

The Virtual Mall: A functional virtual environment for stroke rehabilitation

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Background

- **Patients who have had a stroke constitute a large population with significant needs for rehabilitation.**
- **These patients suffer from motor and/or cognitive or metacognitive impairments which lead to severe restrictions in participation in every day life.**

- **Since there are limited opportunities for implementing purposeful activities within traditional clinical settings via conventional occupational therapy, VR-based therapy appears to provide an answer to this challenge.**
- **Virtual environments aim to simulate function in the real world → greater ecological validity**

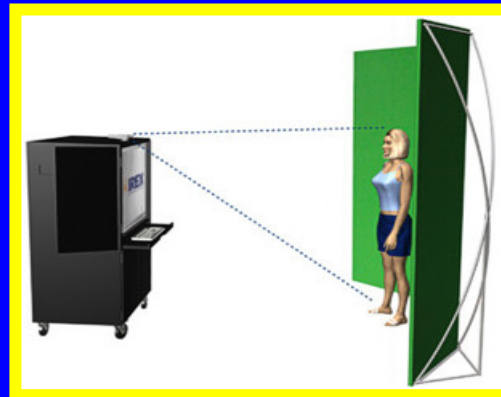
Some Examples of Functional VEs

- Standen & Cromby (1995) and Cromby, Standen, Newman & Tasker (1996) developed a desktop virtual supermarket to train students with learning disabilities to shop. They demonstrated that the student's shopping ability in the real world improved due to training in the virtual world.
- V-STORE - a virtual fruit store which requires the patient to choose and place different fruit in a basket in accordance with verbal commands, designed for the treatment of executive functions deficits (Castelnuovo , Lo Priore Liccione Cioffi, 2003).

- **Klinger, Chemin, Lebreton, & Marié (2004)** developed a virtual supermarket used on a Desk top to train action planning in Parkinson patients. The results of the pilot study (6 PD and 5 control) suggest a slowing down of planning processes in PD.



- These VEs were developed using a desktop system with mouse/ joystick interface → minimal motor requirements and less natural activation
- Several research groups have used the GX-VR system with different population groups and found it has great potential for the use in rehabilitation (Kizony et al., 2003; Sveistrup et al., 2003; www.irexonline.com)



Gesture Xtreme (GX) VR system

- However, to date, the VEs were game-like scenarios



Aims of Presentation

- (1) to describe the development of a functional virtual environment (VMall) and its usability for stroke patients
- (2) to present the results of a pilot study with eight stroke patients
- (3) to present initial results of assessment and intervention using the VMall



Development of the Virtual Mall (VMall)

The VMall aims to simulate a real shopping mall in order to provide patients with a functional and ecologically valid environment which can be used to train motor, cognitive, and metacognitive skills as well as a shopping task itself.

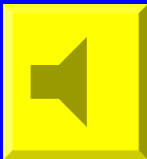

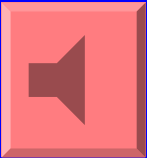


To date, the VMall is a large supermarket consisting of many different aisles (such as dairy products, baking, drinks, stationary, house-wares)



- Photographs of real grocery items were integrated into the VMall.
- Each aisle is composed of a maximum of 60 products located on shelves, and sorted into different aisles.



- The item is enlarged when it is touched and the name of the product is heard. 
- Several additional features have been included to enhance the user's sense of being present within a supermarket environment: 
 - Background “shopping mall” type music
 - Typical announcements of special sales 
 - Such announcements may be recorded easily by a therapist and suited to a particular patient or shopping task.

Activation of the VMall

- The user sees himself within the VMall
- Activation using a red glove only
- Navigation by touching virtual arrows
- Entering the desired aisles by touching the sign of the aisle
- Selecting an item by touching it.



Activation of the VMall



The Shopping Cart

- Once the product is touched it enters the shopping cart.
- The user can go to and from the cart screen and check its contents
- Products can be removed from cart when touched.



