

# Can ions drift in a electric field be modelled to impact nerves activation answer? A popular scientific summary

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This report studies if it is possible to more accurately predict how nerves activate during electrical stimulation if the electrical effects of ions are included. This was accomplished by developing a new model for how ions change the way human tissue conducts electricity and by simulating these effects in computer models.

The nerves we have in the human body can be activated to cause muscle contractions. This normally happens when a nerve cell receives a signal from another nerve cell, however this can also be achieved by exposing the nerve to an electric current. A common technique for this is to attach electrodes to the skin and to carefully pass current between them until the desired muscle activates. Because the ions are charged they "wander" towards its opposite charge in an electric field. This means that if an electric field is sufficient strong it is possible to move around enough ions to change the electrical properties of the tissue, and thus change how electricity passes through the nerves.

This report attempts to model the effects ions have on nerve activation by taking into account and modelling two phenomena; Electrical conductivity and charge accumulation. Electrical conductivity is a measure of how easy an electric current passes through a material, and by changing the concentration of ions using the electric field it is possible to change this property. Charge accumulation is what happens when ions of similar charge "pool up" in the same area and create their own electric field, which interferes with the electric field from the electrodes. Both these effects were modelled mathematically and then simulated in numerical simulations.

Lastly it was studied if the ionic effects could help explain the observed phenomenon that differently shaped electric pulses produce different outcomes in experiments. It has been shown that different pulse shapes lead to different levels of comfort and muscle activation in patient, but conventional models of nerve activation cannot account for this fact.

Unfortunately it was found that these ionic mechanisms could not significantly

improve prediction accuracy or help explain the observed difference between different pulse shapes. This could be due to the modelling simplifications that were made, or it might be implying that ionic effects are irrelevant on the macroscopic scale.