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ORIGINAL REPORT

DIFFERENCE IN IMPACT OF NEUROBEHAVIOURAL DYSFUNCTION ON ACTIVITIES OF DAILY LIVING PERFORMANCE BETWEEN RIGHT AND LEFT HEMISPHERIC STROKE

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Objective: **To explore whether persons with right- and left-sided cerebrovascular accidents differ significantly in mean impact of neurobehavioural impairments on ability to perform activities of daily living.**
Design and subjects: **Retrospective study of data from 215 persons (103 right-sided, 112 left-sided cerebrovascular accident). The Activities of daily living-focused Occupation-based Neurobehavioral Evaluation was used to evaluate ability on an activities of daily living scale and the impact of neurobehavioural impairment on ability on another scale.**
Methods: **To control for possible differences in activities of daily living ability between groups, analysis of covariance, with activities of daily living ability as a covariate, was used to test for a significant difference in impact of neurobehavioural impairments on activities of daily living ability between groups.**
Results: **Expected moderate correlation (r=–0.57) was obtained between activities of daily living ability and neurobehavioural impact measures, and there was no difference in mean neurobehavioural impact measures between groups (F [1, 212] = 2.910, p = 0.090).**
Conclusion: **This study is the first to explore directly the impact of neurobehavioural impairment on activities of daily living ability. While persons with right-sided and left-sided cerebrovascular accidents may differ in type of neurobehavioural impairments, direct evaluation of the impact of such impairments on activities of daily living ability reveals no difference between groups.**

Key words: assessment; neurology; occupational therapy; Rasch measurement; outcome; cerebrovascular accident.

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INTRODUCTION

The aim of this paper was to explore whether persons with right- and left-sided cerebrovascular accidents (RCVA, LCVA) differ in the extent to which neurobehavioural impairments impact activities of daily living (ADL) ability. It is commonly known that persons with RCVA and LCVA have different patterns of impairments. For example, persons with RCVA more frequently have visuospatial impairments, unilateral neglect and motor problems affecting the left body side, whereas persons with LCVA more often have aphasia, apraxia and unilateral motor problems affecting the right body side (1, 2). Knowing this, however, does not tell us anything about the extent to which neurobehavioural impairments impact ADL task performance and if there is a difference between groups.

Titus et al. (3) stated that it is important to study how perceptual disorders affect ADL performance as this may influence goal setting, choice of intervention and predictability of rehabilitation. Despite this, no studies were found that have examined directly whether there is a difference between groups in the extent to which neurobehavioural impairments affect ADL task performance. That is, prior research has focused on whether or not there are differences in ADL task performance between persons with RCVA and LCVA and/or the correlation between various neurobehavioural impairments and ADL ability (3–18).

Among those who have examined for differences in ADL ability between groups, some have noted differences in some aspects of ADL (4, 5), but the majority of studies support the view that the two groups have similar overall ADL ability (6–9). Some authors have also suggested that the lack of differences in ADL ability between groups supports the theoretical notion that functions of both hemispheres are needed for ADL performance (7, 10). While this view implicitly supports a notion that the neurobehavioural impairments of each group have an equivalent impact on ADL, such studies are limited because the direct impact was not evaluated.

Correlational studies between various neurobehavioural impairments and ADL ability support, overall, the theoretical view that there is a relationship between neurobehavioural impairments and ADL ability. That is, most studies have found that lowered ADL ability is associated with neurobehavioural impairments. More specifically, the relationship between various neurobehavioural impairments (e.g. executive functions, apraxia, perception, motor functions) varies, ranging from r=0.2 to 0.8 (3, 11–18).

The problem with such studies is that they examine relationships between ADL ability, as measured by one instrument, and degree of neurobehavioural impairment as measured by another instrument. Yet, it is well known that relationships cannot be interpreted as cause–effect (10, 12, 19). That is, in order to evaluate the impact that neurobehavioural impairments have on ADL task performance, the extent of the impact must be evaluated directly. For example, the frequency of observed errors in ADL performance that can be attributed to specific neurobehavioural impairments must be measured.

