Extracting Implicit Meaning: Right versus Left Hemisphere Damage

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INTRODUCTION

In this world of words, symbols, sounds, actions and events, there are essentially two types of meaning - explicit and implicit - resting at either end of a continuum. Explicit meaning refers to the superficial presentation of data -- word definitions and taxonomic classifications of objects and actions. Implicit meaning refers to that which is intended or suggested, though not explicitly presented. It is meaning that is one or more steps removed from actual sensory presentation. The process of grasping implicit meaning involves moving from what one sees to what one believes.

The crucial variable along the continuum between explicit and implicit meaning is context; not the amount of context, but the degree to which meaning is dependent upon grasping the relationships among contextual features. That is, movement toward increasing levels of implicit meaning depends not on the number of contextual features, but on whether or not they can be integrated in such a way as to create additional levels of meaning. In verbal communication it is commonly accepted that the appreciation of intended or implied meaning depends not only on the semantic content of an utterance, but on the integration of a variety of extralinguistic cues which constitute the contextual framework of the message. The act of determining which features matter and how they are related is a subjective process, largely dependent on the existence and application of the world knowledge and internal association schemata of the listener.

The same process applies in deriving the implicit meaning of nonverbal stimuli. For example, in a picture of two people with their arms around each other, we move from that explicit meaning to the implicit suggestion that they are hugging, based on an internal association. They could be depicted in a fully furnished room which would add richness to the context, but would not necessarily further the meaning. If, however, the picture is in soft focus and the couple is embracing in the moonlight, we may infer that they are in love. The implicit meaning of romance is the result of combining all of the above features, thus increasing the distance from the original explicit meaning

In verbal communication one of the striking differences between right and left hemisphere damaged patients is their ability to grasp implicit or intended meaning. In general, it has been found that this ability is often well preserved in aphasic patients despite an impaired linguistic system (Wilcox et al., 1978). Right hemisphere patients, on the other hand, demonstrate impaired ability to appreciate implicit meaning (Myers, 1979; Rivers and Love, 1980, Wapner et al., 1981; and Moya et al., in press). It has been suggested that, among the reasons for their failure to grasp verbal intention, is difficulty in determining which features matter and in integrating those features into a framework (Gardner et al., 1983; Myers, 1985). It appears that right hemisphere (RH) patients do not utilize contextual features in a way that enables them to move readily from explicit to implicit meaning.

In 1984, Myers and Linebaugh investigated the ability of aphasic patients to manage inferential pictures in a nonverbal sorting task. They suggested that there might be a threshold of contextual dependence beyond which aphasic patients could not go. Their task consisted of sorting pictures by theme. Both the picture meanings and the task itself (generating themes and sorting accordingly) relied on the ability to grasp implicit meaning. Themes of individual pictures and of picture combinations could only be inferred from combinations of such features as light and shadow, dress, posture and number of people depicted, activities, backdrops and settings. It was found that aphasic subjects were significantly impaired on the task relative to normal controls, who made no errors.

The present study was designed to extend that research by looking at the relative contribution of the two hemispheres in grasping implicit meaning. For that reason both right and left hemisphere damaged subjects were included in the experimental sample. In addition, the current study sought to assess the effects of progressively increasing levels of implicit meaning.

METHOD

Subjects. The subjects in this study were divided into three groups. The first group (LH) consisted of 12 aphasic adults each with a unilateral, focal left hemisphere lesion secondary to a single cerebrovascular accident. Their mean age was 54.8 years, and their mean education level was 14.3 years. The mean time post onset for this group was 4.5 months. The mean Aphasia Quotient (AQ) from the Western Aphasia Battery (Kertesz, 1982) was 70.1 with a range of 17.2 to 95.0. The second group (RH) consisted of 12 adults each with a unilateral, focal right hemisphere lesion secondary to a single cerebrovascular accident. The mean age of these subjects was 62.8 years, and their mean education level was 14.7 years. The mean time post onset of this group was 4.5 months. Their mean score on the Hooper Test of Visual Organization (Hooper, 1957) was 14.1 with a range of 6.0 to 23.5. Table 1 provides pertinent information on the subjects in these two brain-damaged groups. The third group (Control) consisted of 12 adults with no history of neurological impairment. Their mean age was 55.6 years, and their mean education level was 15.5 years.

