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COMPLEXITY OF ISOMETRIC FORCE PRODUCTION IS ASSOCIATED WITH TIME TO ACHIEVE STEADY STATE WHEN MOVING TO A NEW FORCE LEVEL

Samantha L. Winter[*1], Mark Burnley[1], Sarah Forrest[2], John Challis[3]

[1]School of Sport and Exercise Sciences, University of Kent, Chatham Maritime, [2]Sport and Exercise Science, Aberystwyth University, Aberystwyth, United Kingdom, [3]Department of Kinesiology, The Pennsylvania State University, State College, United States

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Promising Scientist Award sponsored by Motion Analysis: No

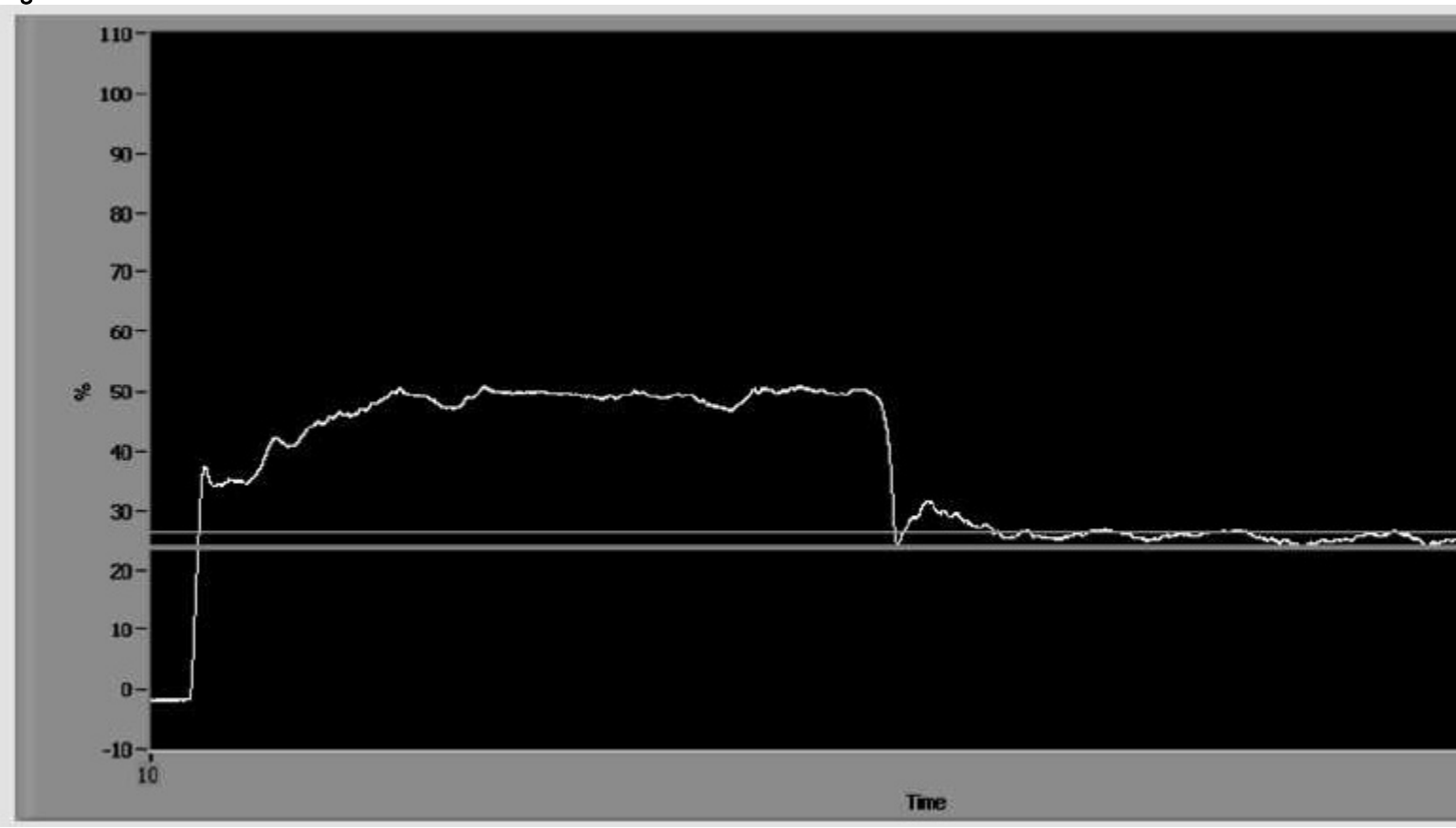
Introduction and Objectives: Motor output and function has been shown to decline in later life, for example older adults have increased stimulus response times [1]; reduced strength [2] and changes in the variability of force production [2]. The loss of complexity hypothesis [3] suggests that a decrease in complexity is associated with ageing as the integration of complex physiological systems declines, and that this reduced complexity is associated with constrained behaviour and a loss of adaptability or flexibility in reponse. The function consequences of this loss of complexity in the fluctuations seen in isometric force records have not been investigated. However, it is possible that the reduced complexity, and more slowly repeating and constrained fluctuations in force seen in older adults [4] would limit ability to adapt to altered force requirements. It was hypothesised that reduced complexity for isometric force records in older adults would be associated with an increase in the time taken to achieve a steady state when moving to a new isometric force level.