The ADL-focused Occupation-based Neurobehavioral Evaluation (A-ONE) is a unique tool that was designed to measure directly the impact of neurobehavioural impairments on ADL ability (20, 21). More specifically, the A-ONE includes two scales, one designed to evaluate ADL ability and another designed to evaluate the impact of neurobehavioural impairments on ADL task performance (10, 22). The Neurobehavioral Impact Scale (NBI scale) of the A-ONE provides Rasch-generated person measures for the number (frequency) of neurobehavioural impairments that have been observed to impact ADL. One advantage of the A-ONE NBI scale is that it can be used to evaluate a wide range of neurobehavioural impairments in naturalistic contexts (21). Thus, the NBI scale is ideal for exploring for the differences in the extent to which neurobehavioural impairments of persons with RCVA and LCVA impact their overall ADL task performances. Another advantage of using the A-ONE is that any potential differences in mean ADL ability between groups can be evaluated (and controlled) by means of the separate ADL scale. Furthermore, if we do not detect differences in impact of neurobehavioural impairments on persons' performances of ADL between the two groups, it opens up the opportunity to compare performance of persons with RCVA and LCVA on the same scale. Such a possibility would be an asset for documentation of rehabilitation services that could be used in future research studies. The specific research question addressed in this study was, therefore: Do persons with RCVA and LCVA differ in the extent of overall neurobehavioural impact on ADL, i.e. do persons with RCVA and LCVA have significantly different mean NBI measures?

METHODS

Participants

The design of this study was a retrospective one whereby A-ONE evaluation records from persons diagnosed with RCVA and LCVA (all available records between 1994 and 2005) at the rehabilitation wards at Landspítali University Hospital in Iceland were reviewed. The analysis included a total of 222 records. The ADL ability and NBI measures were obtained from a CVA sub-sample of a larger study that included participants diagnosed with CVA and dementia[1]. Six potential participants were excluded from this study because they had maximum scores on the ADL scale (RCVA=4, LCVA=2). One additional potential participant with RCVA was excluded due to insufficient ADL data. See Table I for more detailed information related to the age and gender of the participants.

[1]Árnadóttir G, Löfgren B, Fisher AG. Neurobehavioral functions evaluated in naturalistic contexts: Rasch analysis of the A-ONE Neurobehavioral Impact Scale. Submitted.

Table I. *Age and gender of participants by diagnostic group*

	RCVA	LCVA	Total
Age, years, mean (SD)	65.4 (14.4)	67.6 (13.5)	66.5 (14.0)
Range	22–91	22–89	22–91
Gender, *n* (%)			
Male	55 (53.4)	74 (66.1)	129 (60)
Female	48 (46.6)	38 (33.9)	86 (40)
Total, *n* (%)	103 (48.0)	112 (52.0)	215

RCVA: right-sided cerebrovascular accidents; LCVA: right- and left-sided cerebrovascular accidents; SD: standard deviation.

Instrumentation

The A-ONE (10) has been described elsewhere (7, 20–23). As noted earlier, the A-ONE includes 2 scales, the ADL scale designed to evaluate need for assistance during ADL task performance, and the NBI scale designed to evaluate frequency of neurobehavioural-related performance errors detected in the natural context of these ADL task performances. The specific reason for the observed errors is interpreted by use of operational definitions of different neurobehavioural impairments included in the test manual and a clinical reasoning process that has been practiced during 5-day A-ONE training courses (10, 22).

Linear scales of both ADL ability and extent of neurobehavioural impairments have been constructed based on the ordinal scales of the A-ONE by application of Rasch analysis (20, 21,[1]). The Rasch-analysed version of ADL scale includes 20 items and each item is rated based on the observed level of assistance needed for the ADL performance by using a 5-category rating scale (20). The NBI scale constructed and used to evaluate persons with CVA is comprised of 53 dichotomous items (see Table II for A-ONE items retained in the Rasch-analysed ADL and NBI-CVA scales).

The psychometric qualities of the Rasch-analysed NBI-CVA scale included acceptable goodness-of-fit statistics for all items (both infit and outfit) with MnSq $\leq$ 1.4 and $z<2$. Principal component analysis (PCA) revealed a Rasch dimension explaining 77% of the variance and 4% of the unexplained variance explained by the first contrast. Person separation was 2.18 and person reliability was 0.85.

