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Stroke survivors over-estimate their medication self-administration (MSA) ability, predicting memory loss

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Abstract

Background and objective—Medication self-administration (MSA) may be cognitively challenging after stroke, but guidelines are currently lacking for identifying high-functioning stroke survivors who may have difficulty with this task. Complicating this matter, stroke survivors may not be aware of their cognitive problems (cognitive anosognosia) and may over-estimate their MSA competence. The authors wished to evaluate medication self-administration and MSA self-awareness in 24 consecutive acute stroke survivors undergoing inpatient rehabilitation, to determine if they would over-estimate their medication self-administration and if this predicted memory disorder.

Methods—Stroke survivors were tested on the Hopkins Medication Schedule and also their memory, naming mood and dexterity were evaluated, comparing their performance to 17 matched controls.

Results—The anosognosia ratio indicated MSA over-estimation in stroke survivors compared with controls—no other over-estimation errors were noted relative to controls. A strong correlation was observed between over-estimation of MSA ability and verbal memory deficit, suggesting that formally assessing MSA and MSA self-awareness may help detect cognitive deficits.

Conclusions—Assessing medication self-administration and MSA self-awareness may be useful in rehabilitation and successful community-return after stroke.

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Declartaion of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article

Keywords

Anosognosia; memory; patient safety; rehabilitation; stroke

Introduction

Up to 73% of stroke survivors have functionally-significant cognitive problems in the first months of recovery [1]. Medication self-administration (MSA) is difficult after stroke and failures occur in at least 25% of survivors in the acute post-hospitalization period [2]. In stroke-related dementia, medication self-administration may obviously be a problem, but guidelines for how to structure medication self-administration in high-functioning stroke survivors, who nonetheless have cognitive deficits, are not yet available. Unawareness of cognitive deficits (cognitive anosognosia) [3] is a major problem in the lives of stroke survivors [4]. Stroke-related memory and cognitive problems are much more difficult to manage without active self-monitoring. Unawareness of cognitive deficit interferes with attempts to compensate and decreases engagement in rehabilitation [5, 6]. Self-awareness may actually be as important as the degree of cognitive deficit, as relatively minor errors affecting medication self-administration can exert major health effects. Self-estimation of functional abilities is not usually assessed in the clinic setting, but may affect some cognitive domains (memory, visuospatial ability) while leaving others intact (naming, mood) [3]. Stroke survivors might, thus, be good at self-estimating some cognitive abilities and skills, but poor at self-estimating others. A previous study of cognitive anosognosia [3] demonstrated accurate ability to self-estimate picture naming to confrontation (Boston Naming Test, short form or BNT [7]) and mood (Geriatric Depression Scale or GDS [8]).

The current study aimed to learn if a group of consecutive post-stroke patients undergoing acute rehabilitation would over-estimate their MSA ability relative to healthy age-equivalent controls. Secondly, it aimed to learn whether stroke survivors might differ in their ability to self-predict medication self-administration, as compared with their ability to self-predict other areas of cognitive performance. To evaluate medication self-administration, this study assessed the ability to organize medications for self-administration in a written schedule and pillbox (the Hopkins Medication Schedule [9]), which in a prior study of 360 aged women predicted self-reported competence at instrumental activities of daily living.

Considering previous findings [3], it was proposed here that stroke survivors might differ in their ability to self-predict medication self-administration, as compared with their ability to self-predict other areas of cognitive performance. The aim was to learn whether stroke survivors, representative of those undergoing inpatient acute rehabilitation, would selectively over-estimate their own MSA performance, relative to age-equivalent controls. The aim was also to learn if these stroke survivors would demonstrate a high rate of MSA errors on the Hopkins Medication Schedule. MSA errors, of which stroke survivors are unaware, may put them at significantly increased risk of recurrent stroke, medication toxicity, poor management of pain and other problem symptoms and a host of other complications and morbidity. A combination of undetected MSA unawareness and

undetected MSA errors at discharge may impede rehabilitation, as well as the ability to function in an independent living environment after hospital discharge.

Methods

Standard protocol approvals, registrations and patient consents

The study was approved by the institutional review board and all subjects gave informed consent to participate.

