ARENA-based activity profiling of tau and TDP-43 transgenic C. elegans

Heather N Currey¹, Anna Malinkevich², Penny Melquist² and Nicole F Liachko¹,³§

¹Geriatric Research Education and Clinical Center, Veterans Affairs Puget Sound Health Care System, Seattle, WA 98108 USA
²InVivo Biosystems (formerly NemaMetrix, Inc.), Eugene, OR 97402, USA
³Division of Gerontology and Geriatric Medicine, Department of Medicine, University of Washington, Seattle, WA 98104, USA
§To whom correspondence should be addressed: nliachko@uw.edu

Abstract

Figure 1. Activity differences of day 1 adult neurodegenerative disease model C. elegans measured by changes in LED microbeam disruption: (A) Expression of mutant (tau V337M, strain CK10) or wild-type (tau WT, strain CK144) human tau pan-neuronally causes significant activity differences compared to N2. tau V337M and tau WT are also significantly different from each other. Graph displays aggregate population activity per minute. ***p=0.0005, ****p<0.0001, one-way ANOVA with Tukey’s multiple comparison’s test. Data from 3 independent replicate experiments, N=30 worms per replicate. (B) Expression of wild-type (TDP-43 WT, strain CK410) or mutant (TDP-43 M337V, strain CK423 and TDP-43 A315T, strain CK426) human TDP-43 pan-neuronally causes significant activity differences compared to N2. Each TDP-43 strain was also significantly different from each other. Graph displays aggregate population activity per minute. *p=0.02, ****p<0.0001, one-way ANOVA with Tukey’s multiple comparison’s test. Data from 4 independent replicate experiments, N=30 worms per replicate.

Description

Aggregates of the protein tau are the hallmark of several neurodegenerative diseases including Alzheimer’s disease, frontotemporal lobar degeneration (FTLD-tau), progressive supranuclear palsy (PSP), corticobasal degeneration (CBD), Pick’s disease, and chronic traumatic encephalopathy (CTE) (VandeVrede, Boxer et al. 2020). Mutations in the gene coding for tau, MAPT, can cause FTLD-tau with Tukey’s multiple comparison’s test. Data from 3 independent replicate experiments, N=30 worms per replicate. (B) Expression of wild-type (TDP-43 WT, strain CK410) or mutant (TDP-43 M337V, strain CK423 and TDP-43 A315T, strain CK426) human TDP-43 pan-neuronally causes significant activity differences compared to N2. Each TDP-43 strain was also significantly different from each other. Graph displays aggregate population activity per minute. *p=0.02, ****p<0.0001, one-way ANOVA with Tukey’s multiple comparison’s test. Data from 4 independent replicate experiments, N=30 worms per replicate.

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Microbeam by worm movement is recorded by repeat scans of the 6-well culture plate, and allows for real-time processing. The software identifies changes in the location of disrupted beams between scans and assigns an activity score based on differences identified between each consecutive scan (Simonetta SH). Both tau- and TDP-43-expressing worms had significantly less activity per minute than N2 (Figure 1). Further, we found the ARENA-assessed activity data recapitulated the relative severity of phenotypes among the strains as measured by motility assays. For example, both CK10 (tau V337M) and CK144 (tau WT) have significantly uncoordinated movement in liquid, with CK144 having worse motility than CK10, due to its much higher burden of total tau protein expressed (Kraemer, Zhang et al. 2003). Likewise, CK410 (TDP-43 WT) worms have slightly impaired motility compared with N2 when crawling on a plate, CK423 (TDP-43 M337V) are severely uncoordinated, and CK426 (TDP-43 A315T) have the most severe uncoordinated phenotype. The relative toxicities of these strains stem from the effects of the mutations, as TDP-43 protein expression is relatively even among these transgenic strains (Liachko, Guthrie et al. 2010). Interestingly, the ARENA captures activity of these severely uncoordinated worms that move poorly in motility assays such as crawling on an NGM plate or thrashing in liquid (Kraemer, Zhang et al. 2003; Liachko, Guthrie et al. 2010). Therefore, ARENA assessment of aggregate activity may be a more accurate metric for capturing non-locomotor movement of C. elegans that are severely uncoordinated.

Methods
Request a detailed protocol

ARENATracking

All worms used were staged by way of timed egglay, and grown at 16°C on NGM plates seeded with OP50 E. coli to day 1 adult. The experiment was performed in a 6-well plate prepared with 3.5mL NGM per well and seeded with OP50. The worms were picked from stock plates into a prepared 6-well plate, 30 worms per strain, each strain in a unique well. Recordings were performed at room temperature (approximately 22°C). The plate was placed in the ARENA 15 minutes before starting the run to allow worms to acclimate. 14 activity scores were collected per strain over 60 minutes. Statistical analysis was performed with GraphPad Prism 8.

Reagents

Strains Used

N2 Bristol
CK10 bkt10 [aex-3p::tau(V337M 4R1N); myo-2p::dsRED] III
CK144 bkt144 [aex-3p::tau(WT 4R1N); myo-2p::dsRED] IV
CK410 bks410 [snb-1p::TDP-43(WT); myo-2p::dsRED] II
CK423 bks423 [snb-1p::TDP-43(M337V); myo-2p::dsRED] IV
CK426 bks426 [snb-1p::TDP-43(A315T); myo-2p::dsRED] II

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References

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