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AWARENESS OF DEFICITS IN STROKE REHABILITATION

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The aim of this study was to evaluate the awareness of deficit profiles of stroke patients undergoing rehabilitation, and examine the impact of unawareness on rehabilitation functional outcomes. Sixty first-event stroke patients, 36 after right hemisphere damage and 24 after left hemispheric damage were included. The Awareness Interview was administered at admission to rehabilitation, and patients' responses were compared with standardized cognitive and neurological evaluations. The FIM motor scale and a safety rating were used to measure functional outcomes at discharge from rehabilitation and at 1-year follow up. The frequency of unawareness for motor and sensory deficits was low, whereas unawareness of cognitive deficits was much higher. Unawareness was not associated with a specific lesion site, however a significant association was found with cortical involvement, and with lesion size. In the right hemispheric damage group a significant negative correlation was found between total unawareness scores and discharge functional outcomes. Multiple regression revealed that unawareness at admission was a significant predictor of discharge FIM motor scores in the right hemispheric damage group, beyond the contribution of cognitive and demographic variables. Findings delineate the multifaceted nature of unawareness phenomenon, and highlight the significance of unawareness in post-stroke rehabilitation.

Key words: cerebrovascular accident, awareness, rehabilitation outcome.

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INTRODUCTION

Unawareness of neurologically caused impairments has been found in relation to various physical, cognitive and emotional deficits after head injury (1), stroke (2) and dementia (3). From a clinical perspective, lack of awareness is considered an impeding factor in the rehabilitation process. Individuals who are unaware of their limitations may not actively engage in therapeutic activities, may choose activities beyond their abilities and require supervision because of poor safety judgment (4). The aim of the present study was to further the investigation of unawareness of deficits in post-stroke rehabilitation.

Initial studies on awareness after stroke addressed the striking phenomenon of unawareness of paralysis, termed anosognosia for hemiplegia (AHP), typical of patients with right hemisphere damage (RHD) in the acute phase of illness (5). Anderson & Tranel (6) expanded the traditional studies of anosognosia, to include unawareness of cognitive deficits as well. They used the term unawareness to refer to "a condition in which there is a failure to acknowledge acquired impairments of cognitive or motor function in response to explicit questioning". They developed the standardized "Awareness Interview" (AI) to address this issue and studied individuals after brain damage from three diagnostic categories: stroke, progressive dementia syndromes and traumatic head injury. They found that brain damage associated with the above diagnoses is often accompanied by unawareness of impairments. Results pertaining specifically to the stroke group ($n = 32$, examined 3–25 days post onset) showed the following: (1) Overall unawareness scores were significantly associated with cognitive impairment; (2) Unawareness of motor deficit was present in 28% of the RHD group only; unawareness of cognitive deficits was present in 72% of the entire stroke group; (3) The RHD group had significantly higher mean unawareness scores than the left-hemisphere damage (LHD) group after controlling for demographic variables and severity of deficit ($p < 0.001$). The authors highlighted the dissociation between unawareness of motor versus cognitive deficits and the higher prevalence of the latter, pointing to the importance of addressing both types of unawareness in rehabilitation. However, the sample of stroke patients was small, considering the division into two hemispheric groups, and limited to the acute phase post-stroke.

Wagner & Cushman (7) extended the study of Anderson & Tranel (6), focusing on unawareness of cognitive deficits in a sample of 108 hospitalized stroke patients (mean time post onset = 4.9 weeks) and 30 patients hospitalized for non-neurological problems. The AI was used to measure awareness, in addition to the Mini Mental Status Evaluation (MMSE) and the cognitive scale of the Functional Independence Measure (FIM) as measures of cognitive impairment. The results showed that: (1) unawareness was significantly associated with brain injury; (2) unawareness occurred in varying degrees of severity in 39% of the stroke group; (3) overall unawareness scores were significantly associated with overall cognitive impairment and with cortical versus subcortical lesion sites. In contrast to the initial study by Anderson & Tranel (6) these authors did not find a significant difference between hemisphere groups. Hibbard et al. (8), using a similar methodology (Awareness Questionnaire), demonstrated the pervasiveness and persistence of unawareness of deficits (with the highest prevalence found for cognitive ones) in a group of stroke patients studied approximately 1-year post onset. Like in Wagner & Cushman's study (7) no significant lateralization effects were found.