Subjects

A convenience sample of 24 consecutive stroke patients (15 female, nine male; 12 right hemisphere, 11 left hemisphere and one brainstem stroke) admitted to the Kessler Institute of Rehabilitation and a convenience sample of 17 consecutive healthy age-equivalent controls (11 female, six male; average age = 74.5 years, age range = 66–88 years) from the local community were enrolled. Average age of stroke survivor was 68.4 years (age range = 46–87 years). Average days post-stroke was 17.5 days (range = 4–34) with number of acute rehabilitation days ranging from 6–32 at the time of this study. Participants were fluent English speakers who learned English before age 10 and had no speech and language deficits except word-finding problems on a brief cognitive screening [10]. No subjects had had previous strokes or had other chronic neurological or psychiatric conditions. See participant characteristics in Table I.

Measures

Several instruments were administered. To assess medication self-administration (MSA), the Hopkins Medication Schedule (HMS) was used [9]. This includes two parts, a paper- and-pencil measure in which individuals fill out a written schedule given a specific set of directions. For example, a direction instructs the individual to mark on a daily schedule the specific time a medication is taken when the directions indicate the medication should be taken with meals. There is also a pillbox to fill that involves a simulation task in which individuals put pseudo medications in the pill box based on the written directions. The maximum score for the HMS is 11. To assess naming, the short form of the Boston Naming Test (BNT) was administered [7]. This is a 15-item test in which an individual is shown pictures of nouns and instructed to name the picture (for example ‘house’). The Geriatric Depression Scale (GDS) was administered to assess mood [8]. This is a 30-item mood assessment scale in which an individual answers yes or no to a question posed orally. The Hopkins Verbal Learning Test (HVLT) is a test of verbal memory in which the examiner reads a list of 12 words and the individual is instructed to state the words read by the examiner [11]. The maximum score for spontaneous recall on the HVLT is 36. A score of 20 is reported to be a satisfactory score for US High School graduates. The Mini-Mental State Examination (MMSE) [12] was administered; memory-specific items of the MMSE included orientation, previous four Presidents recall and three object registration and recall. A test of dexterity that involved picking up a dime from the table was also administered. For this dexterity test, subjects either received two points (able to pick up dime directly), one point (slid coin to the edge of the table into their hand) or zero points (unable), for a total of four points possible on this task [13].

Procedures

Stroke survivors and controls performed a medication self-administration task, the Hopkins Medication Schedule (HMS). The HMS was given at a mean 9.8 days after admission (SD = 13.6) and 17.4 days post-stroke (SD = 14.0). Participants also performed comparison tasks for which their self-estimation might be accurate. This study evaluated naming using the BNT [7] and mood assessment using the GDS [8] in all of the participants. To assess cognitive status and memory, all participants were given the Mini-Mental State Examination (MMSE [12]) and a verbal list-learning memory task, the Hopkins Verbal Learning Test (HVLT [11]). Lastly, because medication self-administration is affected by manual dexterity even on simulated tasks such as the HMS (and dexterity problems might affect ability to manipulate pills), this study assessed participants' manual dexterity by having them twice pick up a dime from a position 5 inches from the edge of a table in front of them. Stroke patients performed this with their unaffected hand (limb-kinetic praxis test [13]). Per trial, subjects either received two points (able to pick up dime directly), one point (slid coin to the edge of the table into their hand) or zero points (unable), for a total of four points possible on this task.

Self-rating of performance and anosognosia ratio

After taking tests in each of the above domains (medication self-administration, naming, mood, memory, dexterity), participants were asked to self-rate their performance on a visual analogue scale. In order to complete this task, participants were provided with a vertical line in the middle of a 9 × 11 inch piece of paper. On the paper, for example for naming ability, above the line there was a printed statement: 'Naming is the best it could be' and on the bottom of the page, below the line, there was a printed statement: 'Naming is the worst it could be'. Participants were instructed to make a horizontal line through the vertical line, estimating their naming ability. Participants estimated medication self-administration, mood, memory and dexterity in this manner. The method used was the same as previously employed [3] to study cognitive anosognosia (post-testing self-evaluation). Again, as performed in a previous study, a ratio score expressing the accuracy of their self-ratings in each of these domains was created by the following formula:

$$\text{Anosognosia ratio}\,(AR) = \frac{\left(\begin{array}{c}\text{Estimated performance}\\ -\text{actual performance}\end{array}\right)}{\left(\begin{array}{c}\text{Estimated performance}\\ +\text{actual performance}\end{array}\right)}$$

Both the estimated and the actual performance were converted to ratio scores and expressed as percentages of best possible score. The AR always falls between −1 and +1, such that, with perfect self-awareness, estimated = accurate performance and the AR = 0. Over-estimation errors result in a positive AR >0; self-under-estimation as compared with actual test performance results in a negative AR <0. For example, if an estimated performance is 0.85 and an actual performance is 0.65 then a positive AR of 0.2 results, demonstrating over-estimation. Whereas it was previously reported, consistent with past reports, that

under-estimation errors are correlated with self-reported depression [3], estimation of ability to self-administer medications has not previously been reported.

