Visuoperceptual deficits and participation in older adults after stroke

Audrée Jeanne Beaudoin, Bénédicte Fournier, Léonie Julien-Caron, Lucie Moleski, Joanie Simard, Louisette Mercier, & Johanne Desrosiers

Abstract

Introduction: Visuoperceptual deficits frequently occur after a stroke but little is known about how they evolve over time. These deficits may have an impact on participation in daily activities and social roles. **Objectives:** The aims were to 1) track changes over six months in the visual perception of older adults with persistent visuoperceptual deficits after a stroke; 2) examine if these changes differed between participants who had and had not received rehabilitation services; and 3) verify if participation differed between participants with and without visuoperceptual deficits. **Methods:** Visual perception as well as participation of 189 older adults who had had a stroke were evaluated in the first month (T1) after being discharged home from an acute care hospital (NO REHAB group) or rehabilitation unit (REHAB group). For visual perception, only participants presenting deficits at T1 were re-evaluated at 3 months (T2; n=93), and those with deficits at T2 were re-evaluated at 6 months (T3; n=61). **Results:** A total of 57 people (30.2%) had visuoperceptual deficits six months after discharge home. Despite persistent deficits, approximately 45% of the participants in the two groups improved while 50% of the NO REHAB group and 24.3% of the REHAB group deteriorated. Changes in the mean scores on the MVPT-V were similar in the two groups. Participation, and especially participation in social roles, was more restricted in participants with visuoperceptual deficits ($p<0.001$), whatever the severity of the stroke. **Conclusion:** Visuoperceptual deficits are common post-stroke. However, they evolve differently in different people and are associated with a reduction in participation.

1. Introduction

Stroke is the third leading cause of death in industrialised countries (Bouchard & Mackey, 2007). Although the incidence of stroke has decreased in the past 50 years, its prevalence is rising as a result of the aging population and increased survival rate (Paolucci, McKenna & Cooke, 2009). In Australia as well as Canada, stroke is the main cause of chronic adult disability (National Stroke Foundation, 2007; Heart and Stroke Foundation of Canada, 2012). People who have had a stroke may have motor, cognitive, sensory and visuoperceptual deficits (Mercier, Audet, Hébert, Rochette & Dubois, 2001a) that have an impact on activities of daily living (ADLs) and instrumental ADLs (Withall, Brodaty, Altendorf & Sachdev, 2009). In addition, restrictions in participation in daily activities and social roles frequently appear after a stroke (Cardol et al., 2002; Desrosiers et al., 2006; Rochette, Desrosiers, Bravo, St-Cyr Tribble & Bourget, 2007). Thus stroke is a major cause of disability and handicap situations, and help from others is often required to compensate for them (Paolucci et al., 2009). After a stroke, the decision to be discharged to rehabilitation centre or home is mainly based on the severity of the physical impairments/disabilities (Hakkennes et al., 2012), on the availability of home delivered and rehabilitation services and on personal preferences of the patient (Gregory et al., 2010). Therefore, some patients receive rehabilitation services while others do not.

Visuoperceptual deficits frequently occur following a stroke, with an incidence varying between 20% and 54%, depending on the measurement instruments and time of the assessments (Van Ravensberg, Tyldeslev, Rozendai & Whiting, 1984; Rowe, 2009). These deficits are defined as an inability to organise process or interpret visual information and act appropriately upon them (Titus, Gall, Yerxa, Roberson & Mack, 1991). Visuoperceptual deficits are known to have a negative impact on functional independence (Mercier et al., 2001a; Edmans & Lincoln, 1990; Smith, Akhtar & Garraway, 1983). More specifically, in the study by Titus and colleagues (1991) visuoperceptual scores, such as three-dimensional ability, were positively and significantly correlated with dressing ($r=0.55$; $p=0.004$), upper body hygiene ($r=0.42$; $p=0.040$) and feeding ($r=0.50$; $p=0.01$), which demonstrated the importance of visuoperceptual abilities in activities of daily living.