The relationship of unawareness of deficits to rehabilitation outcomes: Labuda & Lichtenberg (9) found that unawareness of deficits, as measured by the AI at admission to a geriatric rehabilitation hospital, contributed significantly to the explained variance of instrumental activities of daily living (IADL) performance at discharge from hospital. Multiple regression showed that unawareness contributed unique variance beyond that accounted for by demographics and overall cognitive deficit. However, the sample included patients with a "variety of physical disabilities and medical conditions", and diagnoses were not specified, therefore it is difficult to generalize the results to the stroke population. Similarly, Prigatano & Wong (10) found that awareness of memory deficit was related to ADL goal attainment in a large sample of heterogeneous brain dysfunctional patients. Studies that focused exclusively on the stroke population (11, 12) found a negative impact of acute AHP on functional outcomes at discharge from rehabilitation.

The above studies clearly establish the significant prevalence of unawareness of deficits in the stroke population at various stages of chronicity. The relation of unawareness to cognitive deficit appears to be consistent as well, yet results pertaining to neuroanatomic associations vary between studies. All authors address the significance of unawareness in the rehabilitation process yet outcome studies are sparse, limited by heterogeneous samples or scope of awareness areas.

The purpose of this study was twofold: (1) describe the unawareness of deficit profile in a sample of first-event left and right hemisphere damaged stroke patients, in the beginning of the rehabilitation process (beyond the acute phase of illness); (2) examine the impact of unawareness on functional outcomes at discharge from rehabilitation and at 1-year follow-up.

METHOD

Participants

Thirty-six RHD and 24 LHD patients admitted to the Loewenstein Rehabilitation Hospital (Ra'anana, Israel) for rehabilitation after stroke were recruited for the study on the basis of the following inclusion criteria:

(1) First occurrence of an ischemic brain infarction or a parenchymal hemorrhage.
(2) Absence of marked mass effect (with possible unrecognizable distant structural damage) and of significant cortical atrophy, in the acute-stage computerized tomography (CT) scan.
(3) Negative neurologic or psychiatric past history.
(4) Right handedness.
(5) A minimum of 6 years formal education.
(6) Fair premorbid knowledge of the Hebrew language, and post-stroke sufficient language skills to understand and respond to basic interview and questionnaires (All the LHD patients were tested by the Israeli Loewenstein Aphasia Test [ILAT], a comprehensive clinical aphasia battery for Hebrew speaking patients. Subjects with severe language impairment, especially those with global or receptive forms of aphasia, had to be excluded).
(7) Independent living in the community prior to stroke.
(8) Time after onset upon admission to the study: 4–8 weeks.
(9) A stable clinical and metabolic state.

Selection of these inclusion criteria was determined by the specific aims of the present research, i.e. to study the prevalence of unawareness of different types of deficits, in relation to lesion side, site and size, among first-event stroke patients undergoing rehabilitation. Use of verbal tests for the measurement of unawareness precluded testing of LHD patients with severe language impairments, a fact revealed in the lower proportion of LHD compared with RHD patients. In both hemispheric groups most patients had lesions confined to the vascular territory of the middle cerebral artery (Table I), however, exclusion of cases with severe aphasia reduced the proportion of cases with large peri-sylvian lesions in the LHD group compared with the RHD group (Table I). The exclusion of patients with recurrent strokes, with significant brain atrophy, etc. prevents generalization of the findings to the general stroke population. Another source of selection bias preventing such generalization derives from the fact that these were all patients referred to a rehabilitation center. In this country, stroke patients evaluated by a neurologist in the general hospital as having no rehabilitation potential are often referred directly to nursing homes. Also, the majority of stroke patients aged 75 years or older are referred to geriatric centers for rehabilitation, rather than to a general rehabilitation center. The final sample comprised 16 women and 44 men, mean age = 57.4 (SD = 11.7), and mean years of education = 10.3 (SD = 2.7). There were no significant differences in demographic variables, time post onset, or basic disability level (FIM scores) between hemisphere groups at admission to the study (Table II).