For each domain, best performance on the task was defined by the task designated to assess that domain, except for memory, on which best performance was defined as previously [3]: HVLT spontaneous recall score, plus the following MMSE items: orientation, previous four Presidents recall and three object registration and recall. For memory, the actual performance on these combined items was converted to an overall percentage for memory test items and this percentage was used in the calculation of the Anosognosia Ratio. See Table I for performance on the cognitive and neuropsychological testing.

Results

In this study a group of 24 stroke survivors and 17 educationmatched controls completed tasks including the assessment of their ability to self-administer medications. It was predicted that stroke patients would over-estimate their MSA performance, relative to controls. To assess this hypothesis, the Anosognosia Ratio (AR) for stroke survivors was compared with that for age-equivalent controls, using independent-samples *t*-tests, over the following domains tested: MSA performance, naming, depression, dexterity and memory. The *p* values given are those with Bonferroni correction for multiple comparisons. Naming, depression and dexterity were control parameters for this comparison, as had been predicted based on a previous study [3] that stroke survivors should be accurate at self-estimating naming and mood. Stroke survivors markedly over-estimated MSA (mean AR = 0.49, SD = 0.43) relative to controls (mean AR = −0.05, SD = 0.085; $t = -6.047$, $p<0.01$). However, estimation of memory deficit, mood, naming or problems with dexterity were not different between stroke survivors (mean memory AR = 0.28, SD = 0.23; mean mood AR = −0.05, SD = 0.17; mean naming AR = 0.04, SD = 0.16; mean dexterity AR = −0.14, SD = 0.27) and controls (mean memory AR = 0.17, SD = 0.12; mean mood AR = 0.01, SD = 0.06; mean naming AR = −0.06, SD = 0.08; mean dexterity AR = −0.08, SD = 0.06; all $p>0.2$, ns). Thus, the results suggest that stroke survivors over-estimated only their MSA performance and otherwise did not demonstrate cognitive anosognosia for amnesia, nor inaccurate self-estimation of mood, naming or dexterity (see anosognosia ratios in Table II.

Compared with controls, stroke survivors scored lower on all neuropsychological tests and questionnaire evaluation of depression symptoms (see neuropsychological characteristics in Table I). Comparing the stroke survivors cut-off scores for abnormal test performance, six of the 24 stroke survivors scored below a 25/30 cut-off for cognitive deficit on the MMSE; five scored 11–15 on the GDS (mild depression); two scored <10 on the BNT, short form; and 15 scored <20 on the spontaneous recall section, HVLT. These proportions of cognitive impairment are similar to those previously reported with prospective cognitive evaluation on an inpatient rehabilitation unit [14]. Although stroke survivors obtained mean lower dexterity scores than controls, this difference did not reach significance.

This method of calculating the AR results in higher values with increases in the cognitive deficit being self-assessed. In order to avoid reporting a group difference primarily reflecting the performance of stroke survivors with more severe cognitive impairment, this study re-

analysed the data with an independent sample *t*-test, excluding the six stroke survivors with MMSE scores below a cut-off for cognitive impairment (25/30; 18 subjects). Stroke survivors with MMSE scores 25–30 still performed across the entire HMS score range (0–11; see Figure 1 demonstrating the relationship between performance on the MMSE and the HMS). This confirmed that the AR for MSA performance self-estimate was higher for stroke survivors, consistent with previous findings ($t = 4.27$, $p<0.001$).

