Right hemisphere brain damage (RHD) in adults can markedly impair high-level inferencing in discourse (e.g., Winner, Brownell, Happe, Blum, & Pincus, 1998; Happe, Brownell, & Winner, 1998; Tompkins, 1995). To assess high-level inferencing, investigators and clinicians have relied on specialized, nonstandard measures, because existing tests of language function in RHD do not tap inferencing with many items or in much depth. Yet standardized assessment measures afford many clinical and investigative advantages, including their known reliability and validity. If a standardized measure that has been thought to be insensitive to high-level inferencing could in fact predict performance on inferencing measures, that would be of great value.

The current study was performed to investigate whether one standardized test, the Discourse Comprehension Test (DCT, Brookshire & Nicholas, 1993) can predict high-level inferencing by adults with RHD. The DCT was chosen because it is a well-controlled measure of narrative processing that has good psychometric properties, and because it taps comprehension of implied information as well as explicitly-conveyed information.

Method

Participants. Thirty-two adults with unilateral RHD due to CVA (confirmed by CT/MRI scan reports) participated in this study. All met stringent inclusion criteria concerning hearing acuity, native language, and handedness. Table 1 provides demographic and clinical data.

Discourse Comprehension Tasks and Measures. The first comprehension task was the DCT (Brookshire & Nicholas, 1993), set A stimuli. Audiorecorded for this study, the stimuli averaged 63.2 seconds in duration. The texts depict "humorous situations that would be familiar to most adults in America" (p. 6). Stimuli are 14 sentences long and extensively controlled for other structural variables, including number of words, number of subordinate clauses, and ratio of clauses to T-units. On average only 1.8 words per passage are designated 'unfamiliar' (i.e., not among the 10,000 most frequent words in printed English (Carroll, Davies, & Richman, 1971), excluding proper names). The stories are relatively 'easy' in listening difficulty, per the Easy Listening Formula (Fang, 1966) that tracks the number of syllables beyond 1 per sentence.

Each narrative is followed by 8 spoken Yes/No questions about either directly-stated or implied main ideas and details. The questions range from 4 to 13 words in length (M = 7.8) and contain no unfamiliar words. They are controlled for ratio of clauses to T-Units and characterized for passage dependency (Tuiman, 1974).

Subjects responded by pointing to index cards containing the words 'Yes' and 'No' in ½" block letters. Both total accuracy overall (max = 40) and total accuracy on the questions about implied information (max = 20) served as outcome measures for this task. See Appendix A for a sample stimulus and comprehension questions.

The second comprehension task, dubbed the 'Higher-level inferencing' task, used stimuli that contain overt contradictions and trigger competing interpretations. As such they require cognitive processes of interest in typical RHD comprehension deficits, including processes related to coherence inferencing, reanalysis, and meaning integration. Participants listened to 6 scenarios from Winner et al. (1998) and pointed to Yes/No cards to indicate their answers to questions about a character's second-order beliefs and second-order expectations, as well as follow-up questions (see Appendix B for examples). A composite accuracy measure (maximum = 18) was constructed to provide a range of scores for correlation with the two DCT outcome measures.

Results

Table 2 provides group data on the discourse comprehension measures. Pearson

correlations coefficients were low-moderate and nonsignificant for both the total DCT outcome measure (r (32) = .316; p = .078) and the DCT-implied measure (r (32) = .214; p = .240).

Discussion and Implications

The discussion will address a number of factors that could account for the inability of DCT outcome measures to predict higher-level inferencing. Among these are the inherent unreliability of any nonstandard measure. Other possible factors include differences in:

1) Structural and representational text properties. For example, unlike the DCT, characters in the high-level inference stories enter and leave the active narrative representation, take turns speaking, and the first-introduced character is not always the story protagonist or focus. Also, in these stimuli, but not the DCT texts, the final statement is literally false and contradicts earlier text material. In all, these structural/representational features trigger quite a variety of competing activations and integration requirements.
2) Task presentation. The high-level inference stimuli, but not the DCT stimuli, are periodically interrupted by comprehension questions.
    a. Nature of the target inferences. The higher-level inference task also queries inferences about characters' knowledge and beliefs, and as such may tap a social dimension that has distinct cognitive underpinnings from those that support structural discourse representation and integration (e.g., Brownell & Martino, 1998).