Instruments

Awareness: Awareness of deficits was measured using the Awareness Interview (AI) (6). The authors reported an inter-rater reliability coefficient of 0.92, and construct validity was established in the stroke population (6, 7). The interview was developed to provide a standardized assessment of awareness of disease and deficits. The patients are initially questioned about the reason for their hospitalization (stroke) and then required to appraise whether they have a problem in motor, sensory, and several cognitive domains. Answers to each domain are rated on a 3-point scale: "patient complains of significant impairment"; "patient describes minimal impairment"; "patient indicates no problem in this domain". Unawareness was operationally defined as the discrepancy between the subject's description of abilities and measurement of those abilities with standardized cognitive and neurological evaluations classified on a comparable 3-point scale: "severe deficit", "mild deficit" and "intact". The discrepancies between the interview and the evaluations provided the awareness measure. In order to enable comparison with the other study using the AI in stroke population (7) we utilized the same scoring procedures—for each domain a discrepancy of 0 indicated no unawareness (given a score of 1 point), a discrepancy of 1 indicated that client was unaware of a mild deficit or rated a severe deficit as minimal (mild unawareness—given a score of 2), and a discrepancy of 2 indicated that the patient was unaware of a severe deficit (severe unawareness—given a score of 3). Over-reporting of deficits was rare, a patient who reported impairment in an area that was tested normal, was rated aware on that item. In order to examine the impact of unawareness on functional outcome, a total "unawareness of deficits" score was computed by summing all discrepancies, as described in the other studies using the AI (6, 7, 9). The neurological examination provided the comparison criteria for the motor and sensory (vision) domains, and the cognitive tests provided the comparison criteria for the cognitive domains of thinking, orientation, memory, and visual attention. The standardized cognitive measures, used routinely at the rehabilitation center, included the orientation and classification subtests of the LOTCA (Loewenstein Occupational Therapy Cognitive Assessment) (13, 14), the picture recognition subtest of the RBMT (Rivermead Behavioral Memory Test) (15) and the Star Cancellation subtest of the BIT (Behavioural Inattention Test) (16).

Outcome measures: (a) The FIM was developed to provide a uniform

Table I. *Lesion characteristics by hemisphere groups. Number of patients are given*

	RHD ($n = 36$)	LHD ($n = 24$)
CVA type:		
Parenchymal hemorrhage	6	3
Ischemic infarction	30	21
Lesion site:		
Frontal	10	9
Parietal	14	7
Temporal	12	7
Occipital	1	1
Thalamic	4	3
Capsular-putaminal	25	19
Intra hemispheric white matter	29	20
Cortical/subcortical involvement:		
Cortical	17	10
Subcortical	33	22
Cortical and subcortical	14	8
Lesion size (max. lesion diameter):		
1–3 cm	14	11
3–5 cm	10	7
>5 cm	12	6

RHD = right hemisphere damage; LHD = left hemisphere damage; FIM = Functional Independence Measure.

data system for medical rehabilitation and to rate severity of patient disability and the outcomes of medical rehabilitation (17). Reliability and validity have been extensively established (18), and the FIM is universally accepted as a disability measure in stroke rehabilitation (19, 20). The FIM includes a motor and a cognitive scale. The motor scale includes 13 items of basic self-care, and the cognitive scale includes 5 items of "social cognition" including language, problem solving, memory and social interaction. The motor scale provided the main outcome measure of this study, and the cognitive scale provided a measure of overall cognition, as suggested by Davidoff et al. (21), and used by Wagner & Cushman (7) with the AI in the stroke population. The FIM was scored by the occupational therapist at admission to, and discharge from rehabilitation and at follow-up. (b) The "Safety Rating Scale" is part of the Routine Task Inventory (22), a structured observation used to rate cognitive levels in daily routine activities. Safety is rated on a 4-point scale from "unable to retain safety procedures", to "anticipates hazards and comprehends safety precautions". Safety was rated by the occupational therapist at discharge from rehabilitation. Safety is a primary concern at discharge planning, and a prerequisite for independent living in the community. Since patients with unawareness are considered at risk for poor safety skills this scale was included in the outcome measures.

