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Motor-cognitive dual-task deficits in individuals with early-mid stage Huntington disease

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ABSTRACT

Background: Huntington disease (HD) results in a range of cognitive and motor impairments that progress throughout the disease stages; however, little research has evaluated specific dual-task abilities in this population, and the degree to which they may be related to functional ability.
Objectives: The purpose of this study was to a) examine simple and complex motor-cognitive dual-task performance in individuals with HD, b) determine relationships between dual-task walking ability and disease-specific measures of motor, cognitive and functional ability, and c) examine the relationship of dual-task measures to falls in individuals with HD.
Methods: Thirty-two individuals with HD were evaluated for simple and complex dual-task ability using the Walking While Talking Test. Demographics and disease-specific measures of motor, cognitive and functional ability were also obtained.
Results: Individuals with HD had impairments in simple and complex dual-task ability. Simple dual-task walking was correlated to disease-specific motor scores as well as cognitive performance, but complex dual-task walking was correlated with total functional capacity, as well as a range of cognitive measures. Number of prospective falls was moderately-strongly correlated to dual-task measures.
Conclusions: Our results suggest that individuals with HD have impairments in cognitive-motor dual-task ability that are related to disease progression and specifically functional ability. Dual-task measures appear to evaluate a unique construct in individuals with early to mid-stage HD, and may have value in improving the prediction of falls risk in this population.

1. Introduction

Individuals with HD typically present with a range of motor impairments, including akinesia, bradykinesia, and incoordination [1] that progress over time and affect functional ability. Declines in cognition are a notable feature of the disease process, and people with HD often have difficulty holding, shifting [2] and dividing attention [3]. Difficulty with divided attention, or simultaneously monitoring two tasks, is particularly significant given that automaticity can change with damage to the nervous system; previously automatic movements, such as walking or balancing in standing may become attention demanding [4] and place an increased load on cognitive resources.

Impairments in simultaneous motor-cognitive tasks, i.e. dual-tasks, have been well documented in neurodegenerative disease populations, including Parkinson's disease (PD) [5], Alzheimer's disease [6] and multiple sclerosis [7]. In HD, prior studies have shown impairments while performing complex cognitive dual-tasks (competing cognitive tasks with a manual or vocal response) [8] and automaticity with bi-manual tapping tasks (motor-motor dual-task) [9], particularly as task difficulty increases. Guidelines to increase task complexity have not been established; while some have utilized decision-making as the added complexity [10],

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studies in other populations have utilized inhibitory control of speech [11] to probe executive functioning and task-switching control under dual-task conditions. Although early work demonstrated no relationship among cognitive performance and walking [12], recent work showed that gait speed during motor-cognitive dual-task walking (i.e., walking with backward counting) has been linked with United Huntington's Disease Rating Scale Total Motor Score (UHDRS-TMS) and performance on cognitive testing [13]. Individuals with greater cognitive impairment also demonstrate greater dual-task interference for complex cognitive tasks [10]. Although individuals with HD can modify their walking speed in response to external cues [12,14], this ability declines with increasing gait impairment, and the impact of cognitive status on this relationship has not been determined.

Individuals with HD commonly experience falls [15]; in one prospective study, 21% of participants experienced 1 fall and 58% experienced at least 2 falls over the course of a year [15]. Difficulty performing dual-tasks has been associated with falls in people with PD [16] and multiple sclerosis [7]. Falls in HD have been linked with slower walking speed and poorer balance [15], but their relationship with dual-task performance has not been evaluated.

The purpose of this study was to a) examine simple and complex motor-cognitive dual-task performance in individuals with HD, b) determine relationships between dual-task walking ability and disease-specific measures of motor, cognitive and functional ability, and c) examine the relationships of dual-task measures to falls in individuals with HD. We hypothesized that individuals with HD would experience reductions in walking speed under dual-task conditions, and that impairments in dual-task walking would be linked with cognitive performance. We further hypothesized that dual-task assessment would be related to prospective falls.

