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Older adults demonstrate greater accuracy in joint position matching using self-guided movements

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ABSTRACT

Greater proprioceptive accuracy has been found with active compared to passive movement. Therapeutic approaches in rehabilitation include varying levels of assistance with arm movements. This assistance may impact proprioceptive acuity. Eighteen older adults participated in a joint repositioning study. The ability to independently reproduce a shoulder flexion angle was investigated when the reference angle was set under the following conditions: (1) the examiner actively assisted participant's motion to the reference angle chosen by the examiner, (2) the participant moved independently, but the examiner provided tactile cueing to stop at the reference angle chosen by the examiner, and (3) the participant independently moved to a self-selected reference angle. Participants were most accurate in the self-guided condition compared to the active assisted or tactile cueing conditions. Both the self-guided and tactilely cued conditions involved active movement, yet accuracy differed. In contrast, there was no difference in accuracy between the active assisted and tactile cueing conditions despite one involving more active movement. The results demonstrate active movement alone does not determine accuracy. External stimuli, either tactile input and/or a reference angle chosen by the examiner may diminish accuracy. This can be clinically relevant as proprioceptive performance has been linked to improved motor performance.

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1. Introduction

There is growing appreciation for the role of sensory information in motor performance. Studies involving participants with a condition of deafferentation have shown sensory information plays a fundamental role in making smooth, coordinated movements (Ghez & Sainburg, 1995; Gordon, Ghilardi, & Ghez, 1995; Sainburg, Ghilardi, Poizner, & Ghez, 1995; Sainburg, Poizner, & Ghez, 1993). In addition, a sensory component has been linked to motor learning in healthy individuals (Mattar, Darainy, & Ostry, 2013; Wong, Kistemaker, Chin, & Gribble, 2012), skill acquisition post neural damage (Xerri, Merzenich, Peterson, & Jenkins, 1998) and neural plasticity (Popa et al., 2013). Collectively, this research underscores the importance of sensory performance in rehabilitation.

Specifically, performance on proprioceptive assessments has been positively associated with motor function in rehabilitation (Damiano, Wingert, Stanley, & Curatalo, 2013; Karagiannopoulos, Sitler, Michlovitz, & Tierney, 2013). Proprioception is the awareness of our body position in space without the use of vision (Proske & Gandevia, 2012). This gives us the ability to be in a dark room without visual cues and still know the position of our limbs. The central nervous system receives sensory input from muscle spindles, cutaneous receptors, and joint mechanoreceptors (Proske & Gandevia, 2009). This information is crucial in our ability to perceive both our position in space and movement through space. While both joint position sense and detection of movement underlie our proprioceptive abilities, the scope of this study is limited to joint position sense.

A higher degree of accuracy with joint position sense tasks has been linked to improved motor performance. For example, in children with cerebral palsy, increased gait speed was associated with greater accuracy of joint position sense at the hip (Damiano et al., 2013). Similarly, accuracy of joint position sense at the wrist following distal radius fracture was shown to positively correlate with the Patient-Rated Wrist Evaluation which includes activities of daily living such as turning a door knob and cutting with a knife (Karagiannopoulos et al., 2013). These studies suggest that improving joint position sense accuracy is related to better functional performance.

Decreased joint position sense has been recorded in older adults. In addition, older adults' performance on joint position tasks has been related to motor function. The bulk of this literature has examined joint position sense in the lower extremities and the relationship to postural control or falls. Older adults that demonstrate diminished joint position sense have poorer outcomes in terms of postural control and falls (Hurley, Rees, & Newham, 1998, mean age = 72; Lord, Clark, & Webster, 1991, mean age = 82.7 years). Diminished joint position sense in the upper extremities has also been noted in older adults (Adamo, Alexander, & Brown, 2009, mean age = 76; Adamo, Martin, & Brown, 2007, mean age = 75). The impact of these changes in joint position sense on performance of upper extremity activities of daily living in a healthy older adult population are not well understood.

The impact of joint position in patient populations such as adults with stroke has also been examined. Roughly fifty percent of patients post stroke demonstrate diminished joint position sense (Dukelow et al., 2010, mean age = 66). Poor joint position sense has been linked to post stroke shoulder pain and poor kinematics with movement (Niessen et al., 2009, mean age of 2 groups in study was 62.8 years and 57.7 years). Thus, decreased proprioceptive abilities in a patient population have also been related to decreased motor performance.

Performance on joint position sense tasks may be influenced by the type of task. For example, the amount of error may be impacted by the use of passive or active movement in a joint position sense task. Greater joint position accuracy has been noted with active compared to passive movement in healthy, young adults (Erickson & Karduna, 2012; Janwantanakul, Jones, Magarey, & Miles, 2002; Lonn, Crenshaw, Djupsjobacka, Pedersen, & Johansson, 2000). A similar benefit for active movement has been noted in a rehabilitation setting. In an assessment comparing individuals with anterior shoulder instability to healthy, age matched controls there was no difference in the amount of joint position matching error when participants moved their arm actively, but a between groups difference was noted when participants were passively moved to the reference angle. The participants with anterior shoulder instability demonstrated greater error compared to the healthy participants in this condition (Hung & Darling, 2012). This suggests that active movement played a role in diminishing the amount of error in the patient population.