Procedure

The data collection team included a rehabilitation physician who selected the patients, performed the neurological examination, and interpreted the CT scans, and an occupational therapist that interviewed, tested and observed the patients. The study was approved by the Hospital Human Rights Committee and all patients signed informed consent forms. The neurological examination was conducted within 1 week of the interview, and the cognitive tests were administered on the same day. Follow-up CT scans were used for the analysis of lesion location and extent (Table II). On the basis of Talairach & Tournoux's (23) atlas, structural brain damage was defined as involving or not the following regions of interest (ROIs): frontal, parietal, temporal, and occipital cortical areas, the capsular-putaminal region (including: external capsule, lentiform nucleus, caudate nucleus, internal capsule), the thalamus, and the intra-hemispheric white matter. Based on the extent of their largest diameter, lesions were classified roughly into one of four groups: <1 cm, 1–3 cm, 3–5 cm, >5 cm (in fact none of the lesions was

Table II. *Demographics and initial disability levels at admission (mean ± SD)*

	RHD ($n = 36$)	LHD ($n = 24$)
Age	56.42 ± 10.62	58.96 ± 13.22
Education (years)	10.50 ± 2.68	10.08 ± 2.70
Time post onset	43.36 ± 19.23	43.33 ± 15.21
FIM motor-admission	56.50 ± 15.93	60.13 ± 20.53
FIM cognition-admission	30.22 ± 5.23	26.29 ± 8.92

RHD = right hemisphere damage; RHD = left hemisphere damage; FIM = Functional Independence Measure.

in the first category). The patients were evaluated 3 times: at admission to the rehabilitation hospital (mean time from onset to evaluation = 43.35 days [SD = 17.59]), at discharge from the hospital (mean hospitalization time = 96.38 days [SD = 31.55]) and at follow-up (mean time from onset to follow up = 347.19 days [SD = 97.51]). The first two evaluations were conducted in the hospital, and the follow-up evaluation was conducted in the patients' homes. Three patients were not available for evaluation at the time of discharge from the hospital, and an additional three were excluded from the study at follow-up because they had undergone another stroke after discharge.

Statistical analysis

Data were analyzed using SPSS version 9.0 for Windows. Comparisons between groups were performed using the *t*-test procedure. In order to take into consideration variance heterogeneity, Levene's test for equality of variances was used to determine when to use the "T-statistic for unequal variances" which SPSS provides for each comparison. Non-parametric tests (Spearman's rank correlation) were used for analyzing variables with non-normal distributions. Fisher's Exact Tests was used in evaluating 2 × 2 tables, since not all cells had the required number of observations for the χ^2-test. Two-way analysis of variance (ANOVA) was computed to examine the effect of lesion site and size on total unawareness in both hemispheric groups. Hierarchical multiple regression was performed to evaluate the impact of unawareness on functional outcomes, with cognitive and demographic variables in the same model.

RESULTS

The deficit profile (Table III) at admission to rehabilitation reveals a high incidence of motor deficits, from mild hemiparesis to complete hemiplegia (88% and 79%, in RHD and LHD patients, respectively), whereas the frequency of visual field deficits, including quadrantanopsia and hemianopsia was low (11% and 8%, in RHD and LHD patients, respectively). The frequencies of cognitive deficits varied, with the highest rate found for thinking in the LHD group (83%), and the lowest rate for orientation to place in the RHD group (8%).

Unawareness prevalence

The frequencies of unawareness to the various deficits at admission are presented for each hemisphere group separately in Table III. The frequencies are presented in relation to the number of patients in each group with the specific deficit, and in relation to the entire hemispheric group. The majority of the patients were aware of having a stroke, overall 5 patients still insisted they did not have a stroke and an additional 12 did not report their stroke spontaneously, but admitted to having one

Table III. *Frequencies of deficits and unawareness of deficits in RHD and LHD groups*