Although visuoperceptual deficits are common following a stroke and have functional impacts, little is known about how they evolve over time. Some longitudinal studies reported significant

visuoperceptual improvements in older adults after a stroke. For example, Nys and colleagues (2005) reported high rates of recovery from visuoperceptual deficits. Indeed, 32.4% of participants demonstrate visuoperceptual deficits in the first few weeks post-stroke, compared to only 5% six to ten months later. Despite gains, many still present visuopercepual deficits some months after stroke as reported by Friedman and Leong (1992) who observed that 45% of their participants still had visuoperceptual deficits according to their results on the Rivermead Perceptual Assessment Battery. Improvements in specific visuoperceptual deficits after a stroke have also been reported in case studies. Improvements have been found in prosopagnosia (difficulty with face recognition) (Malone, Morris, Kay & Levin, 1982), colour perception (Spillmann, Laskowski, Lange, Kasper & Schmitt, 2000), attention in perceiving complex scenes (Trivelli, Turnbull & Sala, 1996) and simultagnosia (difficulty perceiving a scene as a whole) (Smith, Mindelzun & Miller, 2003).

To our knowledge, visuoperceptual deficits after stroke of people who were discharged home or to rehabilitation centre have not previously been compared. We generally expect that people directly discharged home, without rehabilitation services, would have lower level of deficits. Finally, little is also known about the impact of deficits in visual perception on participation after stroke Improvement of level of participation in daily activities and social roles is among the more important aims in occupational therapy.

Better knowledge of how visuoperceptual deficits change after stroke and their relationship with participation would help to more accurately identify the services and rehabilitation approach that might be required. Therefore, the objectives of this study were to: 1) track changes over six months in the visual perception of older adults with persistent visuoperceptual deficits after a stroke, 2) examine if visuoperceptual deficits and their changes over time differed between participants who had and had not received rehabilitation services after their stroke, and 3) verify if participation differed between participants with and without visuoperceptual deficits.

2. Methods

2.1 *Participants*

This study followed a short longitudinal design with three measurement times and is part of a larger study on the needs of older adults post-stroke (Desrosiers et al., 2008). Participants were from three regions of the province of Quebec, Canada (one metropolitan, two urban and rural). They were recruited after being discharged home from an acute care hospital (NO REHAB group) or an intensive rehabilitation unit or geriatric day hospital (REHAB group). Participants had to: a) have had a least one stroke according to World Health Organisation (WHO) criteria (1990), b) be 65 years of age or older, and c) live at home. People with severe cognitive or mental disorders were excluded from the study. The research protocol was approved by the Research Ethics Committee of the eight institutions involved in recruiting participants.

2.2 Data collection

In the main study, participants' physical, cognitive and psychosocial aptitudes were evaluated at three measurement times: T1: between the 18th and 24th day following discharge home, T2: three months later, and T3: six months after T1. To reduce the burden associated with many measurement tools, for the cognitive tests, including visual perception, participants were retested only when they failed on the previous evaluation. Therefore, only the participants presenting visuoperceptual deficits at T1 were reassessed in this domain at T2 and only those still presenting problems at T2 were reassessed at T3.

2.3 Variables and measuring instruments

Visual perception was evaluated with the *Motor-Free Visual Perceptual Test-Vertical version* (MVPT-V) (Mercier, Hébert, Colarusso & Hammill, 1997). This standardised test includes 36 boards with multiple choices; one point is awarded for each correct answer so a score of 36 indicates an optimal performance. It assesses five aspects of visual perception: visual discrimination, figure-ground differentiation, visual memory, constancy of form, and visual synthesis (Mercier, Desrosiers, Hébert, Rochette & Dubois, 2001b). Visual discrimination and visual synthesis are the abilities to perceive the characteristics of each element in the environment and to integrate it in a coherent whole. Figure-ground differentiation is necessary to interact appropriately with the perceived elements in the environment. Visual memory is used to store visual information and to recognise it amongst other types of information. Finally, form constancy is the ability to identify an object when its shape or spatial arrangement varies

(Mercier et al., 1997). The MVPT original version presents the multiple choices (four) horizontally under the stimulus. The vertical version was created to control the hemineglect component found in many people following a stroke (Mercier et al., 1997). Reliability and validity studies have demonstrated the metrological properties of the MVPT-V (Mercier et al., 1997). Normative values for this test by age and schooling were developed with 236 participants aged 50 years and older (Mercier et al., 2001b). In our study, participants who had a score below the 25th percentile were identified as having visuoperceptual deficits.

