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Differential Effects of Right- and Left-Hemisphere Damage on Understanding Sarcasm and Metaphor

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Two subtests—Sarcasm Comprehension and Metaphor Comprehension—of Gardner and Brownell's (1986) Right Hemisphere Communication Battery, adapted to Hebrew, were administered to 27 right-brain-damaged (RBD) patients, 31 left-brain-damaged (LBD) patients, and 21 age-matched normal controls. RBD patients tended to score somewhat lower than LBD patients on Sarcasm Comprehension

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and higher than LBD patients on Metaphor Comprehension. Both patient groups showed a significant impairment in Sarcasm Comprehension relative to normal controls. The difference between RBD patients and normals in Metaphor Comprehension did not reach significance, but there was a significant disadvantage to LBD patients relative to both RBD patients and normal controls. Significant negative correlations between test scores and lesion extent were found for Sarcasm Comprehension in left middle and inferior frontal gyri, and for Metaphor Comprehension in left middle temporal gyrus and the junctional area of the superior temporal and supramarginal gyri on the left. Lesion extent in right hemisphere regions did not correlate with either test performance. The results are interpreted in terms of the recently proposed graded salience hypothesis (Giora, 1997, 1999, in press).

Contemporary linguists (e.g., Sperber & Wilson, 1986) and cognitive psychologists (e.g., Gibbs, 1994; Glucksberg, 1989, 1995, in press; Keysar, 1989, 1994; Ortony, Schallert, Reynolds, & Antos, 1978) hold the view that, in a rich and supportive context, understanding nonliteral language is equivalent to understanding literal language. They contest the view held by traditional theorists (e.g., Grice, 1975; Searle, 1979) that understanding nonliteral language requires a special (e.g., sequential) process. On the traditional view, comprehension obligatorily involves activating the literal meaning first. Nonliteral interpretation is derived only when the literal meaning has failed to meet contextual fit. Understanding nonliteral language must, therefore, involve more complex inferential processes, regardless of context.

Recently, Giora and her colleagues (Giora, 1997, 1999, in press; Giora & Fein, 1999a, 1999b, 1999c; Giora, Fein, & Schwartz, 1998) proposed that the equivalent/special process debate can be reconciled if one considers the type of language processed. According to Giora and her colleagues, it is the degree of meaning salience rather than either context or literality (or nonliterality) that affects processing primarily. For a word or an expression to be considered salient it must be coded in the mental lexicon (e.g., the "institutional" and "riverside" meanings of *bank*). Its degree of salience is determined by conventionality, frequency, familiarity, and prototypicality. For instance, for those of us from urban communities, the "financial institution" sense of *bank* is foremost on our mind—that is, salient—whereas the "riverside" sense is less salient. However, meanings not coded in the mental lexicon (e.g., conversational implicatures constructed on the fly) are nonsalient. According to the graded salience hypothesis, salient meanings should be activated first, before less salient or nonsalient meanings are evoked.

Indeed, when the most salient meaning is intended (e.g., the figurative meaning of conventional idioms or familiar proverbs), it is processed first, without having to access the less salient (literal) meaning (Gibbs, 1980; Turner & Katz, 1997). However, when a less rather than a more salient meaning is intended (e.g., the metaphoric meaning of novel metaphors, the literal meaning of conventional idioms),

the more salient meaning is activated initially, before the intended meaning is derived (Blasko & Connine, 1993; Gibbs, 1980; Giora & Fein, 1999b; Gregory & Mergler, 1990). On this view, parallel process is induced on interpreting conventional metaphors whose metaphoric and literal meanings are equally salient (Blasko & Connine, 1993; Williams, 1992).

Given the graded salience hypothesis, comprehension of nonconventionalized, nonsalient sarcasm should involve a sequential process, because it is the literal rather than the intended sarcastic meaning of its components that is salient (i.e., coded in and directly retrievable from the mental lexicon). Consequently, the sarcastic meaning should be derived after the more salient, literal meaning has been activated[1] (see also Schwoebel, Dews, Winner, & Srinivas, 2000/this issue). Given right-hemisphere (RH) specialization in linguistic reinterpretation (e.g., Bihrle, Brownell, Powelson, & Gardner, 1986; Brownell, Michel, Powelson, & Gardner, 1983; Brownell, Potter, Bihrle, & Gardner, 1986; Zaidel, 1979; and see also McDonald, 2000/this issue), the graded salience hypothesis predicts a selective RH involvement in comprehension of nonsalient sarcasm.

Predictions concerning comprehension of salient language (e.g., instances of conventional metaphors, idioms, or ironies; cf. Giora, in press; Giora & Fein, 1999b) are different. Given that the nonliteral meaning of conventional figurative language is salient (i.e., coded in the mental lexicon), its understanding should involve primarily the left hemisphere (LH), where most of our linguistic knowledge is assumed to be stored. The predictions of the neurological realization of the graded salience hypothesis were tested here separately on nonsalient instances of sarcasm (Study 1) and salient instances of metaphor (Study 2) on a sample of brain-damaged and control participants.

STUDY 1: SARCASM COMPREHENSION

To test the predictions of the graded salience hypothesis, we presented normal, left-brain-damaged (LBD), and right-brain-damaged (RBD) individuals with the Sarcasm subtest of a Hebrew adaptation of Gardner and Brownell's (1986) Right Hemisphere Communication Battery (HRHCB). It was predicted that RBD individuals would perform worse than normal and LBD individuals on this subtest. To control for confounding language deficit, the patients were also tested on a Hebrew adaptation of the Western Aphasia Battery (HWAB) prepared by Dr. Soroker.[2]

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[1]This does not mean that interpretation of the literal statement as a whole has to be fully recovered before nonliteral interpretation begins, only that it is attempted and accessed first.

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Method

Participants. Twenty seven RBD and 31 LBD patients admitted to the Loewenstein Hospital (Ra'anana, Israel) for rehabilitation after stroke were recruited for the study on the basis of the following inclusion criteria: (a) first occurrence of an ischemic brain infarction, or a small parenchymal hemorrhage, as determined from history, physical examination, and the acute-stage CT scan; (b) absence of marked mass effect (with possible unrecognizable distant structural damage) in the acute-stage CT scan; (c) negative neurologic or psychiatric past history; (d) absence of significant cortical atrophy or leukoaraiosis; (e) a stable clinical and metabolic state; and (f) fair knowledge of the Hebrew language.