Advantages of the Environment

- **Flexible**
- **Products, aisles and announcements can be changed easily**
- **Tasks can be suited to the client's level & therapeutic objectives**
- **Hebrew version completed; conversion to other languages feasible (auditory feedback easy to implement, supermarket signs require additional graphics)**

Development (cont.)

- Usability study with stroke patients was conducted during the last stages of development. Some changes were made based on the patient's feedback.
- This was followed by a pilot study of 8 stroke patients at a chronic stage who “shopped” in the VMall, filled in questionnaires, rated their perceived exertion and were interviewed as to the potential of the VMall for rehabilitation.

Results of pilot study (N=8)

- Stroke patients with different degrees of motor impairments were able to shop in the VMall for products using one or both hands.
- They reported a high level of presence, enjoyed the task and thought it to be relevant for their rehabilitation.

	Range	Mean \pm SD
SFQ (5-30)	19-28	22.6 \pm 3.2
Enjoyment (1-5)	4-5	4.1 \pm 0.99
Borg Exertion scale (6-20)	8-17	13.2 \pm 3.8

Current Study

- A study assessing the use of the VMall as an assessment tool and for intervention of stroke patients who suffer from motor and/or executive functions deficits is in progress



The VMall as an assessment tool

64 healthy participants and 14 stroke patients
and have experienced the VMall.

Healthy participants (N=64)

	Young (N=42)	Elderly (N=22)
Age (years)	26.7 ± 6.0	60.0 ± 6.0
Gender - male	20	11
- female	22	11

Stroke patients (N=14)

Age (years) – mean	60.0
– SD	11.0
Months post stroke	
– 3-7 months	11
– 2-4 years	2
Gender – male	11
– female	3
Side of CVA – right	8
– left	6
Mobility – walk	9
– use W/C	4
BADL – independent	11
– dependant	2

Stroke patients – Results of conventional assessments

	Range	Mean \pm SD
MMSE (0-30)	26 - 30	28.6 \pm 1.6
FMA (0-60)	11 - 60	40 \pm 14.7

Procedure

- Participants experienced the VMall and were then asked to shop for a list of 4 items from 2 different aisles (2 items from middle shelf and 2 items from top shelf)
- Outcomes:
 - order of the items purchased
 - number of items bought by mistake
 - total shopping time
 - SFQ and BORG scales.



Data Analysis

- Descriptive statistics for the participants characteristics, the SFQ + Borg + shopping task were used.
- T-tests / ANOVA used to assess differences in shopping task, SFQ, and Borg between
 - patients and healthy participants
 - two age groups of the healthy group