Stimuli. The stimuli for this study consisted of four groups of nine pictures each. The nine pictures in each of the four groups fell into three categories of three pictures each. Pictures in the first group (Sort 1) depicted exemplars of the superordinate categories toys, animals, and clothing. Those in the second group (Sort 2) depicted one or more people engaged in the following categories of activity: cleaning, playing, and construction. The pictures in the remaining two groups depicted a particular theme. Those in the first of these groups (Sort A) depicted the themes despair, work/determination, and play/joy. Those in the second of these groups (Sort B) depicted the themes love/affection, mistrust, and suffering/comforting. The pictures from the "mistrust" group are shown in Figure 1.

These four groups of pictures represent movement along a continuum between explicit and increasing levels of implied meaning. Items in Sort 1 were depicted in isolation. Their meaning was explicit---no inference could be drawn nor could additional levels of meaning be imposed. The meaning of the pictures in Sort 2 represents movement along the continuum. The actions in each picture had to be inferred, since pictures are by nature static representations. However, the contextual features in each picture restricted the number of implications that could be drawn. The themes depicted in Sorts A and B relied on the integration of multiple contextual features and represent

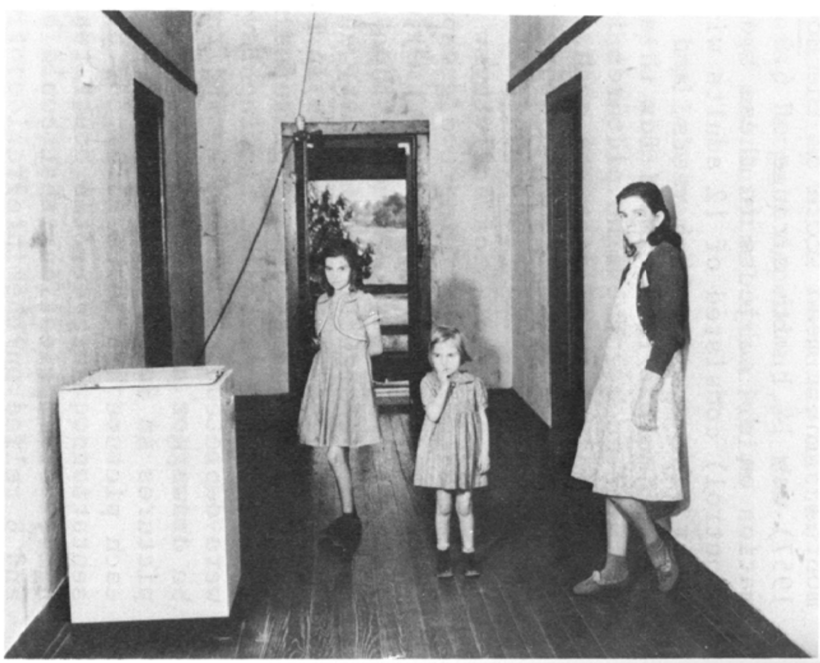

Figure 1. Pictures from the group labeled "Mistrust." Source: Farm Security Administration and Office of War Administration (FSA/OWI). Courtesy U.S. Library of Congress, Washington, D.C.

Table 1. Information on LH and RH subjects.

Subject	Age	Education	Time Post Onset (in months)	
LH GROUP				Aphasia Quotient
1	54	19	13.5	17.2
2	66	16	1.5	57.6
3	29	9	14.0	32.0
4	51	12	8.5	95.0
5	29	12	2.5	93.0
7	52	12	5.0	91.4
8	68	12	7.0	92.0
9	64	12	1.0	40.6
10	65	17	9.0	83.8
11	59	19	15.0	55.1
12	60	16	1.5	91.2
$\overline{X}$	54.8	14.3	7.1	70.1
RH GROUP				Hooper
1	75	9	2.0	12.0
2	69	18	2.0	11.0
3	70	22	10.0	14.0
4	39	12	19.0	15.5
5	74	12	1.0	17.5
6	58	12	1.0	20.5
7	69	18	1.0	11.5
8	42	15	2.0	22.0
9	55	6	4.0	14.0
10	54	20	8.5	22.0
11	73	20	3.0	6.0
12	75	12	1.0	23.5
$\overline{X}$	62.8	14.7	4.5	14.1

further movement along the continuum. Several levels of meaning could be drawn from each picture.

