made on the basis of some features of the movement, such as its direction and speed, the position, shape and size of the opening of the hand or fingers, and the location of the action with respect to the body. The second category of actions (11 items) is similar to those used in the previous studies, in that the action pantomimed the primary function for which the implement was designed, such as in sawing, combing or playing tennis, and so forth. Here, the semantic relation between the action and the object used is implicit in the pantomime.

2. SUBJECTS

The experimental group consisted of 24 aphasic patients with cerebral lesions to the left hemisphere diagnosed by neurological examination and computer axial tomography, their ages ranging between 31 and 68 years with a mean of 57.3 years. The etiology was vascular in 23 cases and tumor or trauma in one case. They were all admitted to the Boston Veterans Administration Hospital for neurological evaluation, speech, occupational and physical therapy.

There were two control groups. One consisted of six normal subjects who had no known neurological or psychiatric disease, ages ranging from 45 to 71 years, with a mean of 63.0. The second group consisted of 15 right hemisphere stroke patients, mean age of 55.4, who were hospitalized at the New England Rehabilitation Hospital for the rehabilitation of physical, cognitive or speech functions, and at the moment of testing they were at least five weeks post stroke.

3. MATERIALS AND METHODS

Twenty-one of the aphasic patients had a neuropsychological assessment which included the Boston Diagnostic Aphasia Examination (BDAE). For the left hemisphere group the type of aphasia, the subjects' scores on the performance IQ, on the verbal commands and reading comprehension subtests of the BDAE were included as parameters in our study. Only performance IQ and anatomical locus of lesion are reported for the right hemisphere subjects (Table I).

3.1. *The Pantomime Test*

A videotape of 20 pantomimed actions was presented on a large black and white TV monitor. All the pantomimes were presented as silhouettes, to prevent giving any clues about those qualities of the movement which could be inferred from facial expressions, for example. The ability to recognize the pantomimed action was assessed by asking the subject to identify a drawing of the imaginary object whose use was depicted in the pantomime. The object drawings were presented in a multiple choice format with three distractors and a target, randomly assigned to one of the two quadrants on the video-monitor. Among the distractors, some were totally unrelated to the target, some were conceptually related (e.g. broken cup for pantomime of snapping in two long thin objects, or the choice of a rifle for the pantomimed action of fencing) and some might be erroneously accepted on the ground that their use shared a perceptual feature with the pantomimed actions (Table II).

TABLE I
Description of subjects

No.	Lesion site	Aphasia type	Age	PIQ	Commands	Reading
Left Hemisphere Patients						
1	Subcortical fronto-temporal	Global	53	66	11	1
2	Parietal	Global	69	69	8	6
3	Frontal-temporal	Global	54	65	4	0
4	Frontal-temporal-parietal	Global	57	75	3	0
5	Basal ganglia	Global	48	79	6	0
6	Posterior	Undefined	61	77	15	7
7	Subcortical-anterior	Undefined	56	90	14	10
8	Anterior-subcortical	Undefined	62	94	15	3
9	Anterior-subcortical	Undefined	66	80	9	7
10	Subarachnoid hemorrhage frontal-temporal	Undefined	42	67	6	5
11	Frontal	Broca	52	77	12	6
12	Frontal-parietal	Broca	69	80	7	2
	including Broca's area	Broca				
13	Fronto-parietal		52	70	3	0
14	Parieto-temporal	Wernicke	50	81	13	5
15	Temporal	Wenicke	60	80	8	8
16	Temporal	Wernicke	55	70	12	0
17	Temporal	Wernicke	55	77	5	2
18	Parieto-temporal	Wernicke	63	93	15	10
19	Parietal-occipital	Anomic	31	73	7	5
20	Parietal-supramarginal gyrus	Anomic	53	77	13	6
21	Frontal	Anomic	71	77	15	8
22	Parietal-occipital-temporal (subcortical lesion)	Anomic	60	79	12	8
23	Posterior parietal	Anomic	71	71	8	0
24	Extensive subcortical	Anomic	65	93	15	7

In order to avoid errors due to visual field defects, the examiner pointed to each of the four choices asking whether it could be the correct answer.