Results

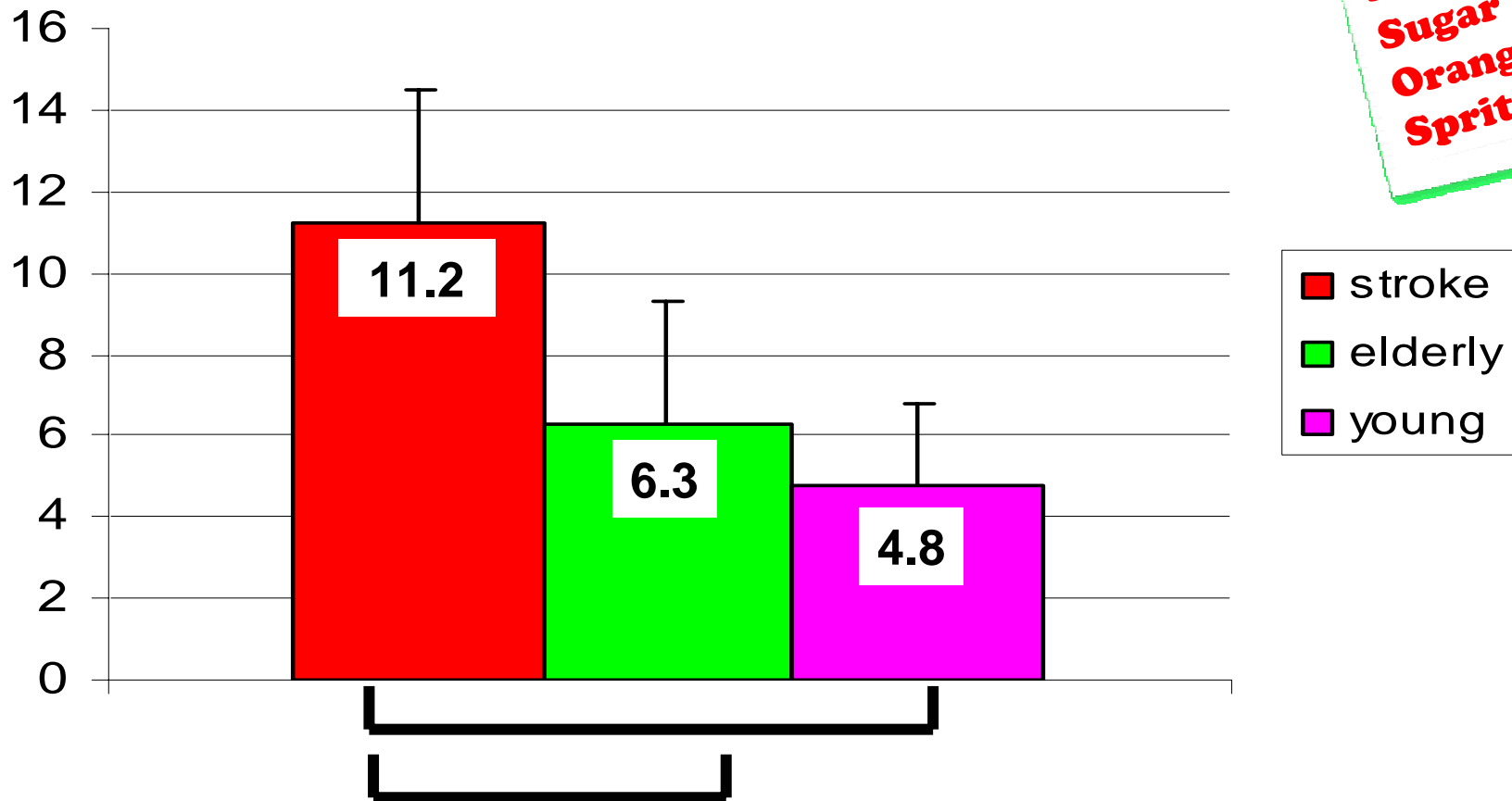
The VMall Experience

	Healthy Young	Healthy Elderly	Stroke Patients
Enjoyment (1-5)	4.2 ± 0.8	4 ± 1.2	4.2 ± 0.8
Total SFQ (6-30)	24 ± 3.5	22.4 ± 4	23.5 ± 3.2
Borg scale (6-20)	8 ± 2.2	10.7 ± 3.5	12 ± 3.6 *

