Supplementary Material

You are as old as the Connectivity you Keep: Distinct Neurophysiological Mechanisms Underlying Age-related Changes in Hand Dexterity and Strength

Differences Between Young and Elderly Adults in Manual Dexterity and Strength

The performance of young and older participants significantly differed in five out of the six tasks in our behavioral battery, confirming the presence of clear age-related differences (Supplementary Table 1).

	Young adults	**Elderly adults**	**Statistical comparison**
9HPT execution time (s)	21.5 ± 1.8	28.2 ± 3.5	$t_{32} = 7.07$, $p < 0.001$
FT keystrokes (n)	33.1 ± 2.8	25.3 ± 4.4	$t_{32} = 6.13$, $p < 0.001$
vmTMT execution time (s)	14.2 ± 2.5	26.8 ± 8.4	$Z = 4.93$, $p < 0.001$
4CRT response time (ms)	418 ± 36	766 ± 170	$Z = 4.96$, $p < 0.001$
Power grip strength (kg)	26.5 ± 7.9	19.6 ± 6.6	$t_{32} = 2.74$, $p = 0.01$
Pinch grip strength (kg)	7.2 ± 1.6	7.5 ± 3.1	$Z = 0.28$, $p = 0.78$

Supplementary Table 1. Demographic, TMS, and motor performance data (mean ± standard deviation) in the two groups.

The 9-Hole Pegboard Test (9HPT) measures hand dexterity (3,55) and is strongly associated with age, with Pearson's *r* coefficients of approximately 0.60 (3). This test is comparable to the Purdue pegboard test, which is also sensitive to age-related changes in dexterity (31,122).

The Finger Tapping (FT) test measures motor speed. While some studies report a decline in performance on this task beginning around age 40, findings are mixed and debated (122). In our study, we found a clear effect of age on FT performance, with older participants demonstrating lower tapping rates, suggesting an overall slowing of motor function.

The 4-Choice Reaction Time task (4-CRT) involves the speeded selection of the appropriate response cued by an external stimulus. It includes a premotor phase of stimulus detection, cognitive computation, and response preparation, as well as a motor phase of movement execution (123). Previous studies have indicated that aging significantly slows CRT performance, particularly affecting the premotor phase in older adults (124,125). However, accuracy is not negatively affected by age, and the speed-accuracy tradeoff appears to favor accuracy in older individuals (125). Consistently, we observed a marked age effect on reaction times in our sample, while accuracy was comparable between the groups.

The visuomotor Trail Making Test (vmTMT) adopted in this study is a modified version of the Trail Making Test standardized by Kopp B, et al. (50). The vmTMT is a tracing task that does not require high-level cognitive processing, as the trail is openly cued. Thus, its administration to normal subjects is considered to measure visuomotor skills. Stirling LA, et al. (126) reported that age negatively affects performance on a tracing task conceptually similar to our vmTMT. Accordingly, older adults in our sample exhibited longer execution times to complete the vmTMT compared to the younger group. We also calculated an error rate by summing the distances between the point of exit from the trail and the following point of re-entry on the track. This value was then divided by the total length of each trail and averaged across all the different trails. The error rate for older adults (1.1 ± 1.3%) was smaller than that of younger adults (4.1 ± 5.2%). However, this measure was not considered when correcting the execution times, as the average error rates were relatively low and could not account for the sensibly slower performance of older adults.

Age-related changes in manual strength have been well-documented (7), with normative data indicating that peak strength in power and precision grip declines as a function of age (3,127,128). However, the decrease in strength is not always consistent and may vary depending on the task (129). In line with this, our data show an age-related decrease in maximum strength during the power grip but no differences in pinch grip.

Consistent with the functional conceptualization of these tasks, the exploratory factor analysis grouped the performances into two latent components. These components were extracted using principal component analysis (PCA), applying the criterion of extracting components with eigenvalues greater than 1. The two-component solution explained a substantial 85% of the variance and was supported by the scree plot of the eigenvalues (Supplementary Figure 1). To enhance interpretability, we then applied a varimax rotation (Table 2). One component clustered tasks related to motor speed and dexterity, such as the 9HPT, FT, 4CRT, and vmTMT (PC1-Dext). The other component clustered strength tests of power and pinch grip (PC2-Strength). Between-group comparisons for the two PCs are reported in Table 1.

