

# Supporting Information

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## SI Text

**Age Is Associated with a Decrease in Mean Activity Level; AD Is Not Associated with a Further Decrease in Mean Activity Level.** As a simple characteristic of activity control, mean activity level was calculated by using the same activity signals in the same time windows (from 11 a.m. to 7 p.m.) that were used to assess the scale-invariant activity pattern (Fig. S1). Young controls had a significantly higher mean activity level (mean  $\pm$  SE: 386.8 arbitrary units  $\pm$  42.9) than all other groups including elderly controls (235.0  $\pm$  26.9,  $P = 0.006$ ), early-stage AD patients (218.5  $\pm$  32.2,  $P = 0.005$ ), very old controls (80.8  $\pm$  12.7,  $P < 0.0001$ ), and late-stage AD patients (96.8  $\pm$  25.3,  $P < 0.0001$ ). There was no significant difference in mean activity level between elderly controls and early-stage AD ( $P = 0.70$ ), and no significant difference between very old controls and late-stage AD ( $P = 0.6$ ). Very old controls and late-stage AD patients both had lower mean activity than elderly controls and early-stage AD ( $P < 0.0001$ ). We note that late-stage AD patients had a smaller scaling exponent  $\alpha$  than the very old controls ( $P < 0.05$ ; see Results) despite the 2 groups having similar mean activity. These findings indicate that scale invariance of activity, as characterized by the scaling exponent  $\alpha$ , provides complementary information on activity control to the mean activity level.

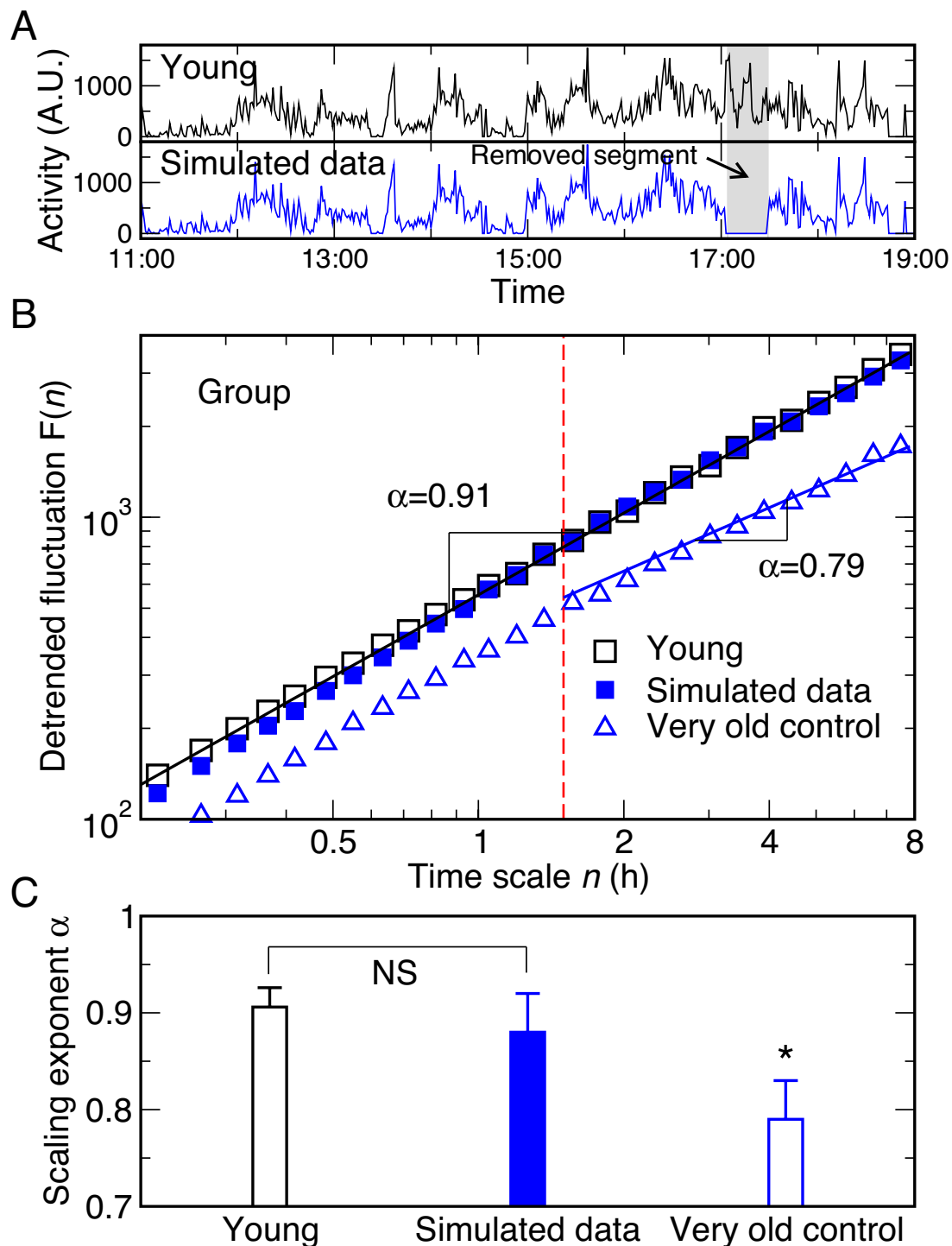
### **Do Aging or AD Increase Daytime Naps? Could Such an Effect Explain the Decreased Scale-Invariant Activity Correlations in These Groups?**