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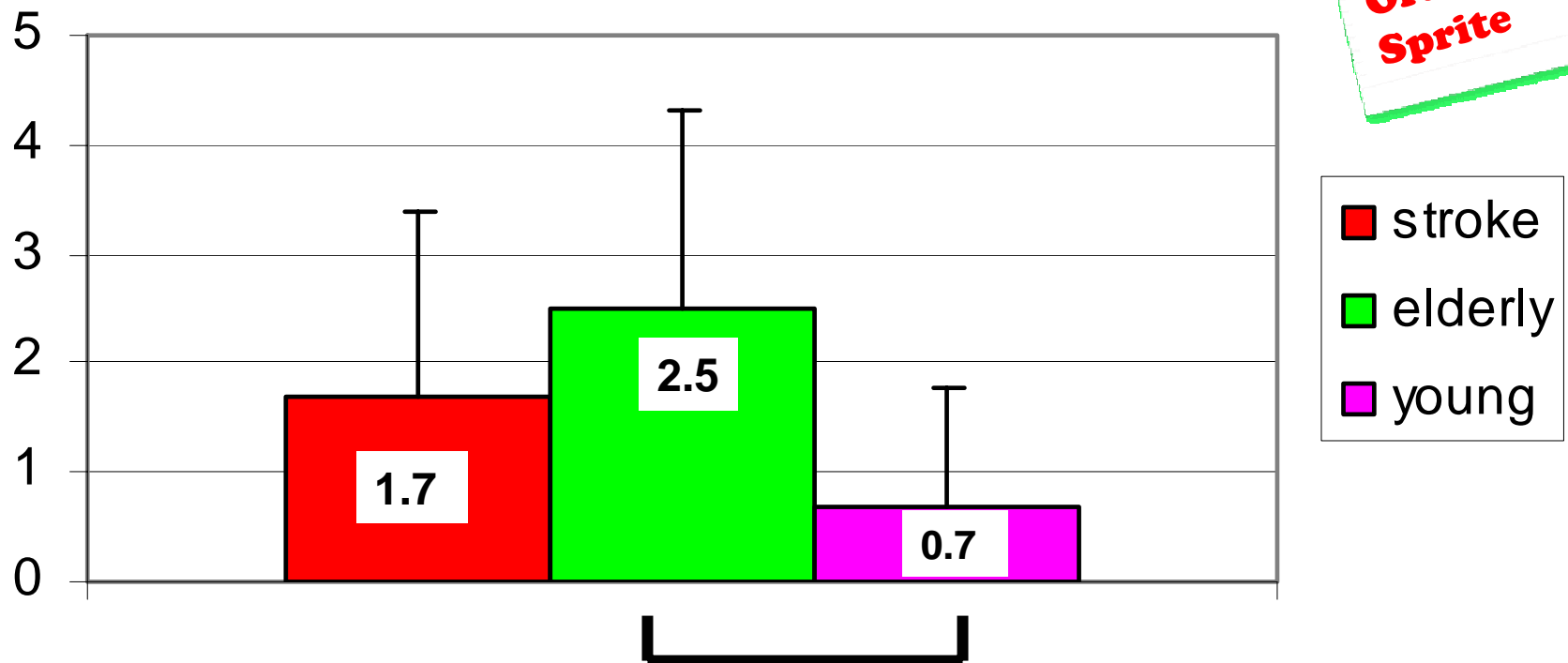
F(2,32)=6.3, p<.005

VMall Task- Time (min) to shop for 4 items



* $F(2,65)=31.8, p<.000$

VMall task - Number of products bought by mistake

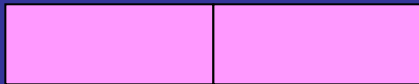


* $F(2,66)=5.7, p<.000$

VMall as an intervention tool for the affected upper extremity and executive functions

To date, 7 patients have completed the study protocol (4 patients with a motor deficit only and 3 patients with a primary executive functions deficit) using a single case study design A-B-A

