

# Associations between executive function and physical function poststroke: a pilot study

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## Abstract

**Objectives** Associations between executive function and physical function poststroke have not been extensively studied. More complex physiotherapy interventions poststroke require a greater degree of cognitive ability, especially executive function. This pilot study aimed to inform the methodology of a larger study by examining the associations between executive function and the performance of basic and complex gait tasks in people poststroke.

**Design** A cross-sectional pilot study was conducted in a convenience sample of 20 participants recruited from a community-based voluntary stroke organisation and from the outpatient services of two urban hospitals.

**Main outcome measures** A battery of tests was used to measure executive function (Trail Making Test, Stroop Word-Colour Test, Zoo Map test, Frontal Assessment Battery and Digit Span backward test). Basic and complex 10 metre gait tests were used to mimic aspects of physiotherapy intervention poststroke. Other measures included the Mini-Mental State Examination (MMSE) and the Motor Assessment Scale (MAS).

**Results** Observational comparisons between participant executive function scores and age- and/or education-matched normative data demonstrated that executive dysfunction ranged between 55% and 100%. Poorer performance in measures of executive function was more frequently associated with poorer performance in complex gait tests compared with basic gait tests. The MAS was not significantly associated with any measure of executive function.

**Conclusions** Executive dysfunction is a common sequel poststroke which may negatively affect physical performance. Physiotherapists should consider executive dysfunction when developing rehabilitation strategies to improve physical function poststroke.

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*Keywords:* Stroke; Executive function; Physical function; Physiotherapy

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## Introduction

Stroke is complex in nature and can result in a wide range of impairments, namely; physical, cognitive, emotional and social. Up to 65% of stroke survivors demonstrate new onset or worsening of cognitive impairments that may interfere with physical recovery and the potential benefits of functional recovery poststroke [1]. Traditionally, physiotherapy intervention poststroke has primarily focused on the rehabilitation of motor impairments with interventions to restore

maximum movement and improve functional ability. However, of particular interest to physiotherapists, there is evidence to support the association between cognitive impairments poststroke (e.g. difficulties with orientation, memory, concentration, attention, and executive function) and deficits in physical function [2–4]. In addition to the physical resources drawn upon during participation in a physiotherapy rehabilitation programme poststroke, cognitive abilities are required in order to gain optimal benefit. It has been demonstrated that the performance of cognitive tasks has an interference effect on the successful completion of physical tasks in healthy older adults [5] and people with unilateral stroke [6]. Many motor activities are

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performed “automatically”, i.e. they do not use conscious attentional resources [6]. As a result of the physical, psychological, social and emotional consequences of stroke, many behaviours or activities that would have been previously automatic or learned responses prestroke may present as complex, novel tasks poststroke. Executive function is one component of cognition that has been increasingly associated with functional recovery poststroke [2,3].

Donovan *et al.* [1] defined executive function as the group of cognitive processes responsible for guiding, directing, and managing cognitive, emotional and behavioural functions, during novel tasks such as organising thoughts and activities, prioritising tasks, managing time efficiently, and decision making. Deficits in any of the domains of executive function may cause difficulties with the performance of exercise and hence compromise the success of physiotherapy rehabilitation programmes in people with stroke, potentially leading to suboptimal physical recovery.

Previous studies have shown executive dysfunction to be a common sequel poststroke [3,7–14]. Nonetheless, there is limited evidence investigating the associations between executive function and physical function such as exercise participation and functional mobility poststroke. A recent review of the literature highlighted that the relationship between executive function and physical function is substantially under-investigated in stroke populations [16]. Much of the focus has been on the associations between executive function and activities of daily living (ADL) [7,8,17] and less attention has been paid to the associations between executive function and aspects of physiotherapy intervention poststroke. Liu-Ambrose *et al.* [18] demonstrated that poorer performance in the Stroop Interference score, which assesses cognitive flexibility, was significantly associated with reduced scoring in the Berg Balance Scale, Timed Up and Go test, Six Minute Walk Test and Stair Climbing test in chronic stroke. A recent longitudinal study by Pahlman *et al.* [19,20] reported that people with executive dysfunction measured by the I-Flex, EXIT and the Stroop test, 3 months and 1 year poststroke also had significantly poorer balance and lower levels of physical activity one year poststroke than people with intact executive function.

Executive dysfunction has also been independently associated with significant declines in physical performance among healthy older adults [5]. Furthermore, the authors categorised physical performance with respect to its complexity, in order to differentiate between physical tasks that demand increased levels of executive function [5]. Results demonstrated that poorer performance in measures of executive function was significantly associated with the performance of dual-task physical tests but not basic, reference physical tasks in a sample of healthy older adults [5].

Hence while the literature suggests associations between executive dysfunction and poorer physical performance in older adults and people poststroke, the associations between executive function and physical function that is basic and that which is complex have not been investigated to date.

Therefore, the objectives of this pilot study were to examine the rates of executive dysfunction poststroke and to investigate its associations with physical function, with particular attention to the differentiation between the performance of basic and complex gait tests poststroke. It was hypothesised that executive function would be more frequently associated with complex gait tasks compared to basic gait tasks. It is increasingly recognised that physiotherapists need to research and develop understanding of how to design exercise programmes for people poststroke that are sustainable. One key insight is the area of executive function and how it may impact on motor performance and exercise participation. The clarification of this relationship will enable the development of appropriate alternative treatment strategies to overcome difficulties with executive dysfunction poststroke.

## Method

This cross-sectional pilot study recruited 20 community-dwelling participants in the chronic stage poststroke from a community-based volunteer stroke organisation and from two outpatient facilities in the Dublin region. Physiotherapists independent of the research provided potential participants with a description of the study. If the potential participants were willing to take part in the study, further information was given via an information leaflet and informed written consent was obtained before participation in the study. Inclusion criteria for the study were: formal diagnosis of unilateral stroke, aged >18 years, Mini-Mental State Examination (MMSE) >24, ambulatory (with/without an assistive device) (as non-ambulatory people poststroke would not have been able to complete the majority of the measures of physical function) and >6 months poststroke (as a sample of convenience was used, wherein people were in the chronic stage poststroke). The exclusion criteria were: a recent fracture or orthopaedic condition which would affect their performance of the physical function tests, aphasia, severe vision impairment and the presence of any other neurological condition in addition to the stroke, e.g. Parkinson's disease, multiple sclerosis. The participants' demographic and clinical details were recorded before completion of the study assessment. These details included: age, gender, side affected by the stroke, date of stroke onset and number of years in formal education. The participants also completed a battery of outcome measures.

## Procedure

All assessments were conducted in a quiet exercise laboratory at the University by a qualified physiotherapist. The order of the measurements was randomised a priori using a computerised random number generator software package to prevent the confounding effects of fatigue or any unknown systematic time-related sources of bias. Each assessment lasted for approximately 1.5 hours.

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