Procedure. Sort 1 was presented first to all subjects, followed by Sort 2 and then Sorts A and B in counterbalanced order. For each subject, the nine pictures of each sort were presented in an identical 3 x 3 matrix. The subjects were instructed to sort the pictures into three groups of three pictures each. On Sorts 1 and 2, they were asked to place pictures that "belonged together" into a group. On Sorts A and B, they were asked to sort according to the "theme" or "gist" of the picture. The pictures placed in each group and the time taken to complete each sort were recorded. After completing all four sorts, subjects were asked to explain their groups ("Tell me why you put these three pictures together.") for Sorts A and B using whatever modalities available.

The number of errors on each sort was determined for each of the 36 subjects. An error consisted of failure to place a picture with at least one other from its group. The maximum number of possible errors on any sort was nine.

RESULTS

Differences among the Control, LH and RH Groups. Table 2 shows the mean number of errors for each of the three groups of subjects on each of the sorts. None of the control subjects made errors on any of the sorts. In addition, none of the LH subjects and only one of the RH subjects made errors on Sort 1 (objects). Because of these nearly error-free performances, statistical analysis of the data for number of errors was conducted only on Sorts 2 (actions), A and B for the LH and RH groups. All comparisons among the means for both errors and time were made using two-factor analyses of variance with repeated measures and appropriate post-hoc comparisons as described by Winer (1971).

Table 2. Mean number of errors (and standard deviation) for each group on the four sorts.

	Sort 1	Sort 2	Sort A	Sort B
Control	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
LH	0 (00.0)	1.2(1.27)	1.8(1.19)	2.3(2.26)
RH	0.3(0.87)	1.4(1.31)	3.2(2.29)	3.7(2.43)

An analysis of variance on the mean number of errors (Table 3) revealed a significant difference between the performances of the two brain-damaged groups. Post hoc analyses of the differences between the two groups' performances on each of the sorts revealed no significant difference between the LH and RH subjects' performances on Sort 2. The difference between the two groups' performances on Sort A also fell short of statistical significance, but was clearly in the direction of the RH subjects making more errors on this sort than did the LH subjects. The RH subjects did make significantly more errors on Sort B ($F=4.04$; $df=1, 66$; $p < .05$) than did the LH subjects.

Table 3. Analysis of variance for errors for Sorts 2, A and B for the LH and RH groups.

Source of Variance	SS	df	MS	F	p
Groups	18.00	1	18.00	5.77	<.05
Subjects within Groups	68.60	22	3.12		
Sorts	35.60	2	17.80	6.10	<.01
Group x Sorts	5.10	2	2.55	0.87	n.s.
B x Subjects within Groups	128.60	44	2.92		

Table 4 shows the mean time each group required to complete each of the sorts. An analysis of variance (Table 5) revealed a significant difference among the groups' times. In addition, the interaction between the groups and the sorts was significant. Results of post hoc comparisons among the group means are summarized in Table 6. These analyses revealed that the control subjects took significantly less time to complete Sorts A and B, but not Sorts 1 or 2, than did the LH subjects. The control subjects also took

Table 4. Mean time in seconds (standard deviation) for each group on the four sorts.

	Sort 1	Sort 2	Sort A	Sort B
Control	16.8(5.86)	26.9(16.27)	49.4(11.91)	44.4(20.11)
LH	37.9(23.07)	60.3(34.98)	107.0(39.19)	112.1(61.61)
RH	74.9(80.49)	123.4(65.67)	229.0(142.20)	203.5(118.29)

Table 5. Analysis of variance for time for Sorts 1, 2, A and B for the Control, LH and RH groups.

Source of Variance	SS	df	MS	F	p
Groups	374000.1	2	187000.0	25.46	$<.01$
Subjects within Groups	242364.3	33	7344.4		
Sorts	178601.1	3	59533.7	17.34	$<.01$
Groups x Sorts	59208.4	6	9868.1	2.87	$<.05$
B x Subjects within Groups	339882.0	99	3433.2		

Table 6. Significant differences in times among the groups for each of the sorts.

