Right hemisphere brain damage (RHD) in adults can markedly impair discourse-level comprehension. Some authors postulate that difficulties in this area can be traced, at least in part, to underlying deficits in lexical-semantic processing (e.g., 1-3). This view stems primarily from a large body of work indicating that the intact right hemisphere arouses and sustains a diffuse network of remote associates and secondary meanings of words as they are processed, while the intact left hemisphere quickly focuses initial meaning activation to a narrow range of dominant interpretations and/or strong associates (e.g., 4-10). This widespread right hemisphere lexical-semantic activation, or 'coarse coding' (1, 2, 11), is hypothesized to underpin nonliteral language interpretation, discourse integration, some kinds of inference generation, and recovery when a reanalysis is required (3, 12-16).

The 'coarse coding impairment' hypothesis quickly gained traction in the RHD comprehension literature, and a presumed deficiency in right hemisphere lexical-semantic processing activity has often been invoked *post hoc* to account for interpretive deficits exhibited after RHD (e.g., 2, 14, 17-19). Yet to date no research has addressed the postulated connection between 'coarse coding impairment' and discourse comprehension in RHD. This study begins to fill that gap. The indicator of 'coarse coding' function was priming of remote semantic features of words. Accuracy on this measure was then related to performance on two measures of discourse comprehension.

Method

Participants were 70 adults, 32 with unilateral RHD due to CVA (confirmed by CT/MRI scan reports) and 38 non-brain-damaged (NBD) controls without reported neurologic impairment. All met stringent inclusion criteria concerning hearing acuity, native language, and handedness. The groups did not differ on demographic variables, but differed reliably on various clinical/neuropsychological tests.

Coarse Coding. Coarse coding was assessed with an auditory lexical decision task, to evaluate priming for peripheral semantic features of words. Participants listened to simple spoken sentences that ended in concrete nouns (e.g., He has an apple). Each sentence was followed by a spoken target phoneme string at both a Short and Long interstimulus interval (ISI; 175 and 1000 ms from sentence-final noun offset). Targets included nonwords and three categories of real words: (a) unrelated words (e.g., '*mermaid*'), (b) subordinate semantic features of the sentence-final nouns that were compatible with the dominant 'mental image' of the noun (Related-compatible; e.g., '*crunchy*') or (c) subordinate semantic features that were incompatible with that dominant image (Related-incompatible; e.g., '*rotten*'), and as such, particularly peripheral to the noun's semantic core. In prior work, RHD and non-brain-damaged control participants did not differ in lexical decision accuracy on Related-compatible or Unrelated trials. But the RHD group was significantly impaired on the Related-incompatible feature trials, at both short and long ISIs. In this study, priming of these 16 semantically-peripheral, *Related-incompatible* trials was taken as the indicator of coarse coding function.

Discourse Comprehension. One comprehension measure, dubbed DCT-Implied (DCT-I), was total accuracy on the Yes/ No questions about implied information in the Discourse Comprehension test (Brookshire & Nicholas, 20), set A stimuli (4 per story, maximum possible = 20). Bridging inferences are required to answer these questions accurately.

The second comprehension measure, dubbed High-level inferencing, used stimuli that contain overt contradictions and trigger competing interpretations. As such they require cognitive processes of interest in association to coarse coding in adults with RHD. These include processes related to coherence inferencing, reanalysis, and meaning integration. Participants listened to 6 narratives from Winner et al. (21) and after each, answered Yes/No questions of various types (see examples in Table 1). Accuracy was summed on 3 types of high-level inferencing questions for each story (second-order belief, second-order follow-up, second-order expectation), for a maximum possible score of 18.

Results

Table 2 presents group data on the coarse coding and narrative comprehension measures, and the results of independent *t*-tests to assess group differences on these variables. The RHD group overall was impaired on all these measures.

The relationship between coarse coding and discourse comprehension was assessed separately for each comprehension measure. Based on DCT-I performance, the RHD group was split into high and low comprehenders (see Table 3). After covarying for estimated working memory capacity (22), which differentiated these comprehension subgroups, there was a significant difference in coarse coding at the Long ISI ($\underline{F}$ (1, 19) = 5.43; $\underline{p} < .05$). This difference was not attributable to age, education, vocabulary recognition, syntactic comprehension, immediate or delayed story memory, visual perception, or visual-spatial skill (all $\underline{t} < /1.93/$; $\underline{p} > .05$), but there was a significant subgroup difference in visual attentional capacity/neglect ($\underline{t}$ (20) = -2.16, $\underline{p} < .05$). Lesion data (see Table 4) suggest that parietal damage may be linked with this coarse coding impairment and relatively poor comprehension of implied material in discourse. Six of the 10 poor comprehenders had a lesion involving the parietal lobe.

For the measure of High-level inferencing, there were no significant differences in coarse coding between high and low RHD comprehenders, at either the Short ($\underline{t}$ (13) = -0.23; $\underline{p} > .05$) or the Long test interval ($\underline{t}$ (13) = -0.50; $\underline{p} > .05$).