Procedures and data analysis

As described in more detail elsewhere (20, 21), all participants had been evaluated as a part of routine occupational therapy services at the Landspítali University Hospital. The 8 therapists who performed the evaluations had all gone through an A-ONE training course and administered the evaluations according to the standardized procedures described in the A-ONE manual. Prior to collection of raw scores and participant demographic information from the available A-ONE forms in the hospital records, written approval for the study was obtained from the ethics committee of Landspítali University Hospital. The first author extracted raw data from the participants' records.

The statistical analysis progressed in 3 phases. First, Rasch analysis was performed using the WINSTEPS Rasch computer software program, version 3.68.1 (24), to obtain both ADL and NBI-CVA person measures for each participant. Rasch analysis procedures have been described in detail elsewhere (25).

In the second phase, we evaluated whether there was a relationship between ADL ability and the extent to which neurobehavioural impairments impact ADL ability, using Pearson product moment correlation procedures in SPSS 12.0.1. The following criteria were used to classify the strength of the relationship: $r=0$–0.30 = little if any; 0.30–0.50 = low; 0.50–0.70 = moderate; 0.70–0.90 = high; 0.90–1.00 = very high correlation (26). Because neurobehavioural impact is assessed directly when the A-ONE is used, we expected a moderate to high correlation.

In the third phase, ANCOVA was used to examine whether the mean NBI measures of persons with RCVA and LCVA differed significantly ($p \leq 0.05$). ADL ability was entered as the covariate to control for differ-

Table II. *A-ONE Items on Rasch-analysed scales*

ADL Scale – Domains and item
Dressing
Put on shirt
Put on pants
Put on socks
Put on shoes
Manipulate fastenings
Grooming and hygiene
Wash face
Comb hair
Brush teeth
Shave beard/apply cosmetics
Perform toilet hygiene
Bathe
Transfers and mobility
Sit up in bed
Transfer from sitting
Manoeuvre around
Transfer to toilet
Transfer to tub
Feeding
Drink from glass/cup
Use fingers to bring food to mouth
Bring food to mouth by fork or spoon
Use knife to cut and spread
Neurobehavioral Impact Scale for CVA – Impairment
Motor apraxia – Dressing
Ideational apraxia – Dressing
Unilateral body neglect – Dressing
Spatial relations – Dressing
Unilateral spatial neglect – Dressing
Organization and sequencing – Dressing
Motoric – Dressing
Perseveration – Dressing
Motor apraxia – Grooming and hygiene
Ideational apraxia – Grooming and hygiene
Unilateral body neglect – Grooming and hygiene
Spatial relations – Grooming and hygiene
Unilateral spatial neglect – Grooming and hygiene
Organization and sequencing – Grooming and hygiene
Motoric – Grooming and hygiene
Perseveration – Grooming and hygiene
Motor apraxia – Transfers and mobility
Ideational apraxia – Transfers and mobility
Unilateral body neglect – Transfers and mobility.
Spatial relations – Transfers and mobility
Unilateral spatial neglect – Transfers and mobility.
Organization and sequencing – Transfers and mobility.
Motoric – Transfers and mobility
Perseveration – Transfers and mobility
Topographical disorientation – Transfers and mobility.
Motor apraxia – Feeding
Ideational apraxia – Feeding
Unilateral body neglect – Feeding
Spatial relations – Feeding
Unilateral spatial neglect – Feeding
Organization and sequencing – Feeding
Motoric – Feeding
Perseveration – Feeding
Sensory aphasia
Paraphasia
Expressive aphasia
Perseveration – Communication
Lability
Apathy
Depression
Irritability
Frustration
Restlessness
Insight
Judgment
Confusion
Attention
Distraction
Initiative
Motivation
Performance latency
Working memory
Confabulation

A-ONE: Activities of daily living-focused Occupation-based Neurobehavioral Evaluation; ADL: activities of daily living; CVA: cerebrovascular accident.

ences in ADL ability between groups. A Levene's test of equality of error variances was performed prior to the ANCOVA to examine presence of homogeneity of the regression slopes between the two groups. As neurobehavioural impairments can be related to increased age as well as stroke, a 2-sample *t*-test also was performed to explore for the presence of significant differences in mean age between the two groups.