	RHD ($n = 36$)					LHD ($n = 24$)				
	Deficit	Unawareness n (% of those with deficit)		(% of all RHD group)		Deficit	Unawareness n (% of those with deficit)		(% of all LHD group)	
	n (%)	Mild	Severe	Mild	Severe	*n* (%)	Mild	Severe	Mild	Severe
Motor	32 (88)	1 (3)	1 (3)	(3)	(3)	19 (79)	3 (16)	0	(13)	(0)
Visual field	4 (11)	1 (25)	0	(3)	(0)	2 (8)	1 (50)	1 (50)	(4)	(4)
Thinking	28 (78)	10 (36)	11 (39)	(28)	(30)	20 (83)	7 (35)	9 (45)	(29)	(38)
Orientation-place	3 (8)	2 (67)	0	(6)	(0)	7 (29)	5 (71)	2 (29)	(21)	(8)
Orientation-time	11 (31)	2 (18)	2 (18)	(6)	(6)	6 (25)	1 (17)	4 (67)	(4)	(17)
Memory	9 (25)	6 (67)	3 (33)	(17)	(8)	7 (29)	2 (29)	3 (43)	(8)	(13)
Visual attention	15 (42)	7 (47)	7 (47)	(19)	(19)	6 (25)	2 (33)	3 (50)	(8)	(13)
Illness/Stroke	36 (100)	6 (17)	3 (8)	(17)	(8)	24 (100)	6 (25)	2 (8)	(25)	(8)

RHD = right hemisphere damage, LHD = left hemisphere damage.

after specific questioning ("did you have a stroke?"). The incidence of unawareness of motor deficit was very low despite the high frequency of the deficit itself. Unawareness of visual field deficit was infrequent, as was the deficit itself. Frequencies of unawareness of cognitive domains were highly varied, with unawareness of thinking deficits dominating in both groups. Deficits in visual attention, as depicted by the star-cancellation task, were—as expected—more frequent among the RHD patients (see Table III).

Total unawareness score: The sum of the individual unawareness of deficit scores comprised the total unawareness of deficits score. The total score ranges from 8 to 24 (higher scores indicating more unawareness). Since the frequency of unawareness of motor and visual-field deficits was low, the total score reflects mainly unawareness for the cognitive domains and unawareness of the stroke. The average total scores were 10.57 (SD = 2.23) and 10.89 (SD = 1.91), for the RHD and LHD groups, respectively. In order to describe the severity of overall unawareness in our sample, we used the classification points depicted by Wagner & Cushman (7): mild unawareness (scores 10–11 on the AI) was found in 50%, moderate unawareness (scores 12–15) in 22%, and severe unawareness (scores 16–24) in 2% of the total sample.

Relation of unawareness to lesion data

Unawareness of specific deficits: Since the number of observations was small in each cell, unawareness scores were recoded into cutoff scores: aware versus unaware (mild and severe unawareness combined). There were no significant differences between the hemisphere groups in all the individual unawareness scores, when comparing groups with deficits.

Total unawareness score: In order to compare the relative contribution of lesion site to the total unawareness score, a two-way ANOVA was performed with cortical versus sub-cortical lesion site, and left versus right hemisphere involvement. A significant main effect was found for the cortical dimension ($F = 6.312$, $p = 0.015$), but not for the hemispheric one ($F = 1.380$, $p = 0.246$), and the interaction was not significant ($F = 0.125$, $p = 0.725$). An additional ANOVA was performed to compare the relative contribution of lesion size (maximal lesion diameter: 1–3, 3–5 and >5 cm) to total unawareness in both hemisphere groups. A significant main effect was found for lesion size (greater lesion size associated with more unawareness) ($F = 4.662$; $p = 0.014$) but not for the hemisphere ($F = 0.659$; $p = 0.421$), and the interaction was not significant ($F = 1.305$; $p = 0.281$).

Functional outcomes and relationships with unawareness of deficits

The means and standard deviations of functional outcomes are presented in Table IV. Basic ADL (BADL) as depicted by FIM motor scores, changed significantly from admission (see Table I) to discharge ($p < 0.001$ in both groups), while no improvement is seen from discharge to follow-up, similar to Katz et al. (14). Mean scores indicate, that while there is significant improvement after rehabilitation, patients still did not reach maximum independence level in BADL. Comparisons of hemisphere groups on these variables revealed no significant differences, except for FIM motor follow-up on which the LHD group scored significantly higher than the RHD one ($p = 0.04$).