Discussion and Implications

Activation of distantly-related meanings and features of words has been proposed to underpin nonliteral language interpretation, discourse integration, some kinds of inference generation, and recovery when a reanalysis is required. This study's results are consistent with a postulated link between some form of coarse-coding impairment and some aspects or types of discourse comprehension (2, 14, 23). However, the results are inconsistent with the thesis that an *early* impairment of activation for distant semantic information (1) underpins RHD discourse inference and integration deficits. Rather, the subset of adults with RHD who were particularly poor comprehenders of implied information in discourse were poor only at *sustaining* activation for peripheral semantic features of nouns, relative to good RHD comprehenders. More work is needed to assess the neuroanatomic correlates of this finding, but parietal cortex is potentially implicated.

There are several possible reasons why poor maintenance of activation for peripheral semantic features was not linked with poor RHD comprehension on the High-level Inference measure. Among these are differences in structural and representational properties of the two types of narrative texts; in presentation of the two comprehension tasks; and in the nature of the target inferences in the two tasks. More work is needed to ascertain the specific aspects of narrative processing that suffer when sustained peripheral feature activation is impaired in adults with RHD.

The total RHD group was significantly poorer than the control group at sustaining activation for peripheral features of nouns. This may appear to contradict prior reports of a 'suppression deficit' for RHD subjects, evidenced by abnormally prolonged maintenance of activation for some secondary (24) and contextually-inappropriate meanings of words (25, 26).

However, because the nouns in this study were embedded in neutral sentences, the suppression deficit account does not apply (27).

While the results of this study have no immediate clinical applications, a better understanding of factors that may influence discourse comprehension in adults with RHD should have eventual clinical implications for this still understudied population.

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Table 1. Sample stimulus for High-Level Inference task (from Winner et al. (21)).

Sample Story: Jack and the Brownie

Betty baked some brownies for the church bake sale. She told her husband Jack not to eat a single one because he was on a strict diet. Then she went out to the store. While she was gone, her husband's friend came over. Jack was hungry and couldn't stick to his diet. When his friend left to go to the bathroom, Jack started eating the brownies.

Fact Question: Did Jack eat some brownies?

Meanwhile, Betty had forgotten something and came back home. Just as she was about to open the door, she saw Jack through the kitchen window, biting into a brownie.

First-Order Belief Question: Did Betty realize that Jack was eating a brownie?

Betty walked into the kitchen. She looked angrily at Jack as he was chewing and held a half-eaten brownie in his hand. Betty walked out of the room. Jack's friend returned from the bathroom and asked Jack, "Hey, does Betty know that you are breaking your diet?"

Second-Order Belief Question: What do you think Jack told his friend? Yes or No?

Second-Order Follow-Up Question: Did Jack think that what he told his friend was really true?

Betty came back into the kitchen. She asked Jack, "Are you having a hard time sticking to your diet?" Jack replied, "I haven't eaten anything fattening all day."

Second-Order Expectation Question: When Jack said that to Betty, did he think that Betty would believe him?

Table 2. Descriptive (M, SD) and statistical data on coarse coding and comprehension measures for two participant groups.

	RHD (N = 32)	NBD (N = 38)
Coarse Coding measure (maximum = 16)		
Short ISI [a]	15.53 (0.72)	15.82 (0.39)
Long ISI [b]	15.31 (0.78)	15.76 (0.43)
DCT-Implied question accuracy		
(maximum = 20) [c]	16.00 (2.21)	17.10 (2.06)
High-level Inference accuracy [d]	9.47 (3.20)	12.34 (3.79)
(maximum = 18) [e]		

Note. RHD = right-hemisphere-damaged. NBD = non-brain-damaged. ISI = Interstimulus interval condition. DCT = Discourse comprehension test (Brookshire & Nicholas, (20)).

[a] t (68) = -2.10; $p < .05$

[b] t (68) = -3.05; $p < .05$

[c] t (68) = -2.16; $p < .05$

[d] The groups did not differ on the lower-level Fact and First-Order belief questions

[e] t (68) = -3.39 ; $p < .05$

Table 3. Descriptive data (M, SD) on coarse coding variables for RHD comprehension subgroups.

	Coarse Coding (maximum = 16)	
	Short ISI	Long ISI
DCT-Implied question accuracy (maximum = 20)		
High comprehenders	15.83 (0.39)	15.75 (0.45)
Low comprehenders	15.20 (1.03)	14.80 (0.79)
High-level Inference accuracy (maximum = 18)		
High comprehenders	15.38 (0.74)	15.50 (0.53)
Low comprehenders	15.14 (1.07)	15.00 (1.00)

Note. RHD = right-hemisphere-damaged. ISI = Interstimulus interval condition. DCT = Discourse Comprehension Test (Brookshire & Nicholas, (20)). DCT-Implied High comprehender score $\geq$ 17; low $\leq$ 14. High-level Inference High score $\geq$ 11; low $\leq$ 7.