Neuronal differentiation induced by scalable thermal stimulation

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Keywords: nanoparticles, thermal stimulation, neuronal differentiation, neurite outgrowth, electrical activity, electrophysiology

Abstract:

In neurons, mild hyperthermia could induce morphological changes and projection outgrowth[1], which were maintained for few days[2]. Moreover, acute thermal stimulation by infrared laser irradiation could modulate neuronal activity by evoking depolarizing currents by transient variations in membrane capacitance[3].

To analyse the long-term effects of heating on neuronal behavior, we investigated the effects of a scalable stimulation at 41,5°C, reached by irradiating Prussian Blue nanoparticles with a near infrared laser, in an *in vitro* model of dorsal root ganglion neurons, the F-11 cells. The nanoparticles were embedded in a PVA matrix, which we used to develop a "smart" petri dish prototype, and stimulation was performed for 30 minutes for 2 consecutive days. Cells maintained at 37°C were used as control.

Results collected during one week after thermal stimulation showed that cells had longer and more numerous neurites compared to the control and could form consistent neuronal networks. The electrophysiological investigation showed that thermal stimulation could improve the typical electrical properties of a mature neuron, such as voltage-dependent Na^+ and K^+ current densities, action potential firing frequency and resting membrane potential, with no detrimental effects on viability. Moreover, these characteristics could be maintained for a longer period, such as 12 days. Taken together, these data suggest that a targeted thermal stimulation could modify neuronal behaviour and induce morphological and functional differentiation in neurons, promoting new neuronal networks. Since these results could be promising for the treatment of neuronal injuries, from the perspective of the clinical translatability of this approach, we are now assessing the molecular and physiological mechanisms underlying the obtained results, to provide a reliable confirmation of these effects also to support the future application of this method *in vivo*.

References

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