A high and significant relationship was found between the total unawareness score and the FIM cognition score measured at admission to rehabilitation in both hemisphere groups (Table IV). A significant moderate negative correlation was found between the total unawareness score and two functional measures at discharge from rehabilitation—FIM motor and Safety Rating Scale—within the RHD group only (Table IV). Unawareness was not significantly correlated with FIM motor follow-up scores, however results approached significance in the RHD group ($r = -0.347$, $p = 0.056$), and were in the opposite direction of the LHD group.

Hierarchical multiple regression was performed to examine the relative contribution of total unawareness at admission in predicting ADL outcome at discharge from rehabilitation,

Table IV. *Functional outcomes and cognition: mean, standard deviation and correlation with total unawareness*

	RHD		LHD	
	Mean (SD)	Corr. with total unawareness	Mean (SD)	Corr. with total unawareness
FIM cognition admission	30.22 (5.23)	−0.561**	26.92 (8.92)	−0.587**
FIM motor discharge	75.89 (15.90)	−0.475**	79.62 (9.67)	0.054
Safety[a] discharge	4.56 (1.32)	−0.506**	5.21 (0.88)	−0.068
FIM motor[b] follow-up	72.34 (12.36)	−0.347	78.91 (9.45)	0.206

RHD = right hemisphere damage; LHD = left hemisphere damage; FIM = Functional Independence Measure; Corr. = Correlation coefficient.
[a] Spearman rank correlation, considering the small ordinal scale of safety variable.
** $p < 0.01$;
[b] *t*-test between hemisphere groups showed a significant difference ($p = 0.04$) on this variable, all other comparisons were not significant.

beyond the contribution of basic cognitive skills, and demographics (see Table V). Discharge FIM motor was the dependent variable and the following variables were entered in 3 blocks to the model: age, gender and education were entered on the first block; Admission FIM cognition, was entered on the second block in order to control for severity of cognitive deficit; total unawareness score, lesion side and the interaction of lesion side with unawareness were entered on the third block, in order to evaluate the unique contribution of unawareness. The interaction between unawareness and lesion side was included in this block since the correlation analyses indicated a different pattern of association between unawareness and functional outcome in the two hemisphere groups. The results of the overall model contributed 36% of the explained variance of discharge FIM motor scores. Demographics variables (age, gender and education) were not significant in this model, and contributed only 3% of the total explained variance. FIM cognition was significant ($p = 0.007$) and contributed 13% of the total explained variance. The unawareness block added an additional 19% to the total explained variance of functional outcome. Within this block significant effects were found for lesion side ($p = 0.037$) and the interaction of unawareness with lesion side ($p = 0.013$), indicating the difference between the hemispheres in the impact of unawareness on functional outcome. The significant hemisphere effect is related to the inclusion of unawarenes in this model, as mentioned previously, separate comparisons of hemisphere groups on outcomes (Table IV) did not reveal any signifcant difference on FIM motor scores at discharge. In sum, the regresssion analyses demonstrate the significance of unawareness for functional outcome, in addition to basic cognitive skills, specifically in the RHD group.

DISCUSSION

Incidence of unawareness

The unawareness profile found in this study reveals several important areas of unawareness after stroke and supports the contention regarding the multifaceted nature of unawareness phenomena in adults with brain damage (4). Thirty per cent of the entire sample did not spontaneously acknowledge having a stroke after a general question regarding the reason for hospitalization (and a small percentage of these actually denied having a stroke after specific questioning). These percentages are similar to those found by Hibbard et al. (8) at a later stage post onset, and demonstrate that knowledge of stroke occurrence should not be taken for granted even at the post-acute rehabilitation stage and beyond.