2. Methods

2.1. Site and participant selection

This study utilized baseline data from the Exercise Rehabilitation Trial in Huntington's Disease (ExeRT-HD) trial [17], which was conducted across six HD specialist clinics in Europe: Cardiff, Birmingham, and Oxford, UK; Leiden, Netherlands; Munster, Germany; and Oslo, Norway (trial registration ISRCTN11392629). The study was approved by the Wales Research Ethics Committee 2 (reference number 13/WA/0315).

2.2. Inclusion and exclusion criteria

Participants were eligible for the study if they met the following criteria, which were set forth for the intervention trial. Inclusion criteria: 1) genetically confirmed diagnosis of HD; 2) >18 years of age; 3) stable medication regime for four weeks prior to trial initiation, and 4) anticipated to maintain a stable regime for the course of trial. Exclusion criteria: 1) any physical or psychiatric condition that would prohibit the participant from completing the intervention or full battery of assessments, 2) inability to independently use an exercise bike, 3) unable to understand or communicate in spoken English (UK sites), 4) currently involved in any intervention trial or within four weeks of completing one, and 5) current, regular participation in a structured exercise program five times per week or more.

2.3. Recruitment

Participants were recruited to the ExeRT-HD trial between March 2014 and January 2015; 32 individuals met the inclusion criteria [17] for the study. Written informed consent was taken for all participants.

2.4. Assessors

Data collection was conducted by assessors at each site, who were specifically trained in the methodology utilized for collection of physical activity and functional assessments.

2.5. Assessments

2.5.1. Demographics

We collected age and gender, and measured participant height and weight. Medication was recorded at baseline and is reported elsewhere [17].

2.5.2. Disease-specific measures

The UHDRS-TMS and Total Functional Capacity (TFC) were obtained from clinical records. UHDRS-TMS and TFC scores were conducted by certified raters[1] within three months prior to the assessments.

2.5.3. Cognitive measures

Cognitive function was assessed using the following cognitive tests: 1) Stroop color naming, word reading and interference tests [18], 2) Category Verbal Fluency Test (CVFT-Animals) [18], 3) Symbol Digit Modalities Test (SDMT) [18], and 4) Trail Making A and B [19]. This targeted cognitive battery has been optimized for HD [19].

2.5.4. Dual-task measures

We evaluated dual-task ability using the Walking While Talking Test (WWTT) [20]. During this test, a combination of motor and cognitive tasks were evaluated under simple and complex dual-task conditions. Participants were first asked to cite the alphabet sitting and the time and number of errors were recorded. The participants were then asked to walk for 20 ft out and back (40 ft total), and the time was recorded (timed walking).[2] The participant was then asked to walk the same distance while reciting the alphabet (simple). The time to complete the walk and the number of correct letters and number of errors was recorded. Lastly, the participant was asked to walk the same distance again while reciting every other letter of the alphabet (complex). The time to complete the walk and the number of correct letters and number of errors was recorded. Appendix A provides further detailed information about the task instructions. Dual-task cost (DTC) quantifies the change in performance under dual-task conditions relative to the single task condition [21]. Gait and Cognitive DTCs were calculated following the methods of Hall et al. [21]. DTCs were expressed as percentages to examine Dual-Task Effect [22].

2.5.5. Falls assessment

Falls were assessed prospectively from the time of baseline assessment over a three-month period. Falls were assessed using falls diaries, which were given to all participants at the end of the baseline assessment. Participants were asked to record at the end of each week if they had any falls, and if yes, to describe the

[1] Raters were certified via the European Huntington's Disease Motor Rater certification program.

[2] The assessment was administered over a total distance of 20 m rather than 40 ft in 10 participants at one site. This was noted during the second assessment of the eighth participant; the final three participants from this site (from 10 total participants) were subsequently evaluated under both 20 m and 40 ft conditions, and this data was used to estimate a conversion to the 12.2 m distance for all participants.