	Control			
	Sort 1	Sort 2	Sort A	Sort B
LH	n.s.	n.s.	$<.05$	$<.05$
RH	n.s.	$<.01$	$<.01$	$<.01$
	LH			
	Sort 1	Sort 2	Sort A	Sort B
RH	n.s.	$<.05$	$<.01$	$<.01$

significantly less time to complete Sorts 2, A and B than did the RH subjects. Likewise, the LH subjects took significantly less time to complete Sorts 2, A and B than did the RH subjects.

Pearson product-moment correlation coefficients were calculated between the number of errors and the time taken on Sorts 2, A and B for the LH and RH groups. None of these correlations was statistically significant. The correlations between the time required for each sort and AQ was calculated for the LH group. Only that for Sort 1 was significant ($r=-.53$, $p<.04$), suggesting a relationship between the severity of aphasia and the time required to learn the sorting task. Correlations between the time required for each sort and the Hooper Test of Visual Organization scores for the RH group also were calculated. None of these correlations were statistically significant.

Differences Among the Sorts. Table 2 shows the mean number of errors on each sort for each of the subject groups. The analysis of variance (Table 3) comparing the mean number of errors on Sorts 2, A and B for the LH and RH groups revealed a significant difference among these means. Post-hoc analyses revealed no statistically significant differences among the mean numbers of errors on these three sorts for the LH group. The RH group, however, made significantly fewer errors on Sort 2 than on Sorts A and B. This group's performances on Sorts A and B did not differ significantly from one another.

Table 4 shows the mean time taken on each sort by each of the subject groups. The analysis of variance (Table 5) comparing these means revealed a significant difference among them. Post-hoc analyses revealed no significant differences among the mean times for the four sorts for the control group. LH subjects took significantly less ($p < .05$) time to complete Sort 1 than either Sorts A or B. None of the other differences among their mean times was significant. RH subjects took significantly less ($p < .05$) time to complete Sort 1 than Sorts 2, A or B. They took significantly less time to complete Sort 2 than they did Sorts A or B. The times they required to complete Sorts A and B did not differ significantly.

Group Explanations. The 36 subjects in this study produced a total of 200 different explanations for their groupings of the pictures in Sorts A and B. Two investigators independently placed each explanation in one of the following categories: (1) Explicit: An explanation that reflects the superficial meaning, one that does not rely on the integration of the contextual features, but takes them at face value; (2) Implicit-Accurate: an explanation that reflects the integration of the key contextual features to arrive at an accurate interpretation; (3) Implicit-Inaccurate: an explanation that reflects the integration of some, but not necessarily all, of the key contextual features to arrive at an inferred but inaccurate interpretation.

Point-by-point agreement between the two investigators' categorizations for the full sample of explanations was 97 percent. Ninety-six percent of the control subjects' explanations fell into the Implicit-Accurate category, with one percent and three percent of their explanations falling into the Explicit and Implicit-Inaccurate categories, respectively. Of the LH subjects' explanations, 66 percent fell into the Implicit-Accurate category. Of their remaining explanations, 11 percent fell into the Explicit category and 23 percent into the Implicit-Inaccurate category. Of the RH subjects' explanations, only 33 percent fell into the Implicit-Accurate category, while 24 percent fell into the Explicit category and 43 percent into the Implicit-Inaccurate category.

DISCUSSION

These data suggest that the fully functioning brain apprehends explicit and implicit meaning, at least as presented in this task, with equal efficiency. Control subjects made no errors and moved from sorting the isolated objects in Sort 1, to sorting the inferred actions in Sort 2, to the highly inferential picture themes in Sorts A and B without significant differences in time. LH subjects had more difficulty than controls, but less than RH subjects as they progressed from sorting objects to inferring themes. Like controls, however, their performance in both speed and accuracy did not change as contextual features were added in Sorts 2, A and B, and meaning became increasingly less explicit. RH subjects, however, demonstrated increasing difficulty across the sorts. They took longer than LH subjects and controls to sort by action and theme, and their performance deteriorated as they moved along the continuum.