Table V. *Hierarchical regression of demographic, cognitive and unawareness variables on FIM motor scores at discharge*

Step	Variable	Beta	T (*p*)	F (*p*)	Cumulative R^2
1	Age	−0.18	−1.29 (0.23)		
	Education	0.002	0.008 (0.99)		
	Gender	−0.04	−0.30 (0.76)		
	Block			0.61 (0.61)	0.035
2	FIM cognition (admission)	0.37	2.80 (0.007)		
	Block			7.82 (0.007)	0.168
3	Total unawareness	0.34	1.34 (0.188)		
	Lesion side	1.47	2.14 (0.037)		
	Interaction: Unawareness × lesion side	−1.82	−2.60 (0.013)		
	Block			4.68 (0.006)	0.363

FIM = Functional Independence Measure.
[a] Lesion side was coded as following: 0 = left hemisphere damage; 1 = right hemisphere damage.
Overall $R^2 = 0.36$; Adjusted $R^2 = 0.27$; F for the entire model = 3.74 ($p = 0.003$)[30].

Unawareness of cognitive deficits was distinctly more prevalent than unawareness of motor impairment. The frequency of AHP was significantly lower in this study than that found in Anderson & Tranel's (6) study conducted at an earlier time post onset. However, Wagner & Cushman's (7) study, comprising patients at a similar time post onset, found an 18% rate of AHP, which is closer to the prevalence found in our study (9%). They also established that the central focus of unawareness at this stage post onset was in relation to cognitive impairment and our mean total unawareness scores, representing mainly unawareness to cognitive deficits, were similar to theirs (10.7 versus 11.3).

Theoretical considerations

The number of subjects affected in each anatomical region of interest was generally too small to enable evaluation of specific location effects. Overall unawareness was not associated with any specific lesion site, but was found to be significantly associated with lesion size, and with cortical involvement. There was no significant difference between the hemisphere groups in the mean AI scores. These results are in agreement with those of Wagner & Cushman (7) that found a cortical versus sub-cortical effect but not a hemispheric one. However, they are in contrast to the results of the earlier study by Anderson & Tranel (6) that revealed higher mean unawareness scores in the RHD group compared with the LHD one. This difference may be related to the time post onset, as the later studies were conducted in the post-acute phase, as opposed to the acute one in Anderson & Tranel's (6) study. The difference between hemisphere groups may diminish as time goes on, particularly because of the decline in the frequency of AHP associated predominantly with RHD.

In a different vein, despite the similarity of awareness scores in both hemisphere groups, a significant difference was found in the functional implications of unawareness in the two groups. Unawareness was of functional significance in the RHD group but not in the LHD one, perhaps reflecting the original asymmetry found between the groups at earlier times post-onset. This difference may be additionally interpreted within two central theoretical frameworks for unawareness. The lack of functional significance of unawareness in LHD may be supported by the psychogenic theories, whereby unawareness is interpreted as a defense mechanism, an adaptive motivated response protecting the individual from a painful reality (24). On the other hand, results in the RHD group may be supported by neurogenic theories, interpreting unawareness as a direct result of brain damage, and a maladaptive mechanism (2). However, these interpretations should be regarded as tentative, since results may not represent true hemispheric differences in unawareness, but may have been influenced by the selection bias created by excluding severe aphasic patients.

Impact of unawareness on rehabilitation outcome

The main contribution of this study compared to other AI studies in stroke, relates to the implications of unawareness in rehabilitation. The results indicate that unawareness at admission to rehabilitation in the RHD group was a detrimental factor in achieving adequate safety level and independence in basic ADL functions, at discharge from the rehabilitation hospital. The impact of unawareness was significant even after controlling for cognitive deficit, as demonstrated by Labuda & Lichtenberg (9) as well, in their study of a heterogeneous geriatric population.

From a clinical perspective, rehabilitation professionals are required to address these issues, as awareness should be considered the first building block of the rehabilitation process, a prerequisite for motivated successful participation. Several techniques have been suggested in awareness training programs, including the use of video feedback (25, 26), group therapy (27), game format (28), facilitated discovery of deficits during task performance (29). Further research is required regarding the efficacy of current awareness training in stroke rehabilitation programs, and there is a need for additional treatment methods to be developed.

The results of this study are limited by a small sample size, particularly of the LHD group. Further research is required to verify these findings in larger samples. Secondly the verbal-based method of assessing unawareness did not enable the inclusion of patients with severe aphasia, hence limiting the generalizability to all LHD patients. Observational, performance-based, standardized assessments are needed, in order to include all stroke patients, and to evaluate other aspects of unawareness phenomena as well.

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