Multiple ant-like transport of neuronal cargo by motor proteins

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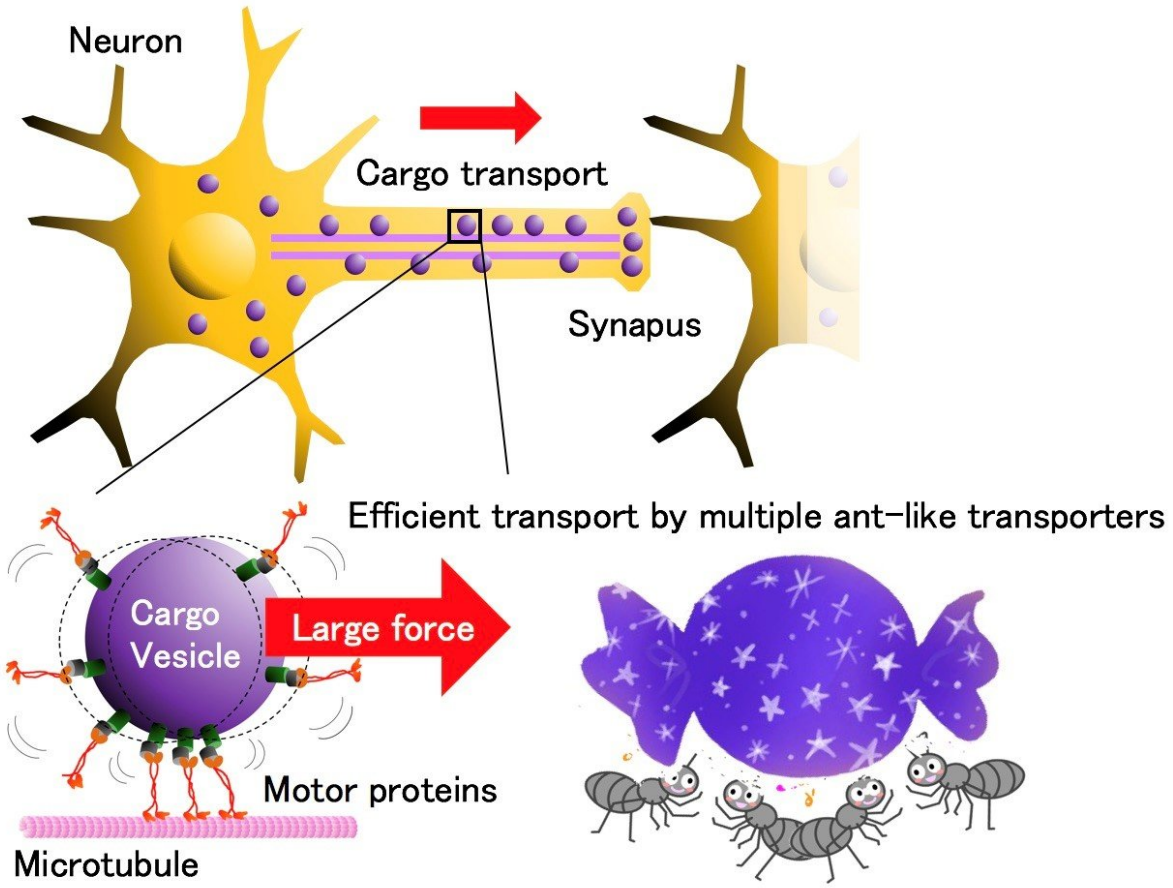

Cargo transport by many motors makes neuronal activity fine. Credit: Kumiko Hayashi

Microtubules are roads made of proteins that extend throughout a cell for motor proteins (carriers) to deliver neuronal cargo packed with many kinds of materials required for cellular activity. The delivery is active along neuronal axons, which function like highways in human societies. Deficits in the supply chain cause neuronal diseases, such as Alzheimer's, Parkinson's or Huntington's disease.

Dr. Kumiko Hayashi and Dr. Shinsuke Niwa, assistant professors of Tohoku University, have successfully estimated the force exerted by motor proteins acting on neuronal cargo in living worms using a newly developed, noninvasive force measurement method (Ref. 1). The force values indicate that a number of carriers are involved in neuronal cargo delivery.

The research shows that cargo packed with synapses was carried cooperatively by multiple motor proteins, much like a group of ants working together, to carry an item too large for any individual motor protein to carry alone. The number of carriers was found to decrease in mutant worms as indicated by the force measurement. The decrease weakened the cargo transport and caused the mis-location of synapses reported recently (Ref. 2). The material delivery by lots of carriers in highway-like axons ensures healthy neuronal activity and is a significant finding in the field.

Despite the need of physical measurements for neuronal cargo transport, it has been difficult to measure force in vivo, until now. The noninvasive force measurement method based on the fluctuation theorem (Ref. 3) enabled measurement by analyzing the fluctuating behavior of cargo vesicles in the cytosol subject to thermal noise and so on. Movement can easily be observed using fluorescence microscopy. Hayashi and Niwa expect the non-invasive force measurement method to be a useful tool in understanding the physical mechanism of neuronal diseases caused by deficits in axonal transport.

More information: Kumiko Hayashi et al, Non-invasive force measurement reveals the number of active kinesins on a synaptic vesicle precursor in axonal transport regulated by ARL-8, *Physical Chemistry Chemical Physics* (2018). DOI: 10.1039/C7CP05890J

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