The *Assessment of Life Habits* (LIFE-H), short version 3.1, was used to measure the level of participation (Fougeyrollas, Noreau & St-Michel, 2002). The LIFE-H 3.1 measures the performance of 77 life habits covering the 12 domains of the Disability Creation Process (DCP) model. Six of these domains relate to daily activities (nutrition, fitness, personal care, communication, housing and mobility) and the other six to social roles (responsibilities, interpretational relationships, community life, employment, education and leisure). The employment and education domains were excluded from this study, leaving 67 items and ten domains. The measure is based on two concepts: 1) degree of difficulty, and 2) type of assistance used (technical assistance, physical arrangements and human help). A ten-point scale (zero to nine) was developed by combining these two concepts, where a higher score suggests better participation. Based on the score obtained on each item, scores were computed in two main domains (daily activities and social roles subscores), and for the instrument as a whole (total score). A change of at least 0.5 over time is considered clinically significant (unpublished data). Studies have demonstrated reliability (Noreau et al., 2004) and construct validity (Desrosiers et al., 2004).

2.4 Statistical analysis

Sociodemographic and clinical characteristics of the participants are described with means and standard deviations or with frequencies and percentages, according to the type of variable. Participants who received rehabilitation services (REHAB group) and those who did not (NO REHAB group) were compared with *t* tests (continuous variables) and Chi square tests (categorical variables).

For the first objective, changes over time in the visuoperceptual deficit scores of all participants were verified with an ANOVA for repeated measures with one factor: time) (after verification for normality of the data). In addition to this analysis, to better understand the individual changes over time of the visuoperceptual deficits not allowed by the ANOVA for repeated measures, which is carried out on the group mean scores, the changes in each participant's score were recorded. Based on the measurement error on the MVPT-V (Mercier et al. 1997), participants with a difference of two or more points between assessments were considered to have improved (≥2) or deteriorated (≤2) while those with a difference of zero or one point were considered stable.

For the second objective, after verification of the normality of the distribution of the data, an ANOVA for repeated measures at two factors (Time and Group) was conducted to compare the REHAB and the NO REHAB groups.

Finally, for the third objective, the interaction of visuoperceptual deficits with the presence of a previous stroke as well as with the use of a walking aid, with is a proxy of severity of the stroke, was first tested, followed by an ANCOVA to compare participation according to the presence or not of visuoperceptual deficits. These tests were performed on the total LIFE-H score as well as on the two subscores (daily activities and social roles).

3. Results

Description of participants:

At T1, the visual perception of 189 people with stroke was evaluated. A total of 93 (49.2%) had deficits and were therefore re-evaluated at T2. At that time, 32 people (34.4%) no longer had deficits, including 13 (40.6%) from the NO REHAB group and 19 from the REHAB group (59.4%). The 61 people with deficits were re-evaluated at T3. At that time, only four participants (6.6%) had a normal performance according to their age and schooling (two participants in each group). This led to a sample size of 57 participants (30.2% of the total sample) who had persistent visuoperceptual deficits, 37 of whom had received rehabilitation services after hospitalisation in acute care.

The participants were composed of similar number of women and men, were mainly retired and were aged from 65 to 92 years old (Table 1). Nearly 30% of them had had a previous stroke. Sociodemographic and clinical characteristics of the participants in the REHAB and NO REHAB groups were similar, with two exceptions: REHAB group participants had their stroke earlier ($p<0.001$) and they used walking aids more often ($p=0.007$), suggesting greater physical disabilities.

(Insert Table 1 about here)

Objective 1: No difference ($p = 0.25$) was found over time for the 57 participants with visuoperceptual deficits (Table 2), even when we controlled for the presence/absence of a previous stroke. Objective 2: Our analyses showed the absence of interaction between Time (1, 2 3) and Group (REHAB vs. No REHAB) ($p = 0.42$) as well as no change over time ($p = 0.13$) (Table 2). However, individual analyses presented in Table 3 show that nearly 46% of both groups improved their performance by two points or more, even though still under the expected score for their age and schooling. Participants in the REHAB group had less deterioration in visual perception (24.3%) than those in the NO REHAB group (50.0%).

(Insert Tables 2 and 3 about here)

Objective 3: There was no interaction between visuoperceptual deficits and presence/absence of a previous stroke, nor between visuoperceptual deficits and walking aid, allowing the use of ANCOVA. Without controlling for these two variables (previous stroke and walking aid), participants with visuoperceptual deficits had lower participation scores than those without deficits at each of the three time measurements ($p <0.001$ except daily activities at T1: $p = 0.009$) (see Figure 1). When controlling for use of a walking aid and previous stroke, the p values are very similar ($p <0.001$ except daily activities at T1: $p = 0.008$ and at T2: $p = 0.004$). The difference between groups was greater for participation in social roles than participation in daily activities.