In the RBD group, there were 20 men and 7 women. All patients were right handers except for one ambidextric patient. The age range was 38 to 78 years (M = 58.8, SD = 9.8), and the mean educational level was 10.7 (SD = 4.9) years of formal schooling. Eight patients were born in Israel, 11 in Arabic countries, and 8 in European countries. All patients spoke Hebrew fluently, and in all but 3 there was also a fair level of Hebrew reading and writing. Eighteen of the 27 patients in this group had signs of contralateral neglect, at least in early stages of their disease. All the patients were examined during the hospitalization period, with time after the onset of stroke being 10.9 (SD = 3.8) weeks.

In the LBD group, there were 20 men and 11 women. Twenty six patients were right handers, 4 were left handers, and one was a converted left hander. The age range was 26 to 78 years (M = 57.7, SD = 13.5), and the mean educational level was 11.2 (SD = 3.8) years. Nine patients were born in Israel, 10 in Arabic countries, and 12 in western, mainly European, countries. All patients spoke Hebrew fluently before the onset of stroke, and all but one had also a fair level of Hebrew reading and writing. Twenty-nine of the 31 patients in this group manifested language problems of different kinds. Of the classifiable LBD aphasics, 4 patients had global aphasia, 7 had Broca's aphasia, 4 had Wernicke's aphasia, 2 had conduction aphasia, and 7 had anomic aphasia. All the patients were examined during the hospitalization period, with time after the onset of stroke being 11.9 (SD = 3.8) weeks. Twenty one age-matched healthy fluent Hebrew speakers served as controls.

Lesion analysis. In the RBD group, brain damage was caused by an ischemic infarction in 26 patients (25 in middle-cerebral-artery [MCA] territory and one in posterior-cerebral-artery [PCA] territory). One patient had a spontaneous hemorrhage in the right thalamus. In the LBD group, 28 patients had ischemic infractions (24 in MCA, 2 in PCA, and 2 in anterior-cerebral-artery territories). Three patients had a spontaneous hemorrhage in MCA territory.

To quantify lesion extent in different areas of interest, lesion information derived from high-quality follow-up (later than 6 weeks post-onset) CT scans was re-

constructed, separately for each patient, on a set of standard templates, using a normalization procedure based on Talairach's proportional grid system (Talairach & Tournoux, 1988). Structure–function correlations were made in 19 of the 27 RBD patients and in 22 of the 31 LBD patients, in whom CT quality and alignment were found suitable for analysis using the normalization procedure. Patients' performance on the sarcasm comprehension and the metaphor comprehension subtests (see following) of the HRHCB was correlated with lesion extent in pre-Rolandic and retro-Rolandic peri-Sylvian regions (anterior and posterior regions, respectively). Anterior localization corresponds to the combined extent of lesion in the middle-frontal gyrus and in the inferior-frontal gyrus. Posterior localization corresponds to the combined extent of lesion in (a) the middle-temporal gyrus, (b) the junction of the superior-temporal gyrus and the supra marginal gyrus, (c) the supra marginal gyrus, (d) the angular gyrus, and (e) the junction of the middle temporal gyrus and the angular gyrus.

Materials. The Sarcasm subtest of the HRHCB (Gardner & Brownell, 1986) was used (see Appendix). It comprises six vignettes, each followed by a factual question and a metalinguistic question asking the participant whether the critical remark is "sarcastic," a "lie," a "mistake," or "true," as exemplified in the following example:

A. Anne and Roger were lawyers in the same law firm. Anne hated Roger because he often teased her for defending clients who couldn't afford to pay her fee. One day Anne was at the courthouse while Roger was defending a very wealthy man. He did a terrible job, completely mishandling what should have been a simple case. Anne said to another attorney, "Roger handled that case well."

Questions

1. When Anne said that Roger handled the case well, Anne was:
    a. making a mistake
    b. telling the truth
    c. telling a lie
    d. being sarcastic
2. Based on what you heard in the story, which of the following is true?
    a. Roger handled the case poorly.
    b. Roger did a good job on the case.
    c. Roger was a tax lawyer.

With two exceptions, the items of the original English version were used. First, rather than rating "lie" as a correct response to the metalinguistic question in Item 5, in keeping with the original, we rated "sarcasm" as a correct response. Given the story context, the original "lie" response is ill-motivated: There is no point in lying

to a person who knows the truth as well as the speaker does. Indeed, 16 out of the 20 normal participants in Spence, Zaidel, and Kasher's (1990) study and all of the normal participants in our study responded to this question with "sarcasm" rather than with "lie." Second, all the passages, except for the one in which the correct answer was "true," were assigned a sarcastic intonation when read to the participants.

Procedure. The participants were tested individually. They listened to a recorded version of the vignettes, one at a time. When the recording of each vignette was over, they were presented with metalinguistic choices. When they answered it, they were presented with the choices. They were asked to select the most suitable one.

Scoring. To compare patients' performance on the Sarcasm Comprehension subtest of the HRHCB with their performance on the Metaphor Comprehension subtest (described later), we converted the raw scores into *z* scores relative to chance guessing distribution. The group subtest scores were subjected to a normalization procedure—that is, the normal approximation to the binomial guessing distortion—using *z* scores, where $z = 0$ indicates chance, variance is determined from the total experimental population, and each subtest is converted to a uniform 10-item test, so that the ranges of scores are uniform across subtests.

Results

Data were collected from 31 LBD, 27 RBD, and 21 normal individuals, but only 24 RBD and 22 LBD individuals—those whose records were complete—were included in the analysis. A one-way analysis of variance (ANOVA) was used with Group (LBD, RBD, Control) as the between-subjects variable. Given the complexity of the data, the results are presented as follows: First, the overall performance of RBD, LBD, and control participants are examined on their ability to recognize sarcasm. Second, analyses are performed on the errors that were made. Finally, performance measures are related to localization of brain damage.