RESULTS

A moderate relationship between ADL ability and extent of neurobehavioural impairments impacting ADL was confirmed ($r=-0.57$). The negative value reflects the inversely related scoring of the two scales, i.e. low ADL values indicate greater need for assistance during ADL task performance and high NBI values indicate greater impact of neurobehavioural impairments on ADL.

A 2-sample *t*-test indicated no significant differences in age between the two groups. Levene's test confirmed equality of error variances in NBI measures between groups. The results of the ANCOVA revealed that the two groups do not differ in the extent of impact of neurobehavioural impairments on ADL ($F(1,212) = 2.910$, $p=0.090$).

DISCUSSION

The results of this study revealed that the persons with RCVA and LCVA do not differ in overall impact of neurobehavioural impairments on ADL despite different patterns of underlying neurobehavioural impairments between groups. Such results also support earlier studies where ADL ability was speculated to be supported by contributions from both hemispheres (3, 7, 8). Thus, the findings of this study extend earlier research that has focused on either: (*i*) group differences in ADL task performance (6–9), or (*ii*) the extent of relationships between neurobehavioural impairments and ADL ability (3, 11–18). The uniqueness of the present study has been the possibility to evaluate directly (vs by indirect association) the magnitude of neurobehavioural impact, from the point of view of the frequency of impairments determined to cause errors in ADL task performance, using a common NBI scale designed to be used with persons with both RCVA and LCVA.

It was interesting to compare our obtained moderate correlation value (r = –0.57) between ADL ability and impact of neurobehavioural impairments on ADL task performance with the values obtained from studies where different neurobehavioural impairments, (e.g. cognition, perception, motor functions), when tested in isolation, have been correlated with ADL ability (3, 11–18). That is, the relationships found in earlier studies have varied markedly, from 0.2 to 0.8 (3, 11–18). Our study suggests that the overall impact is toward the higher end of this range.

The clinical importance of this study is two-fold. First, the possibility of using a single scale to evaluate persons with both RCVA and LCVA and study the impact of neurobehavioural impairments on ADL task performance adds to the methods used in previous studies, in that both groups of individuals can now be compared on the same scale. Earlier, it was often necessary to use different instruments to evaluate each type of impairment, in part because of differences in impairments between groups. Future research might focus on the use of the NBI-CVA scale of the A-ONE in combination with such deficit-specific scales relevant for each group to explore differences in the information provided by these different methods.

Secondly, our results suggest possible clinical implications for intervention. That is, some authors have suggested that interventions for both CVA groups should emphasize training of ADL skills and the use of compensatory strategies (6, 8). Others have stressed the potential of remediating impaired neurobehavioural functions in order to improve ADL performance (3). We suggest that by examining ADL ability using a single scale, and the extent to which neurobehavioural impairments impact ADL by a second scale, task-oriented interventions that include consideration of underlying impairments could be provided. Thus, the opportunity arises to first evaluate and then compare directly the impact of interventions designed to reduce the impact of impairments on ADL task performance. At the same time, it must be recognized that the items on the Rasch-analysed scales of the A-ONE are limited to performance of tasks in 4 ADL domains. Future studies, therefore, could further explore the potential of adding additional tasks on the ADL scale.

One potential limitation to our study is that we have used a retrospective study design. Thus the possibility exists that therapists may have left blank items that were in fact relevant. This probably resulted in our having more missing data than had we used a prospective design and clarified that the therapist should score all possible items. Nevertheless, as the data represent data from "actual practice", it is possible that our results better reflect "reality" than an "ideal" rehabilitation context. A related limitation was that all data were collected from the same hospital in Iceland. It will be critical, therefore, to cross-validate our results on a larger international sample. Only then will the generalizability of our results be verified. A final limitation might be related to the fact that the therapists who administered the ADL scale and the NBI scale were the same, and that the scores they assigned on the NBI scale were influenced by the scores they assigned on the ADL scale. This limitation is not likely to be of major concern, as the neurobehavioural impairment scores are based on frequency of errors impacting ADL performance and such errors can be detected regardless of the ADL scale used. Nevertheless, future research, where the NBI measures are compared with independent measures of ADL, not just the ADL measure from the A-ONE, is recommended.

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