A



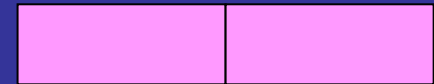
**Two weeks
baseline**

B



**Three weeks of
treatment –
10 sessions**

A



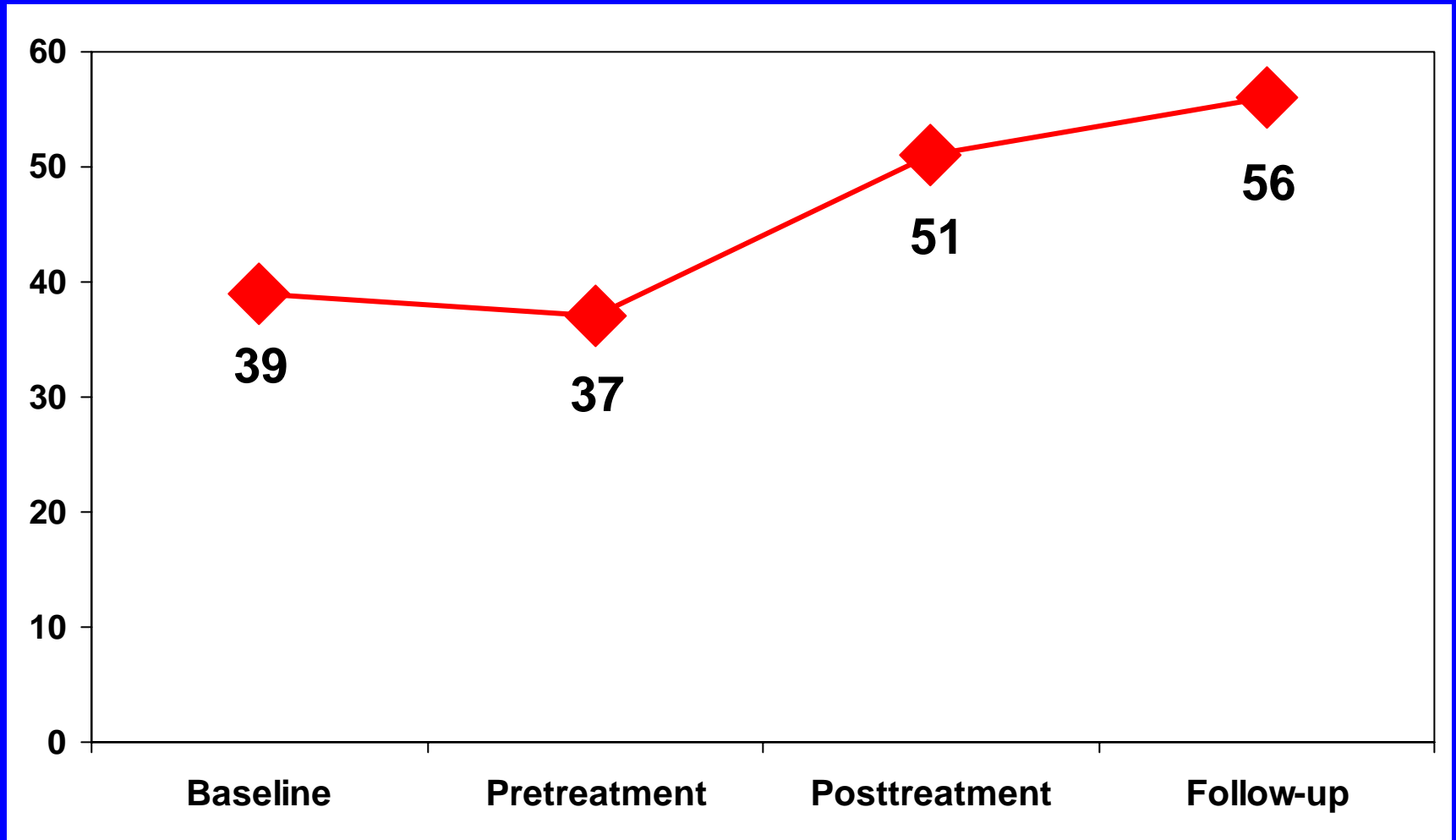
**Two weeks
Follow-up**

VMall as an intervention tool for the affected upper extremity

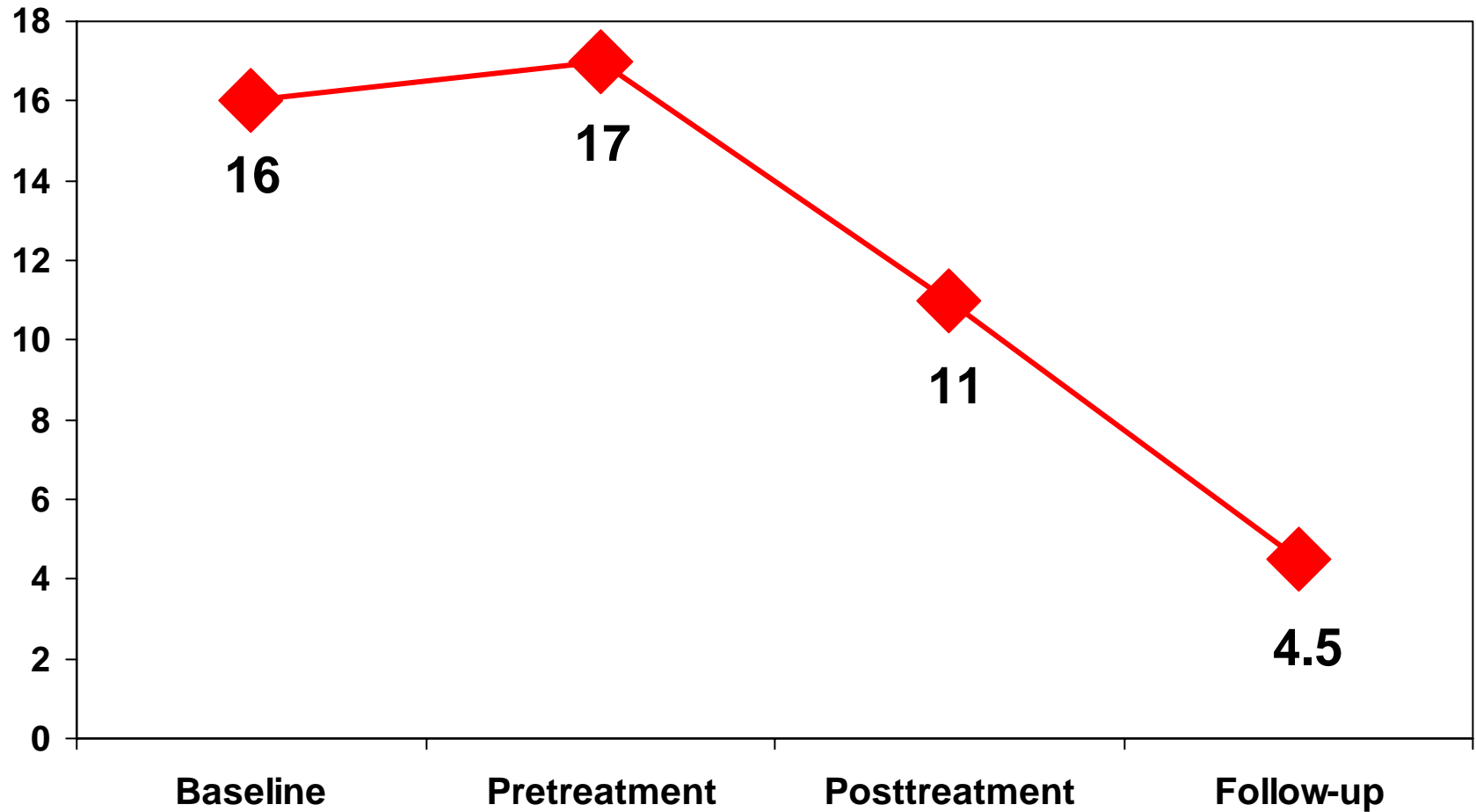
Case study - Mr. S.

- Male, aged 73 years
- Recurrent RT CVA, 7 months post stroke
- Independent prior to stroke
- Uses a walker and drives a scooter
- Weakness of upper extremity (mainly wrist and hand) → hand not functional
- Cognitively intact without deficit of executive functions