TABLE I
(continued)

No.	Lesion site	Aphasia type	Age	PIQ	Commands	Reading
Right hemisphere patients						
	Anterior					
1	Fronto-parietal		57	72		
2	Fronto-parietal		47	81		
3	Fronto-parietal		58	117		
4	Fronto-parietal		47	68		
5	Fronto-parietal		53	84		
6	Fronto-parietal		57	95		
	Posterior					
7	Temporal		37	67		
8	Parietal-temporal		62	101		
9	Temporal		63	73		
10	Parietal		47	99		
11	Parieto-temporal		54	81		
12	Parietal-occipital		63	77		
13	Parietal		60	68		
	Other					
14	Sub-cortical		59	84		
15	Sub-cortical		67	70		

4. RESULTS

4.1. *Comparison Between Groups*

Table I shows that age and performance IQs for the two hemisphere damaged groups are closely matched.

The scores (percentages of correct responses and standard deviations) of right and left brain damaged subject groups on the Pantomime Recognition Test are summarized in Table III.

A multivariate analysis of variance with repeated measures was carried out on these data. For the Pantomime Recognition total score was a significant effect of diagnostic group ($F = 5.05$[df 1,70]; $p < 0.0001$). The scores obtained by the aphasic subjects were significantly inferior to those of the right brain damaged group ($F[1,70] = 17.7$, $p < 0.0001$).

For all subjects the main effect for 'Easy' vs. 'Hard' items is significant (F[df 1,70] $= 139.5$, $p < 0.0001$). The interaction between the side of the

TABLE II

Description of pantomime comprehension test (hard)

Target	Movement descriptions	Distractors	Features considered				
			Size	Weight	Speed	Direction	Position
Shovel	Shoveling: Pantomime of shoveling snow with repeated movement of scooping and tossing past shoulder.	Hand-brush	–	–	0	–	–
		Broom	+	+	+	–	–
		Grass-rake	+	+	+	–	–
Hand-saw	Sawing: Pantomime of sawing a broad; body leaning forward, left hand as though holding board down, right hand making repeated sawing movements.	Scissors	–	0	–	–	–
		Hammer	–	+	–	–	0
		Shovel	–	+	0	–	–
Scissors	Cutting with scissors: Pantomime of holding scissors and cutting by moving thumb up and down while moving hand slowly forward; left hand as though gripping object to be cut.	Knife	–	+	+	+	+
		Nail-clipper	–	+	+	+	+
		Eye-dropper	–	0	0	–	0
Upright piano	Playing piano: Pantomime of playing piano keyboard with both hands, with finger movements and hands moving horizontally across the keyboard.	Typewriter	–	0	+	–	–
		Accordian	–	0	+	–	–
		Desk	+	0	0	–	+
Spoon	Stirring: Pantomime of stirring with a spoon, held arbitrarily with small circular movement.	Pencil	+	+	0	–	–
		Fork	+	+	–	–	0
		Rotary egg-beater	–	0	+	–	+
Wall telephone	Dialing: Pantomime of dialing several numbers on a vertically oriented dial at face height.	Desk phone	+	+	+	–	–
		Pencil-sharpener	–	0	0	–	–
		Key in lock	–	0	0	–	–
Comb	Combing: Pantomime of holding a comb and combing hair.	Grass-rake	–	–	0	–	–
		Tooth brush	–	+	+	–	–
		Bobby-pin	–	0	–	–	+
Rotary egg-beater	Pantomime of using rotary egg-beater: Left hand cupped facing down, right hand operates handle with circular movement in vertical plane.	Meat grinder	–	0	–	+	+
		Screwdriver	–	0	–	–	+
		Bowl with egg	–	0	0	0	0
Tennis racquet	Swinging Racquet: Arm brought back, fully extended, followed by forward stroke and followthrough across front of body; wrist rigid.	Ping-pong-paddle	0	0	–	–	+
		Baseball bat	–	0	+	+	–
		Golf club	–	0	+	–	–
Rowboat	Rowing: Hands held as though gripping two oar handles, arms extended; large forward movement of hands and body, alternating with back-pull, hands describing arc and body pulling back.	Sailboat	–	0	0	0	0
		Map	–	0	0	–	–
		Skipole	–	0	0	–	–
Sword	Fencing thrust: Left hand on hip, right hand as though gripping sword handle horizontally; long forward horizontal thrust.	Rifle	–	+	0	–	–
		Knife	+	+	0	–	–
		Oar	–	0	+	–	0