(Insert Figure 1 about here)

4. Conclusion

The main purpose of this study was to track changes in persistent visuoperceptual deficits of older adults over a period of six months post-stroke and to verify if participation differed between participants with and without visuoperceptual deficits. Following discharge from an acute care hospital or rehabilitation centre, nearly 50% of the 190 participants presented visuoperceptual deficits. Nearly one third of those participants no longer had deficits three months after discharge home (T2). Very few participants (6.6%) who had persistent deficits at T2 no longer had them after six months. The proportion of participants who recovered from their deficits was similar in the two groups (REHAB and NO REHAB) at both measurement times.

No statistically significant change was observed in the scores on the MVPT-V for all the participants with visuoperceptual deficits, considered as a single group or split (REHAB and NO REHAB). However, using means to analyze changes in visuoperceptual deficits hides significant individual variability. Although they still had deficits, 46% of the participants improved their score on the MVPT-V by 2 to 8 points out of 36 over the six months of the study. The percentage of participants who improved was similar in the REHAB and NO REHAB groups. However, more of the participants in the NO REHAB group presented a decline of more than 2 points over time than in the REHAB group (50% vs 24%). Thus the majority of the participants in the REHAB group (nearly 76%) improved or remained stable. Despite comparable visuoperceptual deficits in the two groups, the NO REHAB participants were not referred to rehabilitation services and a larger percentage of them deteriorated after returning home. We cannot explain this higher percentage of deterioration in the NO REHAB. We have to consider that the sample size of this group is very small (n = 20) and therefore, probably not representative.

Two longitudinal studies examined the changes in visuoperceptual deficits after stroke. In the study by Friedman and Leong (1992), the visual perception of 86 participants aged 60 and over, all recruited in an acute care hospital, was evaluated two weeks post-stroke (T1), and 70 of them were re-evaluated three months later (T2) with the Rivermead Perceptual Assessment Battery (Wilson, Cockburn, Baddeley & Hiorns, 1989). Of these 70 participants, 60 (87.7%) had failed at T1 and 45 (64%) still had deficits at T2. Our study confirmed that a significant percentage of elderly individuals present persistent visuoperceptual deficits following a stroke. These results differ from those obtained in the study by Nys and colleagues (2005), which found a greater recovery in visual perception post- stroke. That study looked at the cognitive functioning,

including visual perception, of 111 participants who had had a stroke. In the early weeks post-stroke, only 36 (32.4%) of the participants demonstrated a disorder in visual perception/construction. At follow-up, six to ten months post-stroke, 30 of those 36 participants (83%) had recovered from their deficits. Differences in the recruitment environments, measuring tools and time since stroke could explain the differences between the studies in the prevalence of visual perception deficits.

Our study also showed that visuoperceptual deficits following a stroke are linked to a restriction in participation following the return home. This restriction is still present three and six months after the return home. This is in agreement with studies showing that visuoperceptuual deficits have a negative impact on functional autonomy (Mercier et al., 2001a; Edmans & Lincoln, 1990; Smith, Akhtar & Garraway, 1983). Participation and severity of stroke, estimated by the use of a walking aid, are both related. However, the relationship between participation and visuoperceptual deficits did not change when severity of the stroke was considered in our analyses. Furthermore, visuoperceptual deficits have a greater impact on participation in social roles than daily activities. Daily activities are related to basic needs while social roles fall more into the realm of personal fulfilment. Thus social roles are more likely to be abandoned in order to meet basic needs. Also social roles are performed mainly outside the home and require more complex skills, which may explain the greater impact of visuoperceptual deficits on their performance. Thus the presence of visuoperceptual deficits is linked to a restriction in participation post-stroke even when severity of the stroke was controlled for.

Even though not the focus of this study, we are concerned about the fact that people with visuoperceptual deficits after stroke were discharged home. We do not have systematic information on their follow-up, but we know that the majority of them did not receive rehabilitation services. In general, in acute care hospital, when the patient is independent in the main activities of daily living (ADLs) such as eating, washing and dressing, as well as walking, without significant physical problems, she/he might be considered as being able to discharge home without significant services. Indeed, recovery after stroke is generally estimated by the independence in walking and self-care activities (Radomski, 1995). Visuoperceptual problems are not always apparent or obvious when performed basic ADLs which are usually quite simple

or done automatically. In addition, visuoperceptual deficits are not systematically screened in acute care hospitals.