To fully appreciate the nature of the differences between the LH and RH subjects, it helps to look at the quality of their responses as reflected in their explanations of their picture groups. RH subjects used more explanations that relied on explicit meaning alone than did either LH or control subjects. Also, their "Implicit-Inaccurate" explanations were tied more closely to the explicit end of the meaning continuum than were those of the LH group. RH subjects used terms such as "families," "soldiers," and "parks." The "Implicit-Inaccurate" explanations of the LH group demonstrated a better appreciation of implicit meaning. They used labels like "poverty," "curiosity," and "hugging." Unlike the explanations of the LH subjects, those chosen by the RH group indicate not only failure to integrate contextual features in each picture, but failure to find commonality across the three pictures. Even for correctly grouped pictures, many of their explanations accounted for the features in only one or two of the pictures (i.e. "soldiers" or "Black families"), rather than a feature that was common to all three. There is good reason for this. Explicit meaning reflected in the superficial contextual features of each picture did not carry across any three-picture combination except at the most explicit level (i.e. "people"). Only varying degrees of implicit meaning could hold across pictures. Group explanations generated by the LH group indicate that they were better able to detect commonality of implicit meaning across pictures, despite errors in picture placement.

These data support the view that RH patients are more impaired than LH patients in extracting intended or implicit meaning. The data also help to explain why. Accurate and efficient completion of the task required increasing ability to appreciate the significance of contextual features and to integrate them to derive the implicit meaning from an individual picture. Only by doing this with each picture could subjects derive the implicit meaning across pictures.

The hypothesis that RH patients are likely to be impaired in processing of this type is supported by recent evidence from animal and human studies on directed attention -- that is, attention to external space. It has been proposed that there is an integrated cortical network for directed attention in the right hemisphere, and that the right hemisphere may be considered pivotal in several crucial operations: 1) in establishing the boundaries of relevant space; 2) in initiating and inhibiting motor responses involved in the exploration of space; and 3) in determining the motivational relevance of spatially located stimuli according to past and present needs (Heilman et al., 1984; Mesulam, 1981). Deficits in any of these directed attention functions would impair the exploration and assessment of external stimuli in such a way as to significantly limit the meaning of ongoing events.

The difference between the intact hemispheres is often posed in terms of an analytic/synthetic dichotomy, with the LH better at feature detection and the RH superior at feature integration or synthesis. Although this dichotomy may be useful in the abstract, it fails to sufficiently enrich the clinical picture. To say that the LH predominates in extracting features while the RH predominates in integrating them leaves out the critical steps of weighing the significance of these features and attending to them in the first place. Without these steps one cannot advance beyond explicit meaning.

The explicit-implicit continuum is clinically useful because it reflects the shades of meaning that compose ongoing reality, and because it more accurately portrays levels of deficit in RH patients. As stated earlier, meaning is not divided between explicit and implicit points, it evolves as the number of contextual feature combinations increases. This study demonstrates that RH patients have more difficulty with implicit meaning than do LH patients, and that their deficits follow the continuum from explicit to implicit.

There are several clinical implications of this study. First, LH patients demonstrate problems with highly inferential, contextually complex visual stimuli, a fact that should be taken into account when planning therapy materials. The data also enrich the clinical portrait of RH patients by suggesting that the breakdown in RH communicative abilities at least in part, occurs at the level of meaning itself, regardless of the form or presentation of the stimuli.

ACKNOWLEDGMENT

The authors wish to thank the speech-language pathology staff of the Good Samaritan Hospital, Baltimore, Maryland and Beth Hillis-Trupe of the Medical Rehabilitation Center of Maryland for their assistance in obtaining subjects for this study.

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DISCUSSION

Q: Some people have said that things like motor impersistence and hemiinattention are more prevalent following RH lesions than following LH lesions, but that that may not be true because of the presence of language deficits in the LH. Would you care to comment?