TABLE II (continued)

Description of pantomime comprehension test (easy)

Target	Movement description	Distractors	Features considered				
			Size	Weight	Speed	Direction	Position
ailcart	Pushing: Two hands palm out, arms extended forward at chest height step forward.	Door	+	+	–	+	+
		Ball	–	–	–	+	–
		Streetcar	+	–	–	+	+
owl	Dropping: Two hands initially 10″ apart as though holding a bowl, suddenly moved further apart.	Scattered-cherries	–	+	0	+	+
		Book-face-down	–	+	+	+	+
		Wineglass	–	+	0	+	+
acks of ooks	Settling Down: Arms extended down, hands flexed towards each other about 8″ apart, body slowly arches forward, lowering the hands; movement ends with hands below hip level.	4-drawer-file-cabinet	–	–	0	+	–
		Bouquet-of-flowers	–	0	+	+	+
		Deck of cards	–	–	0	+	+
ey on ring	Throwing: One hand over-arm throw as in throwing a baseball; hand initially cupped, fingers extend at the end of throw.	Dart	–	+	+	–	+
		Large-rock	–	–	–	0	–
		Feather	–	–	0	0	0
ureau rawer	Pulling: Body leaning forward, both arms extended with hands closed in a grip, about 18″ apart at knee height; hands brought forwards towards body.	Jewelry box with drawers	–	0	0	+	–
		Chair	–	+	+	+	–
		Window blind halfway-up	–	0	0	–	–
pple	Plucking: Arm brought above head, with hand partly cupped, reaching up, quick downward movement of hand then slower movements down, palm remaining face-up.	Flower	–	0	+	–	–
		Potato	+	+	–	–	–
		Wineglass	+	+	0	–	–
Vineglass	Place delicately: One handed movement fingers as though grasping a thin vertical object; slow movement down, terminating at hip level; fingers then release grip.	Suitcase	–	–	0	+	–
		House-of-cards	–	+	+	+	+
		Bowl	–	0	0	+	+
encil	Breaking: Hands as though gripping a thin object, held parallel with fists down about 2″ apart, quick rotation of forearms bringing closed fists facing each other, still 2″ apart.	Apple	–	+	+	+	+
		Sliced-loaf-of-bread	–	0	0	0	0
		Broken-cup	–	0	0	–	–
rumpled iece of aper	Crumpling in hand: Hand held at chest height in front of body, fingers loosely cupped, oriented down, fingers engage in crumpling movement.	Ball	–	0	0	0	0
		Broken-wineglass	–	0	0	–	–
		Book	–	–	0	0	0

TABLE III

Mean percentage correct responses and standard deviations

Patient groups		All items	SD	Easy items	SD	Hard items	SD
Left Hemisphere Patients							
All aphasics	(n = 24)	58.88	11.78	68.94	16.94	42.13	14.65
Anomic	(n = 6)	58.33	11.69	71.21	19.43	42.59	10.92
Broca	(n = 3)	63.33	7.64	72.73	18.18	51.85	6.42
Global	(n = 5)	48.01	11.51	63.64	21.32	28.89	6.09
Undefined	(n = 5)	65.01	9.35	74.55	9.96	53.33	19.88
Wernicke	(n = 5)	52.01	11.51	63.64	18.18	37.78	12.67
Right Hemisphere Patients							
All rights	(n = 15)	70.01	14.88	87.88	19.34	48.15	18.14
Rt. anterior	(n = 6)	69.17	15.63	89.39	15.38	44.44	25.38
Rt. other	(n = 2)	75.01	0	95.45	6.43	50.01	7.86
Rt. posterior	(n = 7)	69.29	17.42	84.42	26.09	50.79	14.14

lesion and the easy hard dimension was significant ($F = 6.93$, $p < 0.01$). This interaction is due to the fact that right hemisphere subjects were much more successful than aphasics on the 11 'easy' Pantomime Recognition items (mean percents = 87.9 vs. 69.9), but only slightly superior on the 9 difficult items (Mean percent correct = 48.1 vs. 42.1).