Considering the high prevalence of persistent visuoperceptual deficits and their impact on participation, occupational therapists should be aware of visuoperceptual abilities in patients in every stage of their rehabilitation, including in acute care hospitals. Thus, screening for and identifying visuoperceptual deficits would at least allow rehabilitation professionals to educate patients about their impairments and how to compensate in order to minimize negative impact on participation.

This study had some methodological limitations. Changes were documented only in participants presenting persistent visuoperceptual deficits; participants without deficits were not re-evaluated in order to reduce the burden associated with using a large number of measuring tools. Thus it was assumed that individuals who did not have visuoperceptual deficits would not develop them during the six-month study period, which may not be the case. In addition, since only clients who returned home were recruited, the results cannot be generalized to the entire population with stroke, even if a large percentage of them return home to live (Chuang, Wu, Yeh, Chen & Wu, 2005). The time since stroke differed between the participants but there was no correlation between the MVPT-V score and the time after stroke. Since there was no significant correlation between them we did not further consider the time in our analyses. Also, the changes between the occurrence of the stroke and the discharge from medical or rehabilitation services were not documented. In our analyses, other deficits secondary to the stroke that could also have had an impact on participation were not considered.

This study documented changes in persistent visuoperceptual deficits in older adults who had had a stroke and compared these changes in participants who had and had not received rehabilitation services before returning home. This study also compared the participation of those with and without visuoperceptual deficits. Although many participants improved, the incidence of deficits six months after returning home remained high. Individual changes (improvement, stability and deterioration) were found in participants who still had deficits. The presence of visuoperceptual deficits is related to a restriction in participation.

REFERENCES

Bouchard, R.W. & Mackey, A. (2007). Accident vasculaire cérébral. [Stroke]. In: M. Arcand & R. Hébert. *Précis pratique de gériatrie*. (3rd ed., pp. 577-596) Edisem/Maloine, Saint-Hyacinthe, QC.

Cardol, M., de Jong, B.A., van den Bos, G.A., Beelem, A., de Groot, I.J. & de Haan, R.J. (2002). Beyond disability: perceived participation in people with a chronic disabling condition. *Clinical Rehabilitation, 16,* 27-35.

Chuang, K.Y., Wu, S.C., Yeh, M.C., Chen, Y.H. & Wu, C.L. (2005). Exploring the associations between long-term care and mortality rates among stroke patients. *Journal of Nursing Research*, *13*, 66-74.

Desrosiers, J., Demers, L., Robichaud, L., Vincent, C., Belleville, Ska, B. et al. (2008). Short-term changes in and predictors of participation of older adults after stroke following acute care or rehabilitation. *Neurorehabilitation & Neural Repair, 22*, 288-297.

Desrosiers, J., Noreau, L., Bourbonnais, D., Bravo, G., Rochette, A. & Bourget, A. (2006. Long-term changes in social participation after stroke. *Topics in Stroke Rehabilitation, 13*, 86-96.

Desrosiers, J., Noreau, L., Robichaud, L., Fougeyrollas, P., Rochette, A. & Viscogliosi, C. (2004). Validity of the Assessment of Life Habits (LIFE-H) in older adults. *Journal of Rehabilitation Medicine*, *36*, 177-182.

Edmans, J.A. & Lincoln, N.B. (1990). The relation between perceptual deficits after stroke and independence in activities of daily living. *British Journal of Occupational Therapy*, *53*, 139-142.

Fougeyrollas, P., Noreau, L. & St-Michel, G. (2002). *Life Habits Measure-Shortened Version (LIFE-H 3.1)*, Lac St-Charles, QC.

Friedman, P.J. & Leong, L. (1992). Perceptual impairment after stroke: improvements during the first 3 months. *Disability Rehabilitation*, *14*, 136-139.

Gregory, P., Edwards, L., Faurot, K., Williams, S. & Felix, A. Patient preferences for stroke rehabilitation. *Topics in Stroke Rehabilitation*. *17*, 394-400.

Hakkennes, S., Hill, K.D., Brock, K., Bernhardt, J., Churilov, L (2012). Accessing inpatient rehabilitation after acute severe stroke: age, mobility, prestrike function and hospital unit are associated with discharge to inpatient rehabilitation. *International Journal of Rehabilitation Research*. *35*, 323-329.