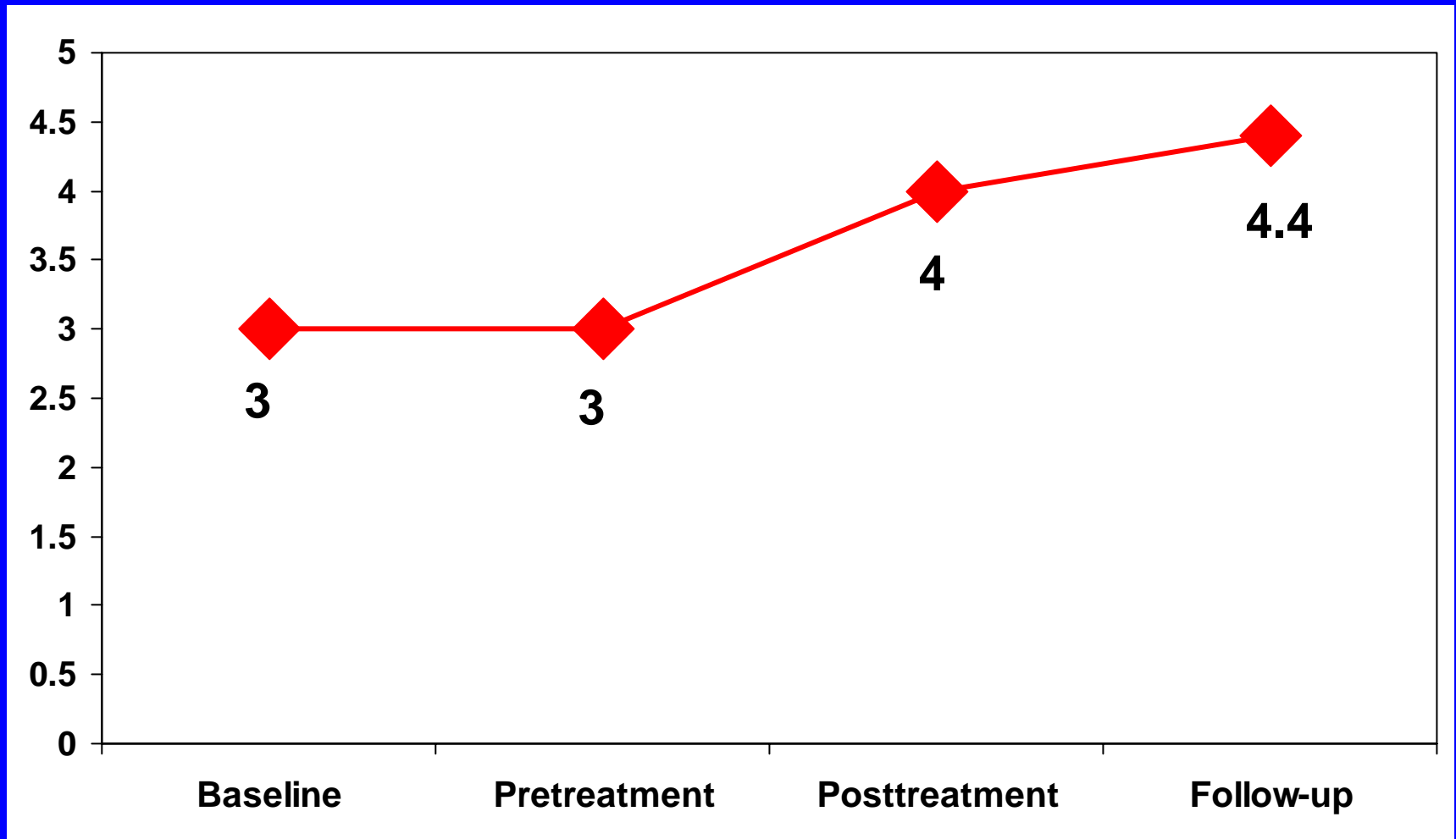
Active Movements of Paretic Hand (FMA)