Overall performance. When tested on all the items of the Sarcasm subtest, including the comprehension questions, there was a main effect of Group. All brain-damaged individuals together performed worse than normals, $F(2, 64) = 20.02$, $p = .0001$. However, an ANOVA with Group (LBD, RBD) disclosed no main effect of side. LBD and RBD participants did not vary on this test, $F(1, 64) = .42$, $p = .52$, with slightly worse performance by RBD individuals. Both RBD and LBD individuals performed significantly worse than the normal controls, $F(1, 64)$

= 34.26, $p = .0001$; $F(1, 64) = 26.08$, $p = .0001$. Covariation with age did not affect the results.

An ANOVA with side (LBD, RBD) and age group (≤ 54 years old, > 54 years old) as independent variables, and with normalized performance (*z* scores relative to chance) on the Sarcasm subtest as the dependent variable, disclosed no main effect or interaction involved in Age Group.

Similarly, when responses to the question testing text comprehension were ignored, and only the responses to the (5) questions regarding sarcasm comprehension were scored (scores ranging from 0–5), there was no main effect of side: RBD (mean score = 1.48) and LBD (mean score = 1.46) individuals seemed to behave alike. There was, however, a main effect of Group (LBD, RBD, Control): RBD and LBD individuals performed significantly worse than normals (mean score = 4.7, where the maximum score = 5).

However, to control for confounding language deficit, we conducted an ANOVA of the same data (Sarcasm answers only) with aphasia quotient (AQ; obtained from pretesting on the HWAB) as a covariate. Results disclose that RBD individuals performed significantly worse than LBD individuals, $F(1, 38) = 4.76$, $p = .035$. Thus, when the presence of aphasia was neutralized—that is, when the effects of general language problems (prevalent among brain-damaged patients) were removed—LBD individuals outperformed RBD individuals. The data are summarized in Table 1.

It could be argued that LBD individuals outperformed RBD individuals in sarcasm comprehension (when responses were corrected for AQ to neutralize the impact of aphasia), because LBD individuals can rely on sarcastic intonation for a cue, whereas RBD individuals cannot. To rule out this possibility, we analyzed the effect that the patients' perception of emotional prosody could have on their ability to process sarcasm. This was made possible by considering the patients' performance on the Prosody subtest of the HRHCB, in which they listened to eight sentences and had to identify the emotion expressed. There was no significant

TABLE 1
Verbal Sarcasm Comprehension by LBD and RBD Individuals: Mean of Correct Responses Corrected for Aphasia Quotient

		Raw Score		*Raw Score Adjusted by AQ*	*Z Score*		*Z Score Adjusted by AQ*
Side	*N*	*M*	*SD*	*M*	*M*	*SD*	*M*
LBD	21	1.95	1.71	2.37	0.72	1.77	1.16
RBD	18	1.72	1.52	1.22	0.48	1.57	–0.02

Note. The number of participants included here was determined by the number of participants for which we could obtain aphasia quotients (AQs), having been tested on the Hebrew Adaptation of the Western Aphasia Battery. LBD = left-brain-damaged; RBD = right-brain-damaged.

difference between RBD and LBD individuals on the Prosody subtest. We entered the performance on the Prosody subtest as well as AQ as covariates in an analysis of covariance (ANCOVA), with Side (LBD, RBD) as the independent variable and the Sarcasm score as the dependent variable. There still was a significant effect of Side, $F(1, 41) = 4.09$, $p = .05$, with better performance by LBD than RBD individuals. Thus, there was a selective RH involvement in the comprehension of sarcasm even when the possible contribution of prosody was neutralized.

To confirm that understanding of Sarcasm is independent of prosody, we further divided the patients into four subgroups: Two subgroups related to (±) Understanding of the sarcastic passages, and two different subgroups classifiable as (±) Prosody in terms of how they fared on the Prosody subtest. To belong in the (+Understanding) group, an individual had to answer correctly at least three of the five comprehension questions following the sarcasm passages; to belong in the (–Understanding) group, an individual had to respond wrongly to at least three of these five comprehension questions. The two Prosody subgroups consisted of those who did well on the Prosody subtest (+Prosody)—that is, got a score of 7 or 8 out of 8 on the 8 Prosody sentences (chance = 2)—and those who did not (–Prosody). We then carried out a three-way ANCOVA with Side (LBD, RBD), (±) Understanding, and (±) Prosody as between-subjects independent variables, and with the sarcasm score as the dependent variable. As before, AQ was used as a covariate. There was a main effect of Side, $F(1, 43) = 6.83$, $p = .01$, with LBD doing better than RBD, but no other significant main effects or interactions. In particular, the Side × Prosody interaction did not reach significance, $F(1, 43) = 3.12$, $p = .08$, suggesting that, when corrected for AQ, understanding in either group is independent of prosody.[3]

Errors. Error analysis may enable us to test the hypothesis that those who did not understand the sarcasm would not go beyond the salient meaning (and select the "truth" choice). However, those who did would attempt to go beyond the salient meaning and either fail (and select either the "lie" or "mistake" choice) or succeed (and select the "sarcasm" choice).

An inspection of the correct and incorrect responses of those who understood and did not understand the passages (according to how they responded to the comprehension questions) indeed revealed that of the individuals who responded cor-

[3]An analysis of variance of Side × Understanding × Prosody without aphasia quotient as a covariate showed a main effect of Understanding, $F(1, 48) = 23.24$, $p = .0001$, and a significant interaction of Side × Prosody, $F(1, 48) = 4.08$, $p = .05$. Although +Prosody left-brain-damaged (LBD) patients fared better on the Sarcasm subtest than –Prosody LBD patients, right-brain-damaged patients did not exhibit any difference with regard to their performance on the Prosody subtest. However, once again the Understanding × Prosody interaction was not significant.

rectly to the comprehension questions, 50.86% selected (correctly) the "sarcastic" choice, 29.92% selected the "lie" choice, 7.52% selected the "mistake" choice, and 11.6% selected the "literal truth" choice. In contrast, among the individuals who responded incorrectly to the comprehension questions, only 18.12% selected (correctly) the "sarcastic" choice, 19.14% selected the "lie" choice, 21.5% selected the "mistake" choice, and 41.2% selected the "literal truth" choice. The popular incorrect response among those who understood the passages, then, was the "lie" choice (29.92%). The popular incorrect response among those who failed to understand the passages was the "literal truth" choice (41.2%).

