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Self-Awareness in Patients with Right Hemisphere Damage

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Self-awareness can be defined as the ability to perceive, identify, and self-regulate one's own performance (Prigatano and Schacter, 1991). The neuronal organization and cognitive functioning of the right hemisphere appears to be particularly well suited for the processes involved in self-awareness (Heilman, Watson, and Valenstein, 1985). The majority of research pertaining to the cognitive disorders associated with right hemisphere damage (RHD) has been in the areas of linguistic processing, pragmatics, attention, neglect, visuospatial processing, and affective processing (Kaplan, Brownell, Jacobs, and Gardner, 1990; Brownell, Potter, Bihrle, and Gardner, 1986; Myers, 1986; Stuss and Benson, 1986; Levine and Grek, 1984; Goldberg and Costa, 1981; and others). However, an increasing interest in self-awareness has emerged in recent years (Sohlberg, 1993; Prigatano and Schacter, 1991; Schacter, 1990; McGlynn and Schacter, 1989; Stuss and Benson, 1986; Lezak, 1983; Konow and Pribram, 1970). These studies have focused primarily on (a) the theoretical foundation of the hemispheric differences of self-awareness, and (b) clinical and pragmatic implications of self-awareness disorders in persons with brain damage. While decreased self-awareness is generally regarded by clinicians as a poor prognostic factor for patients with RHD, there is no empirical evidence to support the notion that self-awareness deficits are associated with RHD. Therefore, the purpose of the present study was (1) to determine if RHD subjects have significantly poorer self-awareness than normal subjects, and (2) to explore the nature of self-awareness deficits in RHD subjects.

METHOD

Subjects

A total of 42 subjects, 21 normal (5 male and 16 female) and 21 RHD (5 male and 16 female) participated in this study. RHD subjects were recruited through the cooperation of physicians and rehabilitation professionals in hospital, out-patient, and home care agencies. Normal subjects who matched RHD subjects in terms of age, gender, and education were located through community bulletin boards, senior citizen newsletters, and volunteer organizations.

All subjects were right-handed, native English speakers, with no significant history of alcoholism, drug abuse, or psychiatric disorder. All subjects had completed at least 9 years of primary education, and demonstrated adequate visual and hearing acuity (aided or unaided) for reception of printed materials and conversational-level speech. RHD subjects had sustained single, unilateral, cerebral vascular accidents at least 2 months prior to their participation in this study, and exhibited no significant degree of diffuse cerebral atrophy or history of previous neurologic disorder. This was evidenced by clinical reports and neuroradiologic examination when available. Normal subjects reported no history of neurological pathology. Table 1 summarizes neuropsychological test performance for both groups. The RHD group scored significantly poorer than the normal group on all but one measure, *the Mini Inventory of Right Brain Injury* (MIRBI-Visuoverbal Processing; Pimental and Kingsbury, 1989).

Subjects ranged in age from 36 to 97 years ($\underline{M}$ = 71.95, $\underline{SD}$ = 11.53) and educational levels ranged from 9 to 18 years ($\underline{M}$ = 12.51, $\underline{SD}$ = 2.24). Analysis of variance revealed no significant differences between groups for age ($\underline{F}(1, 40) = 1.04$; $\underline{p} = .937$) or education ($\underline{F}(1,40) = 1.43$; $\underline{p} = .660$). RHD subjects ranged in time post onset from 2 to 69 months ($\underline{M}$ = 14.62, $\underline{SD}$ = 17.63).

Procedure

A 6-point scale was developed based on clinical observation of RHD patients and a review of the literature (Konow and Pribram, 1970; Prigatano and Schacter, 1991), to measure self-awareness while performance tasks were being carried out by subjects. The scale considered three dimensions: perception of performance, presence or absence of a cue from the examiner or the subject, and any action taken by the subject to modify the response (Table 2).

We chose to examine self-awareness by looking separately at the awareness of performance accuracy and the awareness of performance completeness. The rationale for examining these two components of self-awareness was that clinical observation of RHD patients indicated that these two aspects may be independent skills. Furthermore, it intuitively appeared that the ability to recognize the accuracy of performance and the ability to recognize the completeness of performance may depend upon different cognitive abilities.