Heart and Stroke Foundation (2012). *Statistics*. Retrieved 22 April 2012 from http://www.heartandstroke.com/site/c.ikIQLcMWJtE/b.3483991/k.34A8/Statistics.htm

Malone, D.R., Morris, H.H., Kay, M.C. & Levin, H.S. (1982). Prosopagnosia: a double dissociation between the recognition of familiar and unfamiliar faces. *Journal of Neurology, Neurosurgery, and Psychiatry*, *45*, 820-822.

Mercier, L., Audet, T., Hébert, R., Rochette, A. & Dubois, M.F. (2001a). Impact of motor, cognitive and perceptual disorders on ability to perform activities of daily living after stroke. *Stroke, 32*, 2602-2608.

Mercier, L., Desrosiers, J., Hébert, R., Rochette, A. & Dubois, M.F. (2001b). Normative data for the Motor-Free Visual Perception Test – Vertical. *Physical and Occupational Therapy in Geriatrics*, *19*, 39-50.

Mercier, L., Hébert, R., Colarusso, R. & Hammill, D. (1997). *Motor-Free Visual Perception Test: Vertical.* Novato, CA. Academic Therapy Publications.

National Stroke Foundation (2007). *Clinical guidelines for acute stroke management*. Melbourne, Australia. Authors.

Noreau, L., Desrosiers, J., Robichaud L., Fougeyrollas, P., Rochette, A. & Viscogliosi, C. (2004). Measuring social participation: Reliability of the LIFE-H among older adults with disabilities. *Disability and Rehabilitation, 26*, 346-352.

Nys, G.M., Van Zandvoort, M.J., De Kort, P.L.M., Jansen, B.P.W., Van Der Worp, H.B., Kapelle, L.J. et al. (2005). Domain-specific cognitive recovery after first-ever stroke: a follow-up study of 111 cases. *Journal of the International Neuropsychological Society*, *11*, 795-806.

Paolucci, A., McKenna, K. & Cooke, D.M. (2009). Factors affecting the number and type of impairments of visual perception and praxis following stroke. *Australian Occupational Therapy Journal*, *56*, 350-360.

Radomski, M.V. (1995). There is more to life than putting on your pants. *American Journal of Occupational Therapy*, *49*, 487-490.

Rochette, A., Desrosiers, J., Bravo, G., St-Cyr/Tribble, D. & Bourget, A. (2007). Changes in participation six months after a "mild" stroke: uantitative and qualitative perspectives. *Topics in Stroke Rehabilitation, 14*, 59-68.

Rowe, F. (2009). Visual perceptual consequences of stroke. *Strabismus*, *17*, 24-28.

Smith, D., Akhtar, A. & Garraway, W. (1983). Proprioception and spatial neglect after stroke. *Age and Aging*, *12*, 63-69.

Smith, W.S., Mindelzun, R.E. & Miller, B. (2003). Simultagnosia through the eyes of an artist. *Neurology*, *60*, 1832-1834.

Spillmann, L., Laskowski, W., Lange, K.W., Kasper, E. & Schmidt, D. (2000). Stroke-blind for colors, faces and locations: Partial recovery after three years. *Restorative Neurology and Neuroscience, 17*, 89-103.

Titus, M., Gall, N.G., Yerxa, E.J., Roberson, T.A. & Mack, W. (1991). Correlation of perceptual performance and activities of daily living in stroke patients. *American Journal of Occupational Therapy*, *45*, 410-418.

Trivelli, C., Turnbull, O.H. & Sala, S.D. (1996). Recovery of object recognition in a case of simultagnosia. *Applied Neuropsychology, 3*, 166-173.

Van Ravensberg, C.D., Tyldeslev, D.A., Rozendai, R.H. & Whiting, H.T. (1984). Visual perception in hemiplegic patient. *Archives of Physical Medicine and Rehabilitation, 65,* 304-309.

Wilson, B., Cockburn, J., Baddeley, A. & Hiorns, R. (1989). The development and validation of a test battery for detecting and monitoring everyday memory problems. *Journal of Clinical and Experimental Neuropsychology, 11,* 855-870.

Withall, A., Brodaty, H., Altendorf, A. & Sachdev, P.S. (2009). Who does well after a stroke? The Sydney Stroke Study. *Aging & Mental Health, 13,* 693-698.

World Health Organisation (WHO) (1990). *WHO MONICA Project: MONICA Manual*. Retrieved 23 April 2012 from http://wwwktl.fi/publication/monica/manual/index.htlm

Figure legend:

Figure 1. Participation with and without visuoperceptual deficits