To be able to arrive at a statistical analysis of the errors, we looked into the brain-damaged individuals who understood the passages (+Understanding) and those who did not understand (–Understanding) as mentioned earlier. We predicted that those who understood the passages will tend to select either the "lie" or the "mistake" choice when they err, because they should have detected an error (+ED). Those who did not understand were expected to select the "truth" response when they err, because they did not detect an error (–ED). The data are summarized in Table 2.

Here, *z* scores refer to choices of "lie"/"mistake" (+ED) responses relative to chance and to choices of "truth" (–ED) responses relative to chance. Recall that a chance *z* score is 0; this means that the patient chose the response as many times as would be predicted by chance—that is, 2 out of 4 for each passage for "lie"/"mistake" and 1 out of 4 for each passage for "truth." A negative *z* score represents an infrequent choice of that error. We would expect patients who can perform the Sarcasm subtest to show negative *z* scores on these errors. As Table 2 shows, the +Understanding group indeed chose the two types of errors (+ED, –ED) less frequently than would be expected by chance and about equally often (–.48 vs. –.58). The –Understanding group also chose +ED at a similar negative rate (–.57), but this group chose the "truth" (–ED) responses more frequently than would be expected by chance (.7) and significantly more frequently than they chose +ED responses, $F(1, 13) = 9.78$, $p = .008$.

TABLE 2
Error Detection Among Brain-Damaged Individuals Who Understood and Did Not Understand the Passages

		+ED		*–ED*	
Group	*N*	*M*	*SD*	*M*	*SD*
+Understanding	25	–0.48	1.19	–0.58	0.88
–Understanding	14	–0.57	0.59	0.70	1.17

Note. ED = error detection; +ED = "lie," "mistake"; –ED = "true"; *M* = *z* score relative to chance computed for each type of error ("lie"/"mistake," "truth") separately.

An ANOVA of the errors with Understanding (+Understanding, –Understanding) and Response (+ED, –ED) was performed. There was a main effect of Understanding, $F(1, 37) = 6.22$, $p = .017$; a main effect of Response, $F(1, 37) = 6.09$, $p = .02$; and, critically, a significant interaction of Understanding × Response, $F(1, 37) = 8.49$, $p = .0006$. The difference in Understanding in the +ED (good error detection) is not significant, $F(1, 37) = .07$, $p = .79$, but the difference in Understanding in the –ED (no error detection) is significant, $F(1, 37) = 15.06$, $p = .0004$. This result could ensue from the fact that those who understood the passage tended to select the sarcasm as the correct response. However, our hypothesis that those who did not understand the passages were biased toward the literal interpretation did gain support.

Localization. Table 3 shows the correlations between the performance of LBD and RBD individuals on the Sarcasm subtest and lesion extent in anterior versus posterior peri-Sylvian regions. It was found that lesion extent in anterior regions on the left (corresponding to the middle and inferior frontal gyri, including Broca's area) correlates negatively with sarcasm comprehension. In contrast, the extent of both anterior and posterior lesions did not show significant negative correlations with sarcasm comprehension in RBD patients. The data suggest that both hemispheres contribute to sarcasm comprehension. Even though RH contribution seems greater, it is not localized in any specific peri-Sylvian region, whereas LH contribution is associated with specific left frontal regions. Thus, processing of sarcasm in the two hemispheres appears to be qualitatively different. However, part of the anatomical association in the LH may reflect the linguistic format of the sarcasm test and LH contribution to language processing in general rather than to sarcasm in particular.

Discussion and Conclusions

As predicted by the graded salience hypothesis (Giora, 1997, 1999, in press), results suggest selective RH contribution to nonsalient sarcasm understanding.

TABLE 3
Correlations Between Extent of Lesion ("Anterior" and "Posterior" Peri-Sylvian Regions) and Performance on Sarcasm in the Brain-Damaged Patients

		LBD		*RBD*	
		Anterior	*Posterior*	*Anterior*	*Posterior*
Sarcasm	*r*	–.57	–.35	.22	.03
	p	.01[a]	.14	.34	.88
	N	19	19	20	20

Note. LBD = left-brain-damaged; RBD = right-brain-damaged; *r* = Pearson *r*; *p* = probability.
[a]Indicates findings above chance.

Though both RBD and LBD individuals performed below normals, RBD individuals performed significantly worse than both LBD and normal individuals when analysis neutralized the effect of aphasia. The sequential process assumed by our model for some nonsalient language uses seems to require the support of the hemisphere that specializes in reinterpretation (see, e.g., Brownell, Carroll, Rehak, & Wingfield, 1992; Brownell et al., 1986; Burgess & Chiarello, 1996, and references therein; Chiarello, 1988).

Our results allude to some similarity between children and BD individuals. Both groups performed below normal adults on the sarcastic items. Failure to understand sarcasm occurred both at the first, error-detection stage and at the second, error-correction stage. The RBD and the LBD individuals who understood the passages resemble the young children in Ackerman's (1981, 1983) studies: They could detect some discourse violation, but could not derive the sarcastic intent. Hence, the preference for the "lie" choice (see also Winner, Brownell, Happé, Blum, & Pincus, 1998, for similar findings among RBD adults). In contrast, the RBD and LBD individuals who did not understand the passages resemble the young children in Winner and colleagues' studies (Winner, 1988; Winner, Levy, Kaplan, & Rosenblatt, 1988). They did not detect a discourse rule violation and therefore selected the "literal truth" choice. Winner and her colleagues (Sullivan, Winner, & Hopfield, 1995; Winner, 1988; Winner et al., 1998; and see also Curcó, 1999; Happé, 1993) assumed that young children fail to understand sarcasm because they do not have a theory of mind (for a discussion along these lines regarding RBD individuals, see McDonald, 2000/this issue). Note, however, that most of the BD individuals who understood the passages but failed to infer the sarcastic intent must have a theory of mind, because they tended to select the "lie" response. Though they could tell that the speaker had some intention in mind, they failed to infer that sarcastic intent.