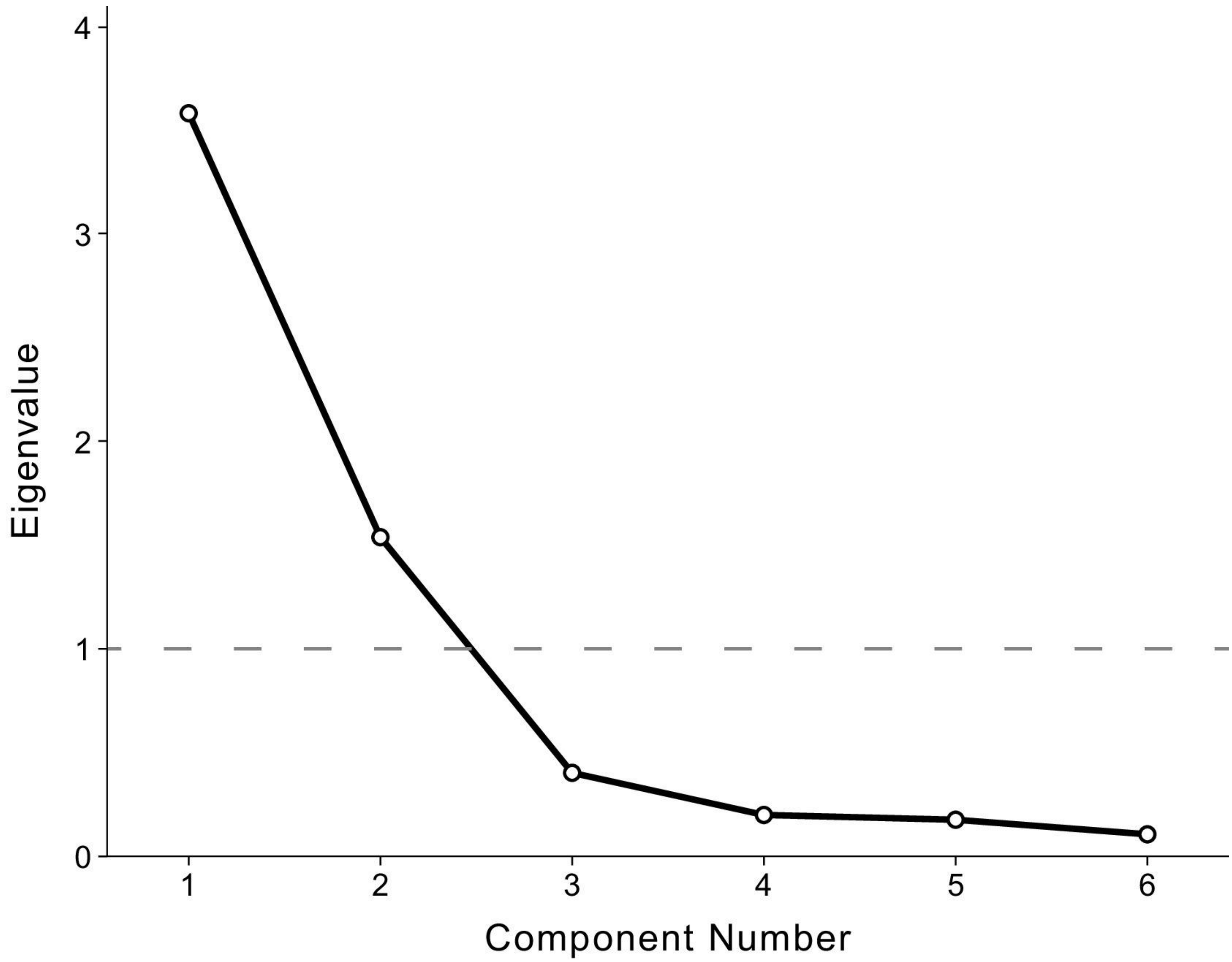

Figure S1. Scree plot of the eigenvalues for all principal components from the exploratory principal component analysis of behavioral tasks. Two components with eigenvalues greater than 1 were extracted.