Examination of group differences on the 'easy' items alone showed a significant main effect involving the 8 diagnostic groups (F[df 7,70] = 3.13, $p < 0.02$). Since post-hoc testing involved many paired comparisons between groups, Tukey's Multiple Range Test with alpha set at 0.05 was used to control for type 1 errors. This test showed that, of the 6 aphasic subgroups and 2 right hemisphere subgroups, only the comparisons between the most impaired and least impaired subgroups met the $p < 0.05$ criterion for significance. Specifically, global and Wernicke aphasics were significantly worse than anterior right brain damaged subjects on 'easy' items. On the other 'hard' items, global aphasics deferred significantly from the unclassified aphasics and from the posterior right brain damaged subjects.

TABLE IV

Distribution of error types by diagnosis: (results are expressed in % of error adjusted to correct for the total No. of errors)

Patient groups		Error types SS	WT	SP	DR	PS
Left Hemisphere Patients						
All aphasics	(n = 24)	33.85	12.06	10.11	17.86	18.95
Anomic	(n = 6)	34.47	10.19	8.74	18.28	17.18
Broca's	(n = 3)	34.45	10.71	9.17	17.62	19.25
Global	(n = 5)	32.57	13.48	7.19	16.69	18.53
Undefined	(n = 5)	31.53	11.54	12.66	19.56	18.19
Wernicke	(n = 5)	36.22	15.11	11.23	16.26	22.61
Right Hemisphere Patients						
All rights	(n = 15)	33.11	11.78	12.78	18.08	21.43
Anterior	(n = 6)	31.91	12.57	12.83	18.51	20.42
Subcortical	(n = 2)	33.23	9.51	15.97	20.41	19.34
Posterior	(n = 7)	33.91	11.13	12.31	17.56	22.52

4.2. *Error Analysis*

As a preliminary to an error analysis, each distractor item was characterized with respect to five perceptual dimensions in which it either matched or did not match the target i.e. the dimensions of size/shape (inferred from hand shapes and distance between hands), weight, speed of movement, direction of movement or position in space. The resulting matrix of matched or unmatched features allowed different numbers of opportunities for mismatch for the five features. Each subject's error score for a particular feature was therefore based on the ratio of the number of mismatches that he had made, to the number of opportunities for mismatch on that feature. This ratio is treated as percent errors for each perceptual dimension (Table IV).

Table V gives the percentage of error on each feature by right and left hemisphere groups, adjusted to correct for the differences in the total number of errors made by the two groups.

Interrelation between measures. Table VI displays the intercorrelation matrix among all of the variables.

TABLE V

Distribution of error types by diagnosis: (percentage of mismatches out of the no. possible responses)

Diagnosis		Error types									
		SS		WT		SP		DR		PS	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Left Hemisphere Patients											
Anomic	(n = 6)	37.72	8.44	11.13	9.25	9.98	6.17	20.84	5.86	19.43	11.71
Broca's	(n = 3)	33.33	5.77	10.33	3.93	8.68	4.85	16.62	9.91	18.37	4.47
Global	(n = 5)	44.11	7.42	17.14	9.92	12.82	13.25	26.61	10.65	27.25	6.85
Undefined	(n = 5)	29.11	5.47	10.73	7.55	11.59	5.47	17.37	8.13	16.26	10.68
Wernicke	(n = 5)	44.37	11.61	17.71	5.96	14.67	11.14	23.32	8.21	28.81	8.04
Right Hemisphere Patients											
Rt. anterior	(n = 6)	25.96	16.46	10.66	8.91	10.32	6.88	13.25	14.33	15.89	13.27
Rt. other	(n = 2)	22.51	3.54	6.07	0.26	11.44	0.46	11.11	7.86	11.15	0.88
Rt. posterior	(n = 7)	27.86	14.39	9.19	2.61	9.76	3.11	12.32	15.21	17.19	12.91