Self-estimating medication self-administration might be related to objective memory deficit, as cognitive self-knowledge might depend on the ability to continuously monitor self-performance in order to obtain an accurate self-rating [15]. This study evaluated the relationship between over-estimation of MSA ability and spontaneous recall performance on the HVLT to consider this association. Interestingly, there was a strong correlation between memory deficit on the HVLT and over-estimation of MSA ability ($r = 0.81$, $p<0.001$). It can be seen in Figure 2 that in this group of 24 stroke survivors, those who performed in the spontaneous recall range considered satisfactory for US high school graduates (i.e. scored greater than 20) scored less than 0.6 on the HMS-AR, indicating that, while there were some who over-estimated their ability, no one did so to the extreme (with the most extreme AR = 1.0). Estimation of MSA ability correlated with memory scores and over-estimation of MSA ability predicted memory deficit. MSA over-estimation may predict memory deficit, but further convergent validation by comparison with other indices for memory testing and comparison of this method with existing screening tools for ease of use and feasibility is needed.

Discussion

Enhancing accurate medication self-administration is seen as a major public health priority (see http://www.u-spharmacist.com/content/s/200/c/33457/), but interventions to enhance medication compliance have emphasized health literacy and social support [16]. Recommendations on how to identify cognitive problems that might interfere with MSA capacity, in stroke survivors who are high-functioning and otherwise competent, are not widely available. This study used the Hopkins Medication Schedule (HMS) to assess stroke survivors' ability to perform medication self-administration. The HMS measures medication self-administration skill and does not specifically include taking actual medications. Rather, a simulation medication self-administration task that is typical of real-life medication administration is employed. In order to include a highly representative sample of stroke survivors, this study included a consecutive sample of individuals. This led to the inclusion of some participants with lower MMSE scores, which it is acknowledged possibly could have affected results, yet, after taking these participants out of the analysis, the results remained consistent. Carlson et al. ([9], p. 9) previously reported that, in 360 aged women participating in the Baltimore Women's Study, the HMS predicted self-reported problems with independent activities of daily living. Interestingly, in that study, only 8–10% of poor performers on the HMS reported problems taking medications. This suggests that assessing competent medication self-administration by asking people to make an abstract self-rating may be less accurate than actual assessment with a simulated task. It should be noted that, in Carlsen et al., self-reported competence referred to ADLs and not specifically to medication self-administration, which is here considered to be a component of ADLs. Regarding the

HMS, it involves only three instructions ('Antibiotics: take one pill 3-times a day, at least 30 minutes before meals; Aspirin: take two tablets every 4 hours. May cause stomach upset if taken on an empty stomach. Make sure to eat meals and snacks with tablets. Water: Drink a full glass of water every 4 hours'). It is, thus, much simpler than the medication regimen most aged people follow daily (average over six medications concurrently [17]). However, in this group of stroke survivors eligible to receive the most expensive post-acute care option, inpatient rehabilitation, a range of performance was obtained, distributed from 0–100%. Thus, it is suggested that this instrument may be useful in rehabilitation assessment of activities of daily living and independence.

Stroke survivors in this study selectively over-estimated medication self-administration; they did not over-estimate memory performance or any other cognitive function, mood or dexterity, compared to controls. Medication administration is a dynamic process that involves executive function and working memory. It is very possible that in the home environment over-estimation of medication self-administration may be even more relevant given the complexities of the setting, the caregiver involvement and the cumulative effect of medication management at home. This study did not assess presence of a caregiver to assist with medication self-management in this study; individual caregiver's assessment of MSA ability in the stroke survivor could have an effect and should be considered in future studies [18]. Moreover, it is possible that the medications taken by the patients could influence response to self-administration questions. Patients taking many new medications or a complex regimen of medications could potentially underestimate their abilities. Given that participants in this study estimated memory and all other cognitive functions except medication abilities comparable to their actual level of performance, this suggests, as previously reported, that cognitive anosognosia (unawareness of cognitive deficit) can be selective to certain cognitive functions and that the stroke survivor might predict self-abilities accurately in some areas, but not in others. It is also possible that a naming task may be easier to estimate than a complex task such as MSA.

Most clinicians are very familiar with the phenomenon described above where stroke survivors are able to predict self ability in some areas and not others when it occurs after right brain stroke in the presence of spatial neglect—a survivor might be able to predict his or her ability to remember a name or perform a non-spatial task, but may be completely unaware of his or her errors on a spatial task such as drawing or line bisection. Because cognitive anosognosia can occur in other, less impaired stroke survivors, the clinician must be careful not to assume that self-estimation of medication self-administration is accurate, even if other areas of cognitive self-estimation appear to be intact. It is proposed that, along with the many contributors to MSA errors, MSA over-estimation may be related to anosognosia, which is rarely discussed in the MSA literature. A complete description of the many deficits that may occur after stroke and affect medication self-administration is beyond the scope of this paper. The emphasis is on HMS performance as a potential method for assessing MSA errors and the rarely considered relationship between self-awareness and anosognosia to MSA errors on this task.