Methods: Young (18 to 25 years) and older (65 to 72 years) neurologically healthy adults produced isometric abduction contractions of the index finger using the First Dorsal Interosseus. Participants established a steady state force at a given effort level (a percentage of maximum voluntary contraction force - %MVC) by matching a target displayed visually. A second feedback condition used both the visual display and an audible tone that varied in pitch when subjects moved below or above the target. The target was then suddenly and unpredictably increased or decreased at a randomly decided time point and participants were instructed to match this new target as quickly as they could, and to hold the new contraction intensity as steadily as possible (Figure 1). The conditions investigated were: increasing force from 5% to 25% MVC, 25% to 50% MVC, 25% to 75% MVC, and decreasing the force from 25% to 5% MVC, 50% to 75% MVC and 75% to 25% MVC. The functional reaction time was taken to be the point at which the force exceeded 3 standard deviations (SD) from the mean force in the direction of the new force level. The time to steady state was the time from the end of the functional reaction time to the start of the 3 second window with the lowest standard deviation for force. The complexity of the force record before the target change, after the target change, and during simple continuous force production with no target change was determined for the different effort levels (5%, 25%, 50%, 75% MVC) using Approximate Entropy (ApEn) [5].

Results: Confirming previous results older adults exhibited reduced complexity indicated by reduced ApEn values at effort levels >25% MVC ($p<0.001$) and this was the case for both the simple continuous force task ($p<0.001$) and the section of the force record after the change in target force ($p=0.0438$). There was no difference in the MVC abduction force for older and younger adults ($p=0.885$). There was also no difference between older and younger adults in the magnitude of the fluctuations in force, as quantified by the standard deviation of force ($p>0.05$). Functional reaction time was increased by around a third in older adults ($p<0.001$) in both feedback conditions. Fuctional reaction time was reduced for both age groups by the addition of the audible signal. Confirming the hypothesis, the time to steady state after the function reaction time increased from a mean of 2.83s in younger adults to 3.23s for older adults ($p=0.025$), and

this difference was unaffected by feedback condition. Post-hoc tests showed that the time to steady state differed for old and young adults at starting effort levels >5% MVC.

Figure:



Caption: Figure 1: Display of force record showing a trial moving from an initial target of 50% MVC to a target of 25% MVC.

Conclusion: Force levels associated with reduced complexity in older adults compared to younger adults were associated with an increased time to steady state when moving from an isometric contraction at one effort level to an isometric contraction at a new effort level. This suggests that there is a change in the neuromuscular system with age evidenced by the reduced complexity that constrains response to altered force requirements. These findings have implications for the control of muscle force production in later life.

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Disclosure of Interest: None Declared