The notable features of the matrix are the significant correlations between the overall Pantomime Recognition scores and Performance IQ in both left and right brain damaged subjects and the absence of any correlation between either the language measures and the overall Pantomime Recognition Test in the aphasic groups. For the left hemisphere aphasic group, the relationship to PIQ appeared to be due primarily to the 'hard' items. In the right hemisphere group it was 'easy' items that showed a markedly greater correlation with IQ.

5. DISCUSSION

In this investigation we addressed the ability of subjects with left or right hemisphere brain damage to interpret pantomimed actions through the identification of an object whose use was depicted by the pantomime. The discussion will bear on two aspects of the problem: first, the relationship between aphasia and impairment of gestural recognition and second, the light thrown by these results on the perception and interpretation of human movement.

TABLE VI

Correlation analysis

	Total items	Hard	Easy	PIQ	Commands	Reading
Left Hemisphere Subjects						
Total items	*	0.614 (p = 0.001)	0.829 (p = 0.001)	0.623 (p = 0.001)	0.216 (p = 0.309)	0.162 (p = 0.448)
Hard	0.614 (p = 0.001)	*	0.069 (p = 0.747)	0.625 (p = 0.001)	0.328 (p = 0.117)	0.346 (p = 0.097)
Easy	0.829 (p = 0.001)	0.069 (p = 0.747)	*	0.345 (p = 0.098)	0.041 (p = 0.847)	−0.039 (p = 0.854)
PIQ	0.623 (p = 0.001)	0.625 (p = 0.001)	0.345 (p = 0.098)	*	0.6 (p = 0.001)	0.526 (p = 0.008)
Commands	0.216 (p = 0.309)	0.328 (p = 0.117)	0.041 (p = 0.847)	0.6 (p = 0.001)	*	0.638 (p = 0.008)
Reading	0.162 (p = 0.449)	0.346 (p = 0.097)	−0.039 (p = 0.854)	0.526 (p = 0.008)	0.638 (p = 0.008)	*
Right Hemisphere Subjects						
Total items	*	0.72 (p = 0.002)	0.846 (p = 0.001)	−0.461 (p = 0.083)		
Hard	0.72 (p = 0.002)	*	0.239 (p = 0.389)	−0.146 (p = 0.601)		
Easy	0.846 (p = 0.001)	0.239 (p = 0.389)	*	−0.532 (p = 0.041)		
PIQ	−0.0461 (p = 0.083)	−0.146 (p = 0.601)	−0.532 (p = 0.041)	*		

5.1. *Aphasia and the Interpretation of Pantomime and Gesture*

The central theme in prior research in this area has been whether pantomime interpretation, like language, places a demand on symbolic processes. It has been proposed that aphasia entails a broad impairment in all aspects of symbol use. Duffy and Duffy (1981) offered, in support of this position, a finding that pantomime interpretation correlated with the level of language impairment including impairment of auditory comprehension. Varney's (1977, 1982) and Seron's (1979) results, however, did not support this position, but these investigations reported a correlation with the reading comprehension of aphasics. The studies cited earlier by Gainotti and his collaborators (1972, 1976) attributed the aphasics impairment to the hypothesized verbal mediation in the interpretation of gestures. The present results fail to support a significant correlation with either the patient's level of auditory comprehension or their level of reading comprehension. Instead, it is the performance IQ that provides the best prediction for our subjects' performance. The one inconsistency in the pattern of results that we obtained was that aphasics scored worse than the right brain damaged subjects. That is, while their performance is not a function of degree of aphasia, it appears to be depressed with respect to that of non-aphasic, RBD subjects. This, of course, can be a function of lesion laterality, rather than presence of a language deficit.