However, the findings and conclusions drawn here should be treated with some caution. Gardner and Brownell's Sarcasm subtest contains a small set of texts, and most of them (five out of six) are sarcastic. Thus, it is possible that the test itself affects comprehenders: It either biases them toward the sarcastic response or makes them respond arbitrarily, because they may believe that it is unreasonable for almost all of the texts to be of the same sort. Despite these methodological shortcomings of Gardner and Brownell's Sarcasm subtest, the data do suggest that the RH plays a selective role in the understanding of nonsalient sarcasm.

STUDY 2: CONVENTIONAL METAPHOR COMPREHENSION

Recall that according to our hypothesis, when multiple meanings are similarly salient, they should be processed together initially. The case of familiar and/or con-

ventional metaphors is illustrative in this respect. Conventional metaphors trigger parallel activation of both their literal and metaphorical meanings (Anaki, Faust, & Kravetz, 1998[4]; Blasko & Connine, 1993; Giora & Fein, 1999c; Williams, 1992) because both meanings are salient. The parallel process proposed to account for comprehension of conventional metaphors applies primarily where the metaphors also have plausible literal readings. For example, the metaphor *"lend a hand"* (in Hebrew or in English) translates metaphorically into "help" and literally into "give a hand."

Given LH sensitivity to salient (e.g., frequent) meanings (Burgess & Simpson, 1988), processing conventional metaphors should be selectively associated with the LH. Furthermore, given LH bias toward literal (usually salient) meanings (e.g., Anaki et al., 1998; Winner & Gardner, 1977; and see Burgess & Chiarello, 1996, for a review of studies suggesting LH bias toward literal interpretations), the plausibility of the literal interpretation of a metaphor may affect its selection as the intended meaning among RBD individuals.

Method

Participants and lesion analysis. Seventeen normal, 31 LBD, and 27 RBD individuals participated, as in Sarcasm Comprehension.

Materials. The Verbal Metaphor subtest of the HRHCB (Gardner & Brownell, 1986) was used. The test contains four highly conventional, clichéd metaphors: *"broken heart," "warm heart," "lend a hand," "a hard man"*). Of the four clichéd metaphors, only *"lend a hand"* (in Hebrew) is susceptible to a plausible literal interpretation.

Procedure. The participants had to provide oral verbal explications of the four metaphoric phrases.

Scoring. Given the open-ended nature of the task, the *z* scores calculated for the four answers assumed 5% guessing distribution.

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[4]Anaki, Faust, and Kravetz (1998) showed that both the literal and metaphoric meanings of context-less conventional metaphors are activated initially in the left hemisphere (LH). However, after a delay of 800 msec the metaphoric meaning in the LH is suppressed. It is retained only in the right hemisphere.

Results

Overall performance. Only 24 RBD and 16 LBD individuals—those whose records were complete—were included in the analysis. A one-way ANOVA with Group (LBD, RBD, Control) as a between-subjects variable disclosed a main effect of group, $F(2, 56) = 11.54$, $p = .0001$. Normal participants understood all the metaphors perfectly. Performance by LBD and control differed significantly, $F(1, 6) = 22.08$, $p = .0001$. However, performance by RBD and control participants did not differ significantly, $F(1, 56) = 2.75$, $p = .10$. A one-way ANOVA with Group (LBD, RBD) as a between-subjects variable disclosed a main effect of side. Performance by LBD and RBD participants differed significantly, $F(1, 56) = 11.86$, $p = .001$, with worse performance by LBD. The analysis of the results was not affected when age, $F(1, 38) = 11.72$, $p = .001$, and aphasia were used as covariates, $F(1, 34) = 4.05$, $p = .05$.

A two-way ANOVA with Side (LBD, RBD) and Age Group (≤ 54 years old, > 54 years old) as independent variables, and with normalized scores on the Verbal Metaphor subtest as the dependent variable, disclosed no main effects or interaction involving Age Group.

Localization. Table 4 shows the correlation between the performance of LBD and RBD individuals on the Verbal Metaphor subtest and lesion extent in anterior versus posterior peri-Sylvian regions. It was found that lesion extent in posterior regions on the left correlates negatively with metaphor comprehension. In contrast, the extent of both anterior and posterior lesions did not show significant negative correlations with metaphor comprehension in RBD patients.

Errors. Unlike LBD individuals, RBD individuals exhibited understanding of conventional verbal metaphors. Analysis of the total (9) incorrect responses of

TABLE 4
Correlations Between Extent of Lesion ("Anterior," "Posterior") and Performance on Verbal Metaphors in the Brain-Damaged Patients

		LBD		*RBD*	
		Anterior	*Posterior*	*Anterior*	*Posterior*
Verbal metaphor	*r*	.03	–.57	.04	.009
	p	.92	.04[a]	.86	.97
	N	13	13	20	20

Note. LBD = left-brain-damaged; RBD = right-brain-damaged; *r* = Pearson *r*; *p* = probability.
[a]Indicates findings above chance.

the RBD (out of 96) reveals that about half (4) involved assigning salient literal readings to the single metaphor that also had a plausible literal reading. Another 4 incorrect responses involved assigning new interpretations to one of the metaphors. Only one of the incorrect responses involved misunderstanding—that is, a totally inappropriate response. This means that RBD individuals understood the conventional verbal expressions almost perfectly. In contrast, of the total (13) incorrect responses (out of 64) of LBD individuals, 10 attest to lack of understanding. Only 3 involved assigning a literal reading to the single metaphor that also had a plausible literal reading. These results support a selective contribution of the LH to understanding conventional verbal metaphors (see also Stachowiak, Huber, Poeck, & Kerschensteiner, 1977).

Discussion

These findings qualify existing results and are inconsistent with the prevailing consensus. Our test included three metaphors that had an implausible literal interpretation and one metaphor that had a plausible literal interpretation. We found that on the one metaphor with the plausible literal interpretation, there was no difference in the bias toward the literal meaning between LBD and RBD individuals (19% vs. 17%, respectively). However, on the three metaphors that had an implausible literal interpretation, LBD individuals had substantially more errors (21%) than the RBD individuals (7%). At any rate, we found no selective RBD bias toward literal meanings. In contrast, Brownell, Potter, Michelow and Gardner (1984) adduced evidence that RBD individuals are biased toward the literal meaning of verbal metaphors. In addition, their LBD participants showed a preserved sensitivity to metaphoric interpretation, and their normal controls displayed flexible sensitivity to both aspects of meaning (cf. Van Lancker & Kempler, 1987, 1993). However, previous studies tended to include pictorial multiple choices and thus involved pictorial interpretation. Indeed, we found a poor correlation between performance on the Pictorial Metaphor subtest and the Verbal Metaphor subtest of the RHCB among RBD individuals (and a significant correlation between these two subtests among LBD individuals; see Zaidel, Soroker, et al., 1999). Furthermore, our study includes a larger-than-usual sample of both LBD and RBD participants.