The research question posed in this study needs further investigation, with factors like these taken into account.

References

Bayles, K. A. & Tomoeda, C. K. (1993). *Arizona Battery for Communication Disorders of Dementia.* Tucson, AZ: Canyonlands Publishing.

Benton, A. L., Hamsher, K. d., Varney, N. R., & Spreen, O. (1983). Judgment of Line Orientation. In *Contributions to neuropsychological assessment* (pp. 44-54). New York: Oxford University Press.

Benton, A. L., Sivan, A. B., Hamsher, K. d., Varney, N. R., & Spreen, O. (1983). Visual Form Discrimination. In *Contributions to neuropsychological assessment*. New York: Oxford University Press.

Brookshire, R.H. & Nicholas, L.E. (1993*). Discourse Comprehension Test.* Tucson: Communication Skill Builders.

Brownell, H. H. & Martino, G. (1998). Deficits in inference and social cognition: The effects of right hemisphere brain damage on discourse. In M. Beeman & C. Chiarello (Eds.), *Right hemisphere language comprehension: Perspectives from cognitive neuroscience* (pp. 309-328). Mahwah, NJ: Lawrence Erlbaum Associates.

Caplan, D. (1987). Discrimination of normal and aphasic subjects on a test of syntactic comprehension. *Neuropsychologia, 25*, 173–184.

Dunn, L., & Dunn, L. (1997). *Peabody Picture Vocabulary Test-III.* Circle Pines, MN: American Guidance Service.

Fang, I. E. (1966). The easy listening formula. *Journal of Broadcasting, 11*, 63-68.

Tompkins, C.A. (1995*). Right hemisphere communication disorders: Theory and management.* San Diego: Singular Publishing.

Tompkins, C. A., Fassbinder, W., Lehman-Blake, M. T., & Baumgaertner, A. (2002). The nature and implications of right hemisphere language disorders: Issues in search of answers. In A. E. Hillis (Ed.), *Handbook of adult language disorders: Integrating cognitive neuropsychology, neurology, and rehabilitation.* (pp. 429-449). New York: Psychology Press.

Tuiman, J. (1974). Determing the passage dependency of comprehension test questions in five major tests. *Reading Research Quarterly, 2*, 206-223.

Wilson, B., Cockburn, J., & Halligan, P. (1987). *Behavioural Inattention Test.* Titchfield, England: Thames Valley Test Company.

Winner, E., Brownell, H., Happe, F., Blum, A., & Pincus D. (1998). Distinguishing lies from jokes: Theory of mind deficits and discourse interpretation in right hemisphere brain-damaged patients. *Brain & Language. 62*(1), 89-106.

Table 1. Demographic and clinical characteristics of study participants.

Characteristics	**RHD** (N=32)
Age (years)	
Mean (SD)	64.5 (11.8)
Range	42-85
Gender	
Male	16
Female	16
Education (years)	
Mean (SD)	14.2 (3.1)
Range	9-22
Lesion site (from CT/MRI report)	
Right cortical anterior	3
Right cortical posterior	10
Right cortical anterior + posterior	5
Right basal ganglia	8
Right thalamus	1
Right subcortical mixed	2
Right MCA (unspecified)	3
Lesion type (from CT/MRI report)	
Thromboembolic	17
Lacunar	2
Hemorrhagic	13
Months post-onset	
Mean (SD)	52.2 (50.9)
Range	4-167
*PPVT–R[a]	
Mean (SD)	157.3 (11.3)
Range	132-173