These stroke survivors included people with cognitive impairment in a range which might have precluded medication self-management in many settings (MMSE <25 total). However,

this study confirmed over-estimation of medication self-administration abilities, even when subjects with lower MMSE scores were excluded from the analysis. It is felt that some caregivers may still give mildly-impaired patients some responsibility to self-administer medications, since many stroke survivors with cognitive disorders are not identified during conventional rehabilitation care [19]. Since prospective cognitive assessment with neuropsychological instruments is time-consuming, this study would suggest that HMS performance and self-estimation of HMS performance may have special rehabilitation utility and value. HMS performance and self-awareness of HMS performance may both in themselves predict independence in stroke recovery. However, these indices might also reliably identify patients with memory loss, since all the patients in this study whose over-estimation of medication self-administration on the HMS resulted in an AR over 0.6 performed abnormally on memory testing. While the AR of 0.6 is not a specific cut-off point and anything greater than 0 is an over-estimation, the 0.6 is notable because it is closer to an AR of 1.0 than an AR of 0 (AR = 0 indicates no over-estimation of performance).

Limitations

A potential limitation of this study is the point at which patients were tested is fairly close to the onset of stroke and may not reflect the participant's skill level at time of discharge. A follow-up assessment at discharge would help clarify this issue. In addition, it is possible that attention and comprehension might affect performance. Testing attention and comprehension would be beneficial to answering this question.

Future research

Further work needs to be completed to clarify mechanisms of MSA over-estimation including research in larger groups of left and right stroke survivors in rehabilitation settings to support the suggestions. In addition, future studies should be carried out at the community level as well, with matched stroke survivor and non-stroke survivor participants. It is hoped that future research will investigate the neuropsychological mechanisms of MSA over-estimation; this may provide further insight with regard to both over-estimation and under-estimation of self-performance.

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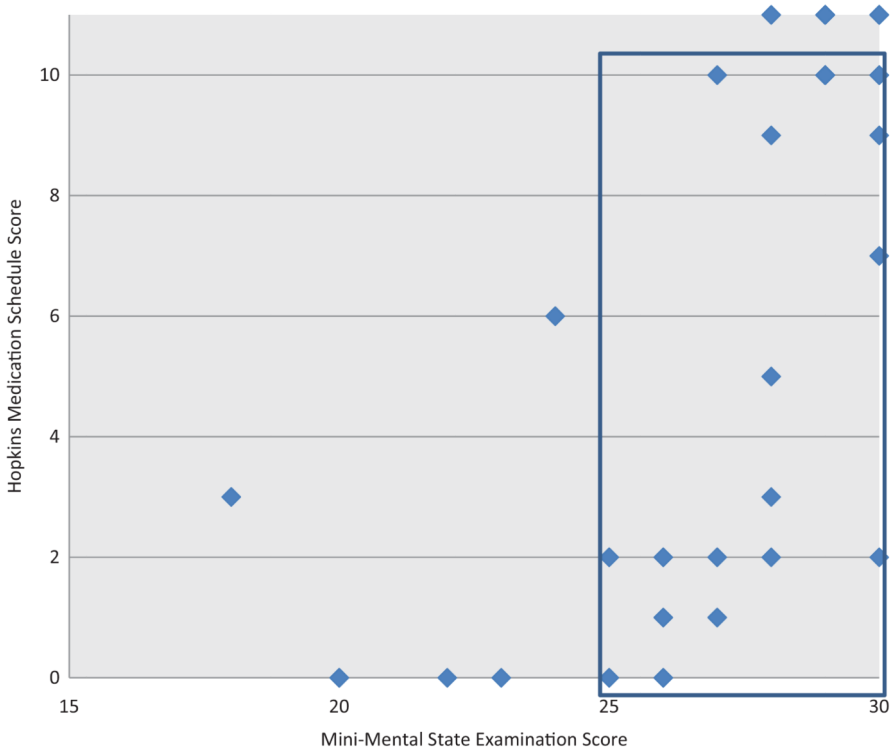

Figure 1.