GENERAL DISCUSSION

The predictions of the graded salience hypothesis regarding the differential effects of RH and LH damage on understanding nonsalient (sarcasm) and salient (conventional metaphor) language gained support. Recall that according to the graded salience hypothesis (Giora, 1997, 1999, in press), comprehension of nonsalient sar-

casm should involve primarily the RH. In contrast, understanding coded meanings (e.g., conventional metaphor) should involve primarily the LH.

Although as a group the patients performed significantly below normals on the figurative language subtests discussed here, RBD individuals performed like normals on the Verbal Metaphor subtest, suggesting selective LH contribution to understanding salient language. That the RH might be selectively involved in interpreting nonsalient language is suggested by the fact that, when the effects of language deficits were neutralized, LBD individuals outperformed RBD individuals on the Sarcasm subtest. Using *z* scores relative to chance, we performed an ANOVA, comparing Sarcasm to Verbal Metaphor in 14 LBD and 21 RBD individuals, with AQ as covariate. Results disclosed a significant interaction between subtest and patient group, $F(1, 32) = 9.14$, $p = .0049$, confirming the dissociation in hemispheric control for the two tests.[5]

Tables 3 and 4 show the correlations between Sarcasm and Metaphor comprehension and lesion extent in anterior and posterior peri-Sylvian regions separately for the LBD and RBD patient groups. As can be seen, significant negative correlations between test scores and lesion extent were found for (nonsalient) Sarcasm Comprehension in left middle and inferior frontal gyri, and for (salient) Metaphor Comprehension in left middle temporal gyrus and the junctional area of the superior temporal and supramarginal gyri on the left. Lesion extent in RH regions did not correlate with either test performance. The distinct correlation patterns further support our claim that (nonsalient) Sarcasm comprehension and (salient) Metaphor comprehension are functionally dissociated. The fact that extent of right brain damage did not correlate with degree of deficit in Sarcasm comprehension is not surprising. Few if any pragmatic functions that are impaired following RBD show anatomical localization (Kasher, Batori, Soroker, Graves, & Zaidel, 1999; Zaidel, Kasher, et al., 1999).

Contrary to Gardner and Brownell and their colleagues' findings (e.g., Brownell, 1988; Brownell et al., 1984; Gardner & Brownell, 1986; Winner & Gardner, 1977), our results suggest no selective RH contribution to normal performance on the conventional metaphor subtests. Rather, they are consistent with previous findings by Zaidel and Kasher (1989), suggesting LH contribution to the understanding of conventional metaphors.

Our results get further support from findings by Spence, Zaidel, and Kasher (1990), which allude to LH contribution to figurative (particularly Verbal Meta-

[5]Zaidel, Soroker, et al. (1999) reported that Sarcasm correlated significantly with Verbal Metaphor both in left-brain-damaged and right-brain-damaged patients. However, the data they analyzed are different from the data we analyzed here. In Zaidel et al., the data on the Sarcasm subtest included both the responses to the text comprehension question and the responses to the question testing sarcasm comprehension. Here, only the responses to the sarcasm comprehension question are taken into consideration, because we are interested here in comprehension of nonsalient ironic language rather than in text comprehension. Hence, the differences between the two reports.

phor) understanding. Spence et al. tested 20 normal participants and 4 commissurotomy patients on Gardner and Brownell's battery. A nonparametric form of the *t* test, the Robust Rank Order test, revealed that the patients (whose free-field performance is presumably controlled by their disconnected LH) performed significantly worse on all the tests except for verbal metaphor.

Though understanding of salient verbal metaphor seems to involve the LH, whereas the RH seems to contribute to the understanding of nonsalient sarcasm, this does not indicate different processing strategies for verbal sarcasm and verbal metaphor. Rather, the differences found indicate different strategies for language uses diverging in salience. Although comprehension of nonsalient sarcasm involves reinterpreting salient meanings, the verbal metaphors used here are conventional utterances. Like other types of linguistic knowledge, they are probably stored in the LH and can be retrieved directly, with no recourse to reinterpretation processes. Had novel or less conventional verbal metaphors been tested in the same manner, the results might have shown greater RH involvement (see, e.g., Bottini et al., 1994).

In sum, we found that (a) in agreement with previous studies, the processing of (nonsalient) sarcasm (or irony) is specialized in the RH and that (b) in contrast with previous studies, the processing of (salient) metaphors is specialized in the LH. This supports a neurological realization of the graded salience hypothesis, according to which salient meanings are processed in the LH and less salient meanings are processed in the RH (for a similar view, see Burgess & Simpson, 1988; for a different view, see, e.g., Van Lancker & Kempler, 1987, 1993).

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REFERENCES

Ackerman, B. (1981). Young children's understanding of a speaker's intentional use of a false utterance. *Developmental Psychology, 17,* 472–480.

Ackerman, B. (1983). Form and function in children's understanding of ironic utterances. *Journal of Experimental Child Psychology, 35,* 487–508.

Anaki, D., Faust, M., & Kravetz, S. (1998). Cerebral hemispheric asymmetries in processing lexical metaphors. *Neuropsychologia, 36,* 691–700.

Bihrle, A. M., Brownell, H. H., Powelson, J., & Gardner, H. (1986). Comprehension of humorous and non-humorous materials by left and right brain-damaged patients. *Brain and Cognition, 5,* 399–411.

Blasko, G. D., & Connine, C. (1993). Effects of familiarity and aptness on metaphor processing. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 19,* 295–308.