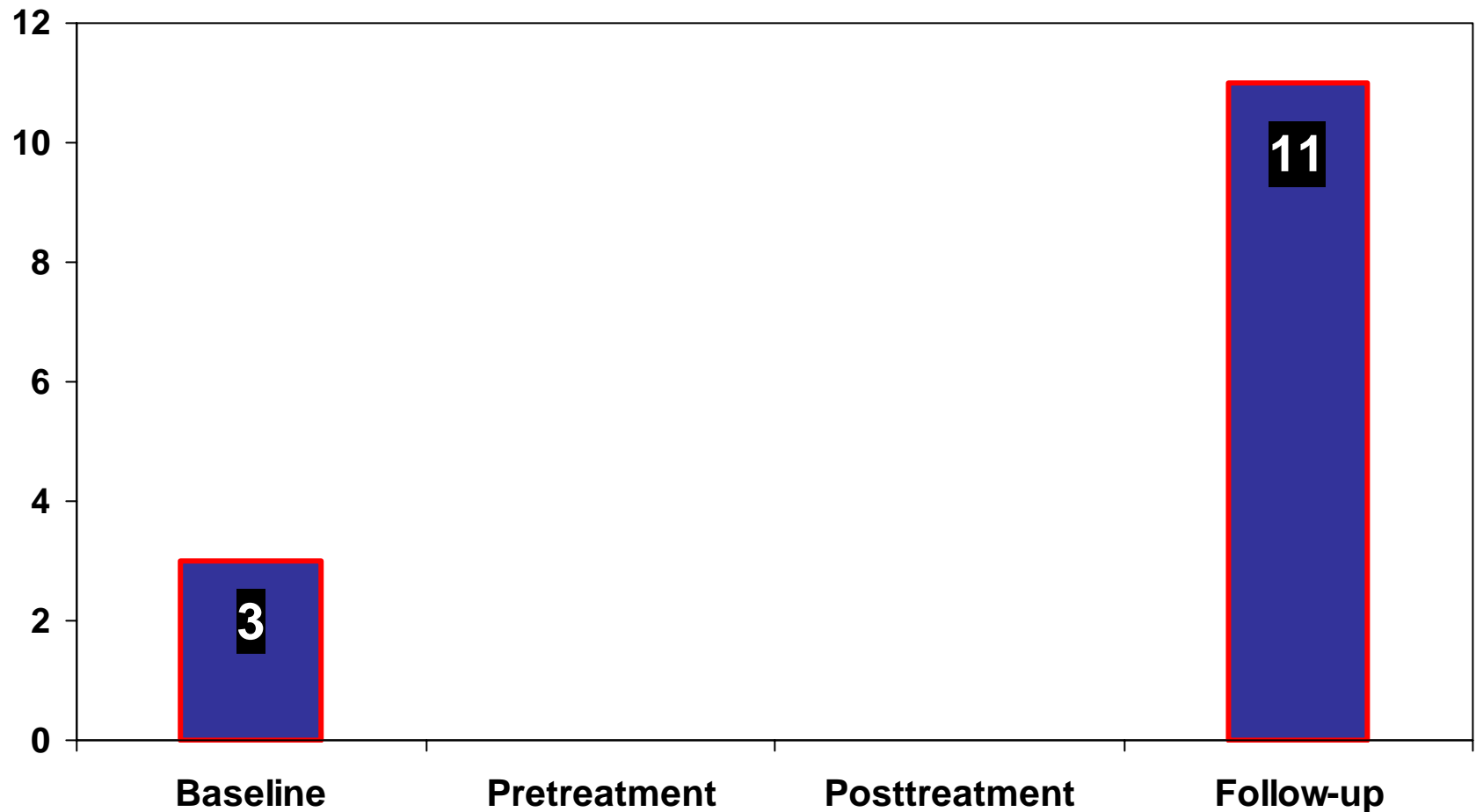
Mean time (sec) to complete 15 functional tasks of the WMFT



Mean quality of active movement (0-5) while performing the WMFT



Number of tasks (0-12) performed using both hands (questionnaire)



VMall as an intervention tool for executive functions

- Our data is currently been analyzed.



Summary

- The VMall appears to have great potential for use with stroke patients during rehabilitation especially when compared to conventional therapy. The VMall:
 - provides an interesting and motivating task
 - encourages active movement especially of the weak upper extremity
 - facilitates the use of executive functions
- Based on the few patients who have completed the intervention protocol using the VMall, an improvement can be seen. Further data collection and analysis is in progress.

Summary (cont.)

- **Differences between age groups of healthy participants and between healthy and stroke subjects points to the sensitivity of the VMall as an assessment tool.**
- **Training of an important and complex task like shopping is done easily using the VMall and therefore can be repeated many times, facilitating the patient's independence.**

Acknowledgments

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