A set of standardized performance tasks was needed to which the scale could be applied. A variety of tasks from commonly used neuropsychological tests were selected for this purpose because they met the following criteria: (1) the task was sensitive to the disorders commonly observed in RHD patients; (2) the task was familiar to clinicians; and (3) the task

Table 1. Summary of Performance Scores for Neuropsychological Tests

Test	Group	#	Range	Mean	Standard Deviation	Significance Level Between Groups*
Rehabilitation Institute of Chicago Evaluation of Communication Problems in Right Hemisphere Dysfunction (Rice)-Sentence Copying (Burns, Halper, & Mogil, 1985)						
	Normal	21	92–100%	99.05%	2.16%	p = .012**
	RHD	21	72–100%	92.57%	8.79%	
Mini Inventory of Right Brain Injury (MIRBI)-Visual Scanning (Pimental & Kingsbury, 1989)						
	Normal	21	50–100%	97.62%	10.91%	p = .000***
	RHD	21	0–100%	61.90%	38.42%	
MIRBI-Visuoverbal Processing (Sentence to Dictation, Oral Reading)						
	Normal	21	90–100%	98.7%	3.3%	p = .126 NS
	RHD	21	22–100%	92.4%	18.1%	
MIRBI-Visuomotor Construction (Clock)						
	Normal	21	0–100%	80.95%	29.5%	p = .000***
	RHD	21	0–100%	38.1%	31.2%	
Wechsler Intelligence Scale for Children (WISC–III)-Picture Arrangement (Wechsler, 1991)						
	Normal	20	2–19	8.1	4.0	p = .000***
	RHD	18	2–10	2.3	2.9	
Wechsler Adult Intelligence Scale-Revised (WAIS–R)-Block Design (Wechsler, 1981)						
	Normal	21	2–95	58.9	24.8	p = .000***
	RHD	19	0.4–84	20.3	21.3	
WAIS–R-Digit Symbol						
	Normal	20	25–98	58.9	24.8	p = .000***
	RHD	20	2–95	22.6	22.5	
WAIS–R-Trailmaking-Trails A						
	Normal	19	24–76	37.74	12.1	p = .000***
	RHD	15	45–341	126.2	90.3	ANOVA
Trailmaking-Trails B						
	Normal	14	44–180	89.5	32.6	p = .001**
	RHD	7	101–209	151.0	43.5	ANOVA
Line Bisection - Left Lines (Schenkenberg, Bradford, & Ajaz, 1980)						
	Normal	21	-10.66 to 6.22%	0.27%	4.4%	p = .008**
	RHD	20	-11.22 to 57.22%	10.9%	16.9%	ANOVA
Boston Diagnostic Aphasia Examination (BDAE)-Calculations (Goodglass & Kaplan, 1983)						
	Normal	20	50–100%	88.7%	15.2%	p = .000***
	RHD	20	0–87%	56.6%	24.5%	

* Independent t-tests were used to determine group differences unless otherwise specified.
** $p < .01$
*** $p < .001$

Table 2. Self-Awareness Scale

Score	*Description*
5	Accurate perception of performance. No additions and/or corrections are necessary before being asked the self-awareness questions.
4	Accurate perception of performance. Additions, modifications, and/or corrections are made prior to being asked the self-awareness questions.
3	Accurate perception of performance. The appropriate additions and/or corrections are attempted after being asked the self-awareness questions, or after the subject made obvious commentary to self about error or omission and attempted a self-correction—making additional trials redundant. (These attempts may not necessarily result in a complete and/or accurate final performance on the task.)
2	Accurate perception of performance. No effort made to make additions and/or corrections after being asked the questions or after any commentary by the patient himself.
1	Inaccurate perception of performance. The patient may or may not make an effort to make additions and/or corrections after being asked the question, or after making comment to himself, but his perception is still inaccurate. This score would also be given if a patient said his performance was not complete/accurate, but it actually was complete/accurate.
0	No response, irrelevant response, confabulatory response, refusal to participate, etc.

allowed for measurement of two response components: (a) definable beginning and end points (to allow for a measure of awareness of completeness); and (b) an objective dimension of accuracy that could be definably different from the completeness component. For example, drawing a clock with hands set at ten after eleven would allow for a judgment of performance completeness (i.e., all numbers, hands, and clock face are present) as well as an independent judgment of performance accuracy (i.e., numbers, hands, and clock face are positioned correctly even if some components are missing). These neuropsychological tasks (Table 3) were administered in random order to all subjects. Self-awareness questions were asked to assess the completeness and accuracy of performance after each of the 22 items in the battery. These questions were necessarily modified according to the characteristics of each item. Responses to self-awareness questions on each of the 22 items were rated according to the self-awareness scale (Table 2).