Bottini, G., Corcoran, R., Sterzi, R., Paulesu, E., Schenone, P., Scarpa, P., Frackowiak, R. S. J., & Frith, C. D. (1994). The role of the right hemisphere in the interpretation of figurative aspects of language: A positron emission tomography activation study. *Brain, 117,* 1241–1253.

Brownell, H. H. (1988). Appreciation of metaphoric and connotative word meaning by brain damaged patients. In C. Chiarello (Ed.), *Right hemisphere contributions to lexical semantics* (pp. 19–31). New York: Springer.

Brownell, H. H., Carroll, J. J., Rehak, A., & Wingfield, A. (1992). The use of pronoun anaphora and speaker mood in the interpretation of conversational utterances by right hemisphere damaged patients. *Brain and Language, 43,* 121–147.

Brownell, H. H., Michel, D., Powelson, J., & Gardner, H. (1983). Surprise but not coherence: Sensitivity to verbal humor in right hemisphere patients. *Brain and Language, 18,* 20–27.

Brownell, H. H., Potter, H. H., Bihrle, A. M., & Gardner, H. (1986). Inference deficits in right brain damaged patients. *Brain and Language, 27,* 310–321.

Brownell, H. H., Potter, H. H., Michelow, D., & Gardner, H. (1984). Sensitivity to lexical denotation and connotation in brain-damaged patients: A double dissociation. *Brain and Language, 22,* 253–265.

Burgess, C., & Chiarello, C. (1996). Neurocognitive mechanisms underlying metaphor comprehension and other figurative language. *Metaphor and Symbolic Activity, 11,* 67–84.

Burgess, C., & Simpson, G. B. (1988). Cerebral hemispheric mechanism in the retrieval of ambiguous word meanings. *Brain and Language, 33,* 86–102.

Chiarello, C. (1988). Semantic priming in the intact brain: Separate roles for the right and left hemispheres? In C. Chiarello (Ed.), *Right hemisphere contributions to lexical semantics* (pp. 59–69). Berlin: Springer-Verlag.

Curcó, C. (1999, June). *Irony: Negation, echo, and metarepresentation*. Paper presented at Pragma99: International Pragmatics Conference on Pragmatics and Negotiation, Tel Aviv University and The Hebrew University of Jerusalem, Tel Aviv and Jerusalem.

Gardner, H., & Brownell, H. H. (1986). *The Right Hemispheric Communication Battery.* Boston: Psychology Service.

Gibbs, R. W., Jr. (1980). Spilling the beans on understanding and memory for idioms in conversation. *Memory & Cognition, 8,* 449–456.

Gibbs, R. W., Jr. (1994). *The poetics of mind*. Cambridge, England: Cambridge University Press.

Giora, R. (1997). Understanding figurative and literal language: The graded salience hypothesis. *Cognitive Linguistics, 7,* 183–206.

Giora, R. (1999). On the priority of salient meanings: Studies of literal and figurative language. *Journal of Pragmatics, 31,* 919–929.

Giora, R. (in press). *On our mind: Salience, context, and figurative language*. New York: Oxford University Press.

Giora, R., & Fein, O. (1999a). Irony comprehension: The graded salience hypothesis. *Humor, 12,* 425–436.

Giora, R., & Fein, O. (1999b). Irony: Context and salience. *Metaphor and Symbol, 14,* 241–257.

Giora, R., & Fein, O. (1999c). On understanding familiar and less-familiar figurative language. *Journal of Pragmatics, 31*(12), 1601–1618.

Giora, R., Fein, O., & Schwartz, T. (1998). Irony: Graded salience and indirect negation. *Metaphor and Symbol, 13,* 83–101.

Glucksberg, S. (1989). Metaphors in conversation: How are they understood? Why are they used? *Metaphor and Symbolic Activity, 4,* 125–143.

Glucksberg, S. (1995). Commentary on nonliteral language: Processing and use. *Metaphor and Symbolic Activity, 10,* 47–57.

Glucksberg, S. (in press). *Understanding figurative language: From metaphor to idiom.* New York: Oxford University Press.

Gregory, M. E., & Mergler, N. L. (1990). Metaphor comprehension: In search of literal truth, possible sense, and metaphoricity. *Metaphor and Symbolic Activity, 5,* 151–173.

Grice, P. H. (1975). Logic and conversation. In P. Cole & J. Morgan (Eds.), *Speech acts. Syntax and semantics* (Vol. 3, pp. 41–58). New York: Academic.

Happé, F. G. E. (1993). Communicative competence and theory of mind in autism: A test of relevance theory. *Cognition, 48,* 101–119.

Kasher, A., Batori, G., Soroker, N., Graves, D., & Zaidel, E. (1999). Effects of right- and left-hemisphere damage on understanding conversational implicatures. *Brain and Language, 68,* 566–590.

Keysar, B. (1989). On the functional equivalence of literal and metaphorical interpretations in discourse. *Journal of Memory and Language, 28,* 375–385.

Keysar, B. (1994). Discourse context effects: Metaphorical and literal interpretations. *Discourse Processes, 18,* 247–269.

McDonald, S. (2000/this issue). Neuropsychological studies of sarcasm. *Metaphor & Symbol, 15,* 85–98.

Ortony, A., Schallert, D. L., Reynolds, R. E., & Antos, S. J. (1978). Interpreting metaphors and idioms: Some effects of context on comprehension. *Journal of Verbal Learning and Verbal Behavior, 17,* 465–477.

Schwoebel, J., Dews, S., Winner, E., & Srinivas, K. (2000/this issue). Obligatory processing of the literal meaning of ironic utterances: Further evidence. *Metaphor & Symbol, 15,* 47–61.

Searle, J. (1979). *Expression and meaning.* Cambridge, England: Cambridge University Press.

Spence, S., Zaidel, E., & Kasher, A. (1990). The right hemisphere communication battery: Results from commissurotomy patients and normal subjects reveal only partial right hemisphere contribution [Abstract]. *Journal of Comparative and Experimental Neuropsychology, 12,* 42.

Sperber, D., & Wilson, D. (1986). *Relevance: Communication and cognition.* Oxford, England: Blackwell.

Stachowiak, F.-J., Huber, W., Poeck, K., & Kerschensteiner, M. (1977). Text comprehension in aphasia. *Brain and Language, 4,* 177–195.

