

Guiding Neuronal Growth with Light

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We have shown experimentally that we can use weak optical forces to guide the direction taken by the leading edge, or growth cone, of a nerve cell. In actively extending growth cones, we place a laser spot in front of a chosen area of the nerve's leading edge, promoting growth into the beam focus. This allows us to guide neuronal turns as well as enhance growth. The power of our laser has been selected so that the resulting gradient forces are sufficiently powerful to bias the actin polymerization-driven lamellipodia extension, but too weak to hold and move the growth cone. We are therefore using light to control a natural biological process, in sharp contrast to the established technique of optical tweezers, which uses large optical forces to manipulate entire structures. Our results therefore open a new avenue to controlling neuronal growth in vitro and in vivo with a simple, non-contact technique. Currently we have been using 800nm with continuous application of powers ranging from 20 to 130 mW over a circular area of 1 to 4 μm in radius. Recently we've developed an active feedback mechanism to trace the contour of the growth cone and subsequently raster the beam image upon that, instead of the pure beam profile we had used previously.

(Abstract supplied by Allen Ehrlicher, main author)