A: I think that the recent data from Mesulam and Heilman and others indicates very clearly that while there may be some right-sided neglect following a LH lesion, that neglect is indeed much more prevalent following a RH lesion. This becomes clear if you look at neglect as a problem in directed attention which, I think, is the definite trend. The cortical network in directed attention is more likely a mechanism in which the RH is more predominant, and hence what you find is a much more likely chance that there will be a neglect or several types of neglect following a RH lesion. I am not commenting on motor impersistence, now, only on neglect, though data from Kertez suggests that it, too, is a deficit related to directed attention. I think you should now look at neglect not as a unitary function, but rather as different types or syndromes. It's been suggested, for example, that frontal neglect, in which there is difficulty in manipulation and construction and so on, is a very different syndrome from parietal neglect, which impairs the ability to determine the boundaries of relevant space and the significance of a stimulus. There appears to be more anatomical evidence for this network in the RH, and so neglect in the RH is more prevalent and more severe. I don't think LH and RH neglect are comparable, and I don't think it's because language problems mask neglect in LH lesions. I have read the theory that so much cortex in the LH is devoted to language processing that it doesn't have the kind of attentional capacity that the RH does.

Q: I think we're seeing that the idea that the ability to process context is completely preserved is a simplistic notion, and it seems as if your data and research by Cohen and Kelter and some other people show that aphasic people might have some problems analyzing their world in context. Do you think we need to concentrate more on that as a clinical objective?

A: One of the things about this task is that it showed that aphasic patients do have some trouble - that the ability to derive implicit meaning is affected to some degree by brain damage itself. Clearly, though, if you look at the group explanations, the aphasic patients had more implicit explanations than the rights, but they did make errors. So, yes, I guess we'd have to focus on their ability to manage contextual information. You could test for it by presenting tasks like this one. Present them with pictures or tasks that don't require a verbal response to see if you can tease out their ability to comprehend intended meaning.

Q: Some of us are interested in the locus of lesion in the LH, thinking that it may be that something about aphasia differs depending on where that lesion is. Do you have any concern about that in the RH group or in RH patients?

A: Oh, absolutely. One of the problems in RH research is that lesion site is just beginning to be mentioned. It is important. We have lesion site data. Most of our subjects had lesions that affected the parietal lobe, many had temporal-parietal lesions, but we didn't have lesions that separated out neatly into anterior-posterior, which would have been helpful in adding information on lesion site-deficit correlations. Equally important, I think, is the need to specify degree of neglect in some standardized way.

Q: If we take your explicit-implicit continuum and apply it to the language performance of brain damaged people, could we conceivably begin to think about left and right hemisphere damaged patients existing on some kind of continuum?

A: The LH patients made errors, but didn't follow the pattern of the RH subjects. I don't know as I would say that RH patients are at the explicit end and LH subjects are at the inferential end. I'd have to think about it.

C: The key was in the group explanations. There may be a continuum in terms of severity, but one of the things we agonized over was trying to task-analyze the task in terms of why the LH subjects have problems versus why the RH subjects did. I think we are beginning to get at that information. It may be that you could place the two groups on a continuum in severity, but that the reasons that they are having problems may be very different.

Q: What do you think would happen if you were to play with color or shading to make salient those features that deal with implicitness?

A: That's an interesting idea. I think it would be very hard to do. In the picture of the girl, for example, with her head on her knees. The controls would say she is in a state of despair or upset. The RH subjects would say she is resting. Now, the controls are saying what they do because there is such a large black background behind her. She is so small relative to it, sitting there on the bench. I don't know how you'd heighlight that darkness. A lot of the pictures depicted themes through an attitude or posture, and you can't make that red or green.

Now, in addition, let me make a comment to you about therapy implications. I think it is a mistake to start out with a patient who may have difficulty with implicit meaning - to start out at this level with these kinds of pictures. What you are then doing is tapping into LH functions (the analytic and feature extraction capacities). It is as if you are throwing up your hands and saying we can't retrain integration or recognition of stimulus significance other than by an analytic mode. This is in a way like saying that the patient has aphasia so let's just compensate for the loss and start right in with pragmatics. In aphasia therapy we always work on the language deficit itself as well. With RH patients we tend not to work on the deficit <u>per se</u> because it is perhaps easier to use language and have them analyze information. I think you have to back up and move away from things that have to be analyzed verbally and move back to the level of directed attention itself - to the problem itself. It might be that you should use something like meaningless shapes or something that cannot be named or analyzed in traditional ways -- things that differ in some way that you can manipulate by touch as well as by sight. Or perhaps have the patient listen for commonality or differences in sound. I think you have to address that level because that is the level that I think the problem is at.