Because the SCN affects the sleep/wake cycle in humans (1), changes in SCN function may affect sleep/wake cycle dynamics, for instance by increasing the frequency and duration of daytime naps. To examine whether or not such changes could explain the

reduced scaling exponent of activity correlations in the elderly groups, from each subject's daytime recordings, we first identified all bouts of  $>25$  min without movement (activity = zero) as possible naps. (Note, similar results are seen when daytime naps are defined by other minimum durations of inactivity, from 10 to 40 min.) Of the 5 groups there were no significant differences in mean inactive bout durations except for a much longer inactive duration in the very old controls (young control,  $1.1 \pm 0.6\%$  of the daytime recordings; elderly control,  $1.7 \pm 0.5\%$ ; early AD,  $1.3 \pm 0.5\%$ ; very old control,  $9.0 \pm 3.2\%$ ; late-stage AD,  $2.1 \pm 1.3\%$ ;  $P < 0.05$  for very old control vs. all other groups). We note that there was no significant difference in estimated daytime naps between the 2 groups with the largest difference in the scaling exponent  $\alpha$  of activity (young controls and late stage AD). Thus, it is unlikely that daytime naps account for the observed alterations of scale-invariant activity. Nonetheless, because there was the 1 group (very old controls) with a difference in the amount of potential daytime naps compared to the other groups, we performed an additional analysis. We randomly imposed equivalent artificial inactive segments to the activity recordings of young controls (i.e., the group most different from the very old controls) to match the amount of inactive bouts seen in the very old controls. This simulation of daytime naps in young control subjects' recordings did not significantly change the scaling exponent (at time scale more than  $\approx 1.5$  h,  $\alpha = 0.91 \pm 0.02$  for original activity signals of young controls; and  $\alpha = 0.88 \pm 0.04$  for original signal plus simulated naps;  $P > 0.28$ ) (Fig. S2). We conclude that increased daytime naps in the very old controls are very unlikely to account for the observed alterations of their scale-invariant activity.

1. Dijk DJ, Czeisler CA (1994) Paradoxical timing of the circadian rhythm of sleep propensity serves to consolidate sleep and wakefulness in humans. *Neurosci Lett* 166:63–68.





**Fig. S2.** Effects of inactive bouts (estimated daytime naps) on scale-invariant behavior. (A) An example of daytime activity recordings between 11 a.m. and 7 p.m. in a young control subject and corresponding simulated data with an artificially imposed “inactive” segment (gray region). Inactive segments had the same size of 26 min and were randomly placed within the original activity data of young controls with a probability of 9%, matching the amount of estimated daytime naps in the very old control group. (B) Group average of the scale-invariant patterns in activity signals of young control subjects (black open square) and in the simulated data (blue filled squares). The average scale-invariant pattern of very old control subjects is also presented for comparison (blue open triangles). (C) The scaling exponents  $\alpha$  of activity in young controls, simulated data, and activity of very old controls. There was no significant difference in  $\alpha$  between activity of young controls and simulated data (indicated by “NS”), showing that increased daytime naps are unlikely to be responsible for the decreased scale-invariant activity regulations at large time scales in very old control subjects compared with young controls (indicated by \*).