Infant Numerical Cognition and Ephaptic Synchronization

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November 23, 2023

Abstract

In this letter, the authors suggest that the explanation for infant numerical cognition might lie in ephaptic synchronization.

In the chapter on the development of the brain and its cognitive functions, the authors of [1] suggest that