In this respect, the status of pantomime recognition is very similar to that of pantomime production, where precisely the same arguments and conflicting findings are reported. On the one hand, Goodglass and Kaplan (1963) found that aphasics were more impaired than RBD subjects, but that their impairment was independent of severity of aphasia and more closely related to the performance IQ. Similar conclusions concerning the lack of correlation with the degree of language impairment were reached by de Renzi (1989) and by Borod et al. (1989).

In our view, pantomime interpretation does not make symbolic or verbal demands, although it clearly makes demands on visually based inference. The actions presented are direct pictorial representations, not codified as symbols by any conventional system. The patients' task is most analogous to finding a picture that will best complete an incomplete scene. Interpreting pantomime should not be confused with the interpretation of codified gestural symbols such as those of sign language, or of conventionalized, non iconic gestures.

Obviously, speculation of this type does not take the place of the empirical data, but it inevitably influences the demands for rigor or design and replicability of results that empirical data should satisfy before they are accepted. In our view, the proposal that pantomime interpretation suffers analogously with language in aphasia does not satisfy such requirements.

5.2. *Pantomime Recognition and the Perception and Interpretation of Human Movements*

We will first compare our results with those of other investigators. Second, we shall discuss our results on two new aspects of pantomime recognition: one concerns the nature of the relationship between actions and objects, that is the *function*, and the other concerns the rank of difficulty of salient

perceptual features which describe the pantomimed action and the objects whose use has been gestured.

5.3. *Recognition of Function*

The Pantomime test addresses the ability of LBD and RBD groups to recognize the uses, or functions of objects in actions. Vaina (1983) and Vaina and Jaulent (1991) suggest two types of action – object compatibility: direct and inferred. Direct compatibility is exemplified by actions which implement the use of a specific object, such as the use of specific tools, for example. Inferred compatibility refers to the use of objects in actions other than those for which they have been designed. The direct function of a key, for example, is to open a lock. However, it can also be thrown or used to scratch a piece of soft metal.

The properties necessary for achieving the goal of an action are collectively called Action-Requirements (Vaina & Jaulent, 1991). For the actions involving the hands as the primary implement, such requirements can be grouped into three types, as they relate to the object, to the movement, or to the grasp-type. Thus, for example, for the action placing something down, the object-requirements address the weight and size of the object and the fact that it has to be detached (movable). The movement requirements, encode the characteristics of the movement implementing the action, and the grasp requirements involve both the shape of the object and more importantly, the purpose of the movement. If the action performed on a pencil, for example, is breaking it in half, the grasp type will be different from that for the action of writing (Napier, 1956). The features describing the movement requirements for an action such as pushing a heavy object are obviously different from the movement characteristics for throwing.

Action comprehension involves inferring the compatibility with all three requirements and is addressed experimentally in this study by the hard items of the pantomime test. In this case the compatibility of an object (e.g. bowl, keys, or pencil) with actions (e.g., dropping, throwing or breaking) is determined by matching the various object dimensions to the specific action requirements. The inference must be carried out at a level of visual description and categorization which permits specifying the function. This implies that sufficiently detailed descriptions may often be necessary for the correct matching, and it is thus possible that the failure to achieve this may account for the impaired performance of the two groups of brain damaged subjects.

Marr and Vaina (1982) and Vaina and Bennour (1985) propose a hierarchical structure for the perception of human movement, in which the coarsest levels specify the spatial movement parameters of the whole body, followed at the next level by the limbs, and at the finest level by hand and finger configuration. The specific orientation and position in space of the hand and the shape of the hand (e.g. pulling a window shade versus plucking an apple; placing down a wine glass versus a suitcase) are made explicit at fine levels in the representation. The data analysis indicated that the coarse information was preserved; i.e. the general direction of the movement is the easiest action feature. On the other hand, the features made explicit at more specific, or finer levels, such as the hand shape/size were the most difficult. The grasp-requirements are related to the finer levels which describe the characteristics of the hand, and they also were difficult.

NOTES

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