Sullivan, K., Winner, E., & Hopfield, N. (1995). How children tell a lie from a joke: The role of second-order mental state attributions. *British Journal of Developmental Psychology, 13,* 191–204.

Talairach, J., & Tournoux, P. (1988). *Co-planar stereotaxic atlas of the human brain.* Stuttgart, Germany: Verlag.

Turner, N. E., & Katz, A. (1997). Evidence for the availability of conventional and of literal meaning during the comprehension of proverbs. *Pragmatics and Cognition, 5,* 203–237.

Van Lancker, D. R., & Kempler, D. (1987). Comprehension of familiar phrases by left- but not by right-hemisphere damaged patients. *Brain and Language, 32,* 265–277.

Van Lancker, D. R., & Kempler, D. (1993). Acquisition and loss of familiar language: Idiom and proverb comprehension. In F. R. Eckman (Ed.), *Confluence: Linguistics, L2 acquisition and speech pathology* (pp. 249–257). Amsterdam: Benjamins.

Williams, J. N. (1992). Processing polysemous words in context. Evidence from interrelated meanings. *Journal of Psycholinguistic Research, 21,* 193–218.

Winner, E. (1988). *The point of words: Children's understanding of metaphor and irony.* London: Harvard University Press.

Winner, E., Brownell, H., Happé, F., Blum, A., & Pincus, D. (1998). Distinguishing lies from jokes: Theory of mind deficits and discourse interpretation in right hemisphere brain-damaged patients. *Brain and Language, 62,* 89–106.

Winner, E., & Gardner, H. (1977). The comprehension of metaphor in brain-damaged patients. *Brain, 100,* 717–729.

Winner, E., Levy, J., Kaplan, J., & Rosenblatt, E. (1988). *Journal of Aesthetic Education, 22,* 51–63.

Zaidel, E. (1979). Performance on the ITPA following cerebral commissurotomy and hemispherectomy. *Neuropsychologia, 17,* 259–280.

Zaidel, D. W., & Kasher, A. (1989). Hemispheric memory for surrealistic versus realistic paintings. *Cortex, 25,* 617–641.

Zaidel, E., Kasher, A., Soroker, N., Giora, R., Graves, D., Batori, G., Gil, M., & Korn, C. (1999). *Hemispheric control of basic speech acts: Evidence from unilateral brain damage.* Manuscript in preparation.

Zaidel, E., Soroker, N., Kasher, A., & Batori, G. (1999). *Effects of right and left hemisphere damage on performance of the "Right Hemisphere Communication Battery."* Manuscript in preparation.

APPENDIX

The English version of the materials used for the Sarcasm subtest:

A. Anne and Roger were lawyers in the same law firm. Anne hated Roger because he often teased her for defending clients who couldn't afford to pay her fee. One day Anne was at the courthouse while Roger was defending a very wealthy man. He did a terrible job, completely mishandling what should have been a simple case. Anne said to another attorney, "Roger handled that case well."

Questions

1. When Anne said that Roger handled the case well, Anne was:
    a. making a mistake
    b. telling the truth
    c. telling a lie
    d. being sarcastic
2. Based on what you heard in the story, which of the following is true?
    a. Roger handled the case poorly.
    b. Roger did a good job on the case.
    c. Roger was a tax lawyer.

B. Don and Betsy liked to play cards and were members of a bridge club. One night when Betsy and Don were partners, they won a very difficult game because Betsy had played very skillfully. Don said to another player, "Betsy plays bridge well."

Questions

1. Based on what you heard in the story, which of the following is true?
    a. Betsy played bridge poorly.
    b. Betsy was a good bridge player.
    c. Betsy was a good gin rummy player.

2. When Don said that Betsy played bridge well, Don was:
    a. telling a lie
    b. making a mistake
    c. being sarcastic
    d. telling the truth

C. Max and Vinnie were shoemakers. Max was losing a lot of business to Vinnie because Vinnie sold his shoes for less than Max. Vinnie was able to do this because he used low-quality materials, but the shoes Vinnie made fell apart quickly. Max said to another shoemaker, "Vinnie makes shoes well."

Questions

1. When Max said that Vinnie makes shoes well, Max was:
    a. telling a lie
    b. telling the truth
    c. being sarcastic
    d. making a mistake
2. Based on what you heard in the story, which of the following is true?
    a. Vinnie made shoes poorly.
    b. Vinnie was a good shoemaker.
    c. Vinnie made his shoes out of plastic.

D. Alice and Doreen were in the same English class. At the end of the semester the teacher awarded a prize to the student who read the most books. Alice detested Doreen because Alice had wanted the prize, but Doreen read very quickly and finished more books than anyone else. Alice said to another student in the class, "Doreen is a slow reader."

Questions

1. When Alice said that Doreen was a slow reader, Alice was:
    a. being sarcastic
    b. telling the truth
    c. telling a lie
    d. making a mistake
2. Based on what you heard in the story, which of the following is true?
    a. Doreen read poorly.
    b. Doreen read fast.
    c. Doreen read Shakespeare.

E. Olivia and Penny shared a house with three other people. They all took turns cooking dinner. It was Olivia's night to cook and she made lasagna. It came out burnt and almost impossible to eat. Penny said to another roommate, "Olivia is a good cook."

Questions

1. Based on what you heard in the story, which of the following is true?
    a. Olivia cooked well.
    b. Olivia cooked with a gas oven.

c. Olivia was a bad cook.

2. When Penny said that Olivia was a good cook, Penny was:
    a. telling the truth
    b. being sarcastic
    c. telling a lie
    d. making a mistake

F. Clara and Fred were violinists in the school orchestra. Clara was the lead violinist and Fred was second. Clara was jealous of Fred because for one piece, the conductor chose Fred to perform a brief solo. During the rehearsal Fred played very poorly making a lot of mistakes and causing the conductor to go over it again and again. Clara said to another violinist, "Fred is a good soloist."

Questions

1. Based on what you heard in the story, which of the following is true?
    a. Fred played the violin solo well.
    b. Fred did a bad job playing the violin solo.
    c. Fred played a cello solo.
2. When Clara said that Fred was a good soloist, Clara was:
    a. telling a lie
    b. telling the truth
    c. making a mistake
    d. being sarcastic