Mini-Mental state scores (MMSE; *x*-axis) plotted against performance on the Hopkins Medication Schedule (HMS; *y*-axis) for subjects in the current study. Stroke survivors with MMSE scores above a typical dementia cut-off score (25; shaded box) still performed across the whole range on the HMS (0–11), suggesting that low-scoring patients had significant impairment on this task. See text.

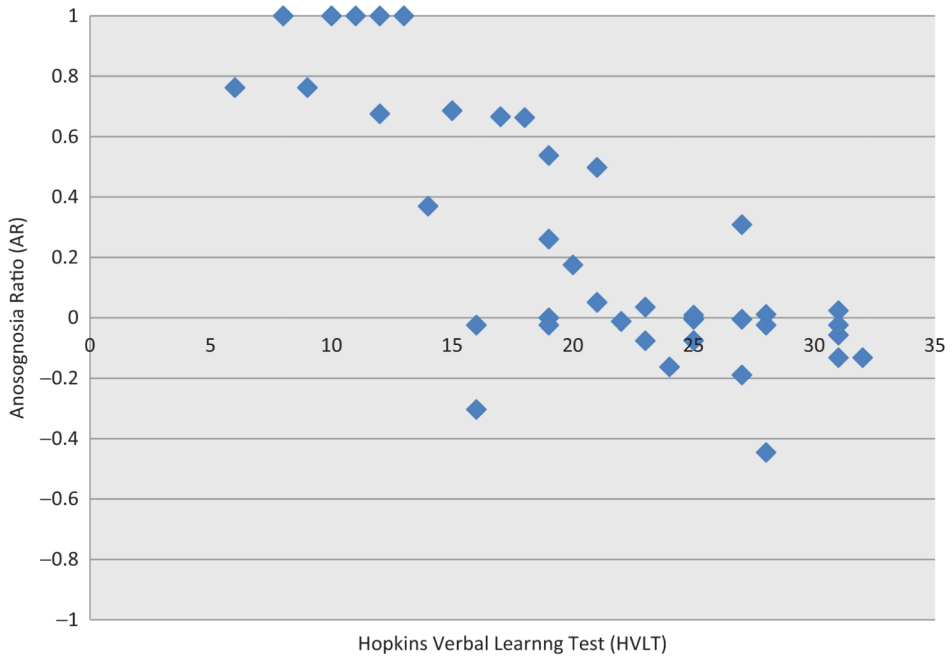

Figure 2.

Correlation between spontaneous recall scores on the Hopkins Verbal Learning Test, a verbal memory test (*x*-axis) and anosognosia ratio indicating self-awareness of MSA ability (AR)—an AR indicating over-estimation above 0.6 was present only in subjects with scores below the cut-off score (20; vertical line) for high school educated people. See text.

Table I

Demographic and neuropsychological characteristics of subjects.

	Stroke (*n* = 24, 15 females)	Control (*n* = 17, 11 females)
Age (in years)	68.4 (13.22)	74.5 (8.63)
Education (in years)	13.9 (2.98)	14.8 (1.92)
HMS (of 11)	10.7** (0.47)	4.0** (3.94)
MMSE (of 30)	26.2** (3.50)	29.4** (0.86)
GDS (of 30)	5.5* (4.06)	2.5* (2.21)
HVLT Spont. recall (of 30)	17.5** (7.40)	24.5** (5.11)
BNT (of 30)	13.3* (2.42)	14.8* (0.53)
Dexterity	3.5 (0.83)	3.9 (0.24)

HMS, Hopkins Medication Schedule; MMSE, Mini Mental State Examination; GDS, Geriatric Depression Scale; HVLT, Hopkins Verbal Learning Test; BNT, Boston Naming Test.

* Independent-samples *t*-test, $p<0.05$

** $p<0.01$.

Table II

Anosognosia ratios (ARs).

	Stroke survivors		Control group		
	Mean AR	**SD**	**Mean AR**	**SD**	**Statistical findings**
MSA performance	0.49	0.43	−0.05	0.085	$t = -6.047$; $p < 0.01$
Naming	0.04	0.16	−0.06	0.08	$p < 0.2$, ns
Mood	−0.05	0.17	0.01	0.06	$p < 0.2$, ns
Dexterity	−0.14	0.27	−0.08	0.06	$p < 0.2$, ns
Memory	0.28	0.23	0.17	0.12	$p < 0.2$, ns