*Cleft Object Sentence Comprehension[b]	
Mean (SD)	9.5 (.78)
Range	7-10
*Auditory Working Memory for Language[c]	
Word recall errors	
Mean (SD)	13.2 (7.0)
Range	1-27
*Behavioural Inattention Test[d]	
Mean (SD)	137.0 (13.5)
Range	85-146
*Visual Form Discrimination[e]	
Mean (SD)	28.1 (3.5)
Range	20-32
*Judgement of Line Orientation[f]	
Mean (SD)	22.2 (5.2)
Range	9-30
ABCD[g] Story Retell	
*Immediate Retell	
Mean (SD)	13.2 (2.5)
Range	7-17
Delayed Retell	
Mean (SD)	12.7 (3.1)
Range	5-17

Note. RHD = right hemisphere brain damage; anterior = anterior to Rolandic fissure; posterior = posterior to Rolandic fissure

[a]PPVT–R = Peabody Picture Vocabulary Test--Revised; Dunn & Dunn (1981; maximum = 175).

[b]Caplan (1987; maximum=10; cleft object sentence subset)

[c]Tompkins et al. (1994; maximum errors = 42).

[d]Wilson, Cockburn, & Halligan (1987; maximum = 146; neglect cutoff = 129).

[e]Benton, Sivan, Hamsher, Varney & Spreen, (1983; age & gender corrected score; maximum = 35).

[f]Benton, Hamsher, Varney, & Spreen (1983; maximum = 32).

[g]ABCD = Arizona Battery for Communication Disorders in Dementia; Bayles & Tomoeda, (1993; maximum = 17)

* = significantly poorer than a matched, non-brain-damaged control group (by independent t-test, $p < .05$)

Table 2. Descriptive data (M, SD) on comprehension measures.

	RHD (N = 32)
DCT-Total accuracy (maximum = 40)	33.84 (3.26)
DCT-Implied question accuracy (maximum = 20)	16.00 (2.21)
High-level Inference accuracy (maximum = 18) [d]	9.47 (3.20)

Note. RHD = right-hemisphere-damaged. DCT = Discourse comprehension test (Brookshire & Nicholas, 1983).
Note. All RHD data are significantly lower than those of a matched, non-brain-damaged control group.

Appendix A. Sample stimulus from Discourse Comprehension Test (Brookshire & Nicholas, 1993).

Sample Story:

Neil Williams was short of money. The new term was about to begin and he didn't have enough money to pay his tuition. So, one day, he walked to his parents' home and borrowed their car. Then he drove to the bank to get a student loan. The loan officer at the bank was a tough old woman who always said she had never made a bad loan. She questioned Neil about his grades, about his sources of income, and about his plans for a job when he graduated. Things looked grim for Neil, especially when the woman asked for collateral because all Neil had to offer was his old wreck of a car. Finally the woman said to him that she wasn't convinced that he really needed the money. Neil thought hard. He had to convince the woman that he really did need the money. "Well," he said, "For lunch today I had a macaroni sandwich." The woman looked at him with surprise. Then she took out a form and began writing. Finally she looked at Neil and said, with a smile, "You obviously need a loan—or someone to cook for you."

Comprehension Questions (and correct answers):

Was Neil a high school student? (No, Implied main idea)
Did Neil's parents live nearby? (Yes, Implied detail)
Did Neil go to the bank to get a loan? (Yes, Stated main idea)
Did Neil need the money to start a new business? (No, Stated main idea)
Did Neil own a car? (Yes, Stated detail)
Did Neil go to the bank in the morning? (No, Implied detail)
Did Neil tell the woman that he had a cheese sandwich for lunch? (No, Stated detail)
Did Neil get the loan? (Yes, Implied main idea)

Appendix B. Sample stimulus from Winner et al. (1998)

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?

Joke Version: 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?"
Lie Version: Jack did not see that Betty was watching him. As Jack was eating, his friend returned from the bathroom and asked him, "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?

Interpretation Question: When Jack said, "I haven't eaten anything fattening all day," was he: (a) lying to avoid getting caught, or (b) joking to cover up his embarrassment?