Table 3. Self-Awareness Questions and the Neuropsychological Performance Tasks to Which They Were Applied

Neuropsychological Performance Tasks	*Number of Items Used*	*Completeness Question*	*Accuracy Question*
Rey–Osterrieth Complex Figure	1	Did you draw all of the parts?	Did you draw everything correctly? *Are the lines that you drew drawn correctly?
RICE-Sentence Copying	1	Did you write the whole sentence?	Did you write everything correctly? *Of what you did copy.....?
MIRBI-Visual Scanning	2	Did you get all of the As?	Did you get only the letters you wanted?
MIRBI-Sentence to Dictation	1	Did you write the whole sentence?	Did you write everything correctly?
MIRBI-Oral Reading	1	Did you read all the words in the paragraph?	Did you say all the words that you read correctly?
MIRBI-Clock	1	Did you draw all of the parts?	Did you draw everything correctly?
Supplemental Oral Reading Paragraph	1	Did you read all the words in that paragraph?	Did you say all the words that you read correctly?
WISC–III-Picture Arrangement	5	Did you use all the pictures?	Are the pictures in the right order?
WAIS–R-Block Design	4	Did you use all the blocks?	Did you put the blocks in the right places?
Digit Symbol	1	Did you fill in all the squares?	Did you put the right symbols in the right squares?
Trail Making (Trails A & B)	2	Did you connect all the numbers (and letters)?	Did you connect all the numbers (and letters) in the right order?
Line Bisection	1	Did you mark each of the lines?	Did you mark each line right in the middle?
BDAE-Calculations	1	Did you do all of the problems?	Did you get the right answers?
Total test items = 22			

Note: See Table 1 for explanation of neuropsychological test abbreviations (test name, author(s), and date).
*Example of alternate form of the accuracy question. Alternate form was used if the subject acknowledged incompleteness in order to be sure the subject understood the independence of accuracy and completeness.

for Right Hemisphere-Damaged (RHD) and Normal Subjects

Test	*Cases*	*Corrected for Ties Chi-Squared*	*Significance*
WAIS–R-Block Design #1	Normal = 19		
	RHD = 21		
Accuracy		2.416	.120
Completeness		3.312	.069
WAIS–R-Block Design #2	Normal = 19		
	RHD = 21		
Accuracy		9.504	.002*
Completeness		3.490	.061
WAIS–R-Block Design #3	Normal = 19		
	RHD = 21		
Accuracy		8.079	.004*
Completeness		6.130	.013*
BDAE-Calculations	Normal = 21		
	RHD = 21		
Accuracy		8.416	.003*
Completeness		15.018	.000*
MIRBI-Clock	Normal = 21		
	RHD = 20		
Accuracy		14.263	.000*
Completeness		4.893	.027*
WAIS–R-Digit Symbol	Normal = 20		
	RHD = 20		
Accuracy		6.298	.012*
Completeness		16.999	.000*
Line Bisection	Normal = 20		
	RHD = 21		
Accuracy		11.888	.000*
Completeness		10.997	.000*
Oral Reading-Supplement	Normal = 21		
	RHD = 21		
Accuracy		3.271	.046*
Completeness		1.296	.254
WISC–III-Picture Arrangement #1			
	Normal = 18		
	RHD = 20		
Accuracy		3.947	.046*
Completeness		3.517	.060
WISC–III-Picture Arrangement #2			
	Normal = 18		
	RHD = 20		
Accuracy		5.075	.024*
Completeness		3.517	.060

continued

Table 4. Results of Kruskal–Wallis Analysis on Self-Awareness Scores for Right Hemisphere-Damaged (RHD) and Normal Subjects (continued)

Test	*Cases*	*Corrected for Ties Chi-Squared*	*Significance*
WISC–III-Picture Arrangement #3	Normal = 17		
	RHD = 20		
Accuracy		2.107	.146
Completeness		5.115	.023*
WISC–III-Picture Arrangement #4	Normal = 17		
	RHD = 20		
Accuracy		1.094	.295
Completeness		9.747	.001*
WISC–III-Picture Arrangement #5	Normal = 16		
	RHD = 20		
Accuracy		4.803	.028*
Completeness		3.977	.046*
Rey–Osterrieth Complex Figure	Normal = 20		
	RHD = 20		
Accuracy		6.870	.008*
Completeness		6.546	.010*
RICE-Sentence Copy	Normal = 21		
	RHD = 21		
Accuracy		7.61	.005*
Completeness		3.685	.054
MIRBI-Sentence to Dictation	Normal = 21		
	RHD = 21		
Accuracy		4.347	.037*
Completeness		4.736	.029*
MIRBI-Visual Scanning 1	Normal = 21		
	RDH = 21		
Accuracy		1.00	.317
Completeness		14.051	.000*
MIRBI-Visual Scanning 2	Normal = 21		
	RHD = 21		
Accuracy		1.00	.317
Completeness		6.471	.011*

Note: See Table 1 for explanation of neuropsychological test abbreviations (test name, author(s), and date).
*$p \leq .50$

Spearman rank–order correlation coefficients were performed on data for each test item to determine the relationship between self-awareness of accuracy and completeness. For normal subjects, there was a significant positive relationship between these two measures on 3 of the 19 test items: Line Bisection ($r = .486$, $p = .025$), MIRBI-Oral Reading ($r = .548$, $p = .010$), and MIRBI-Sentence Copy ($r = .442$, $p = .045$). However, for the RHD group there was no significant relationship between self-awareness of accuracy and completeness on any test item.

Spearman rank–order correlation coefficients were also performed on the data to determine the relationship between self-awareness of both accuracy and completeness, and actual performance on the corresponding test items. For normal subjects there was a significant positive relationship between self-awareness of completeness and performance on the Rey–Osterrieth Complex Figure ($r = .829$, $p = .000$) and the MIRBI-Clock ($r = .529$, $p = .020$); and between self-awareness of accuracy and performance on the following test items: Rey–Osterrieth Complex Figure ($r = .603$, $p = .004$), BDAE-Calculations ($r = .780$, $p = .000$), WISC–III-Picture Arrangement 5th item ($r = .729$, $p = .000$), and MIRBI-Sentence to Dictation ($r = .546$, $p = .010$). In marked contrast, correlations between the self-awareness measures and performance for the RHD group failed to reach significance (p # .05) for all but one test item. There was a statistically significant although weak correlation between self-awareness of completeness and performance on the MIRBI-Clock (r 5 .434, p 5 .049) for RHD subjects.

CONCLUSION AND CLINICAL IMPLICATIONS

Clinical observations and literature suggest that self-awareness deficits are associated with RHD, but no empirical evidence to support this idea has been reported to date. The results reported herein showed that RHD subjects had significantly poorer self-awareness of performance on a set of 17 neuropsychological tests when compared to normal controls.

Self-awareness of performance and actual performance on corresponding neuropsychological tests were not strongly correlated for RHD subjects. While this might initially seem counterintuitive, it is consistent with reports of amnesic patients who are capable of learning without awareness (Sohlberg and Mateer 1989). Thus, it appears that self-awareness and performance are not necessarily dependent upon each other.

Goldberg and Barr (1991) have suggested that self-awareness of performance depends upon a tripartite control loop consisting of: "(1) the internal representation of the desired cognitive product; (2) feedback regarding one's own output; and (3) comparison between the content of the feedback and the representation of the desired cognitive product" (pp. 152). The independence of self-awareness and performance demonstrated by the RHD subjects of this study suggests that the breakdown in self-awareness for these subjects did not occur at the level of internal representation of the desired cognitive product. Rather, it would appear that RHD subjects have difficulty at the level of feedback and/or comparison of feedback to desired cognitive products. Further research is needed to elucidate the exact nature of breakdown in self-awareness in RHD patients.

Finally, the authors' conceptualization of self-awareness as being comprised of two independent components was supported by the finding that self-awareness of completeness and accuracy were not highly correlated in RHD subjects. Future planned investigations will explore whether there is a hierarchy of difficulty between these two components of self-awareness.

A larger reliability sample would have been preferable than the one used in our study. We suspect the potential for improved reliability with additional scorer training and evaluation of a larger percent of patients' data.

Because these data suggest that self-awareness deficits are a discriminating variable between RHD subjects and normals, clinicians might consider an objective assessment of self-awareness into their diagnostic battery for RHD patients. Also, they may want to evaluate intra- and interjudge agreement of scoring self-awareness deficits in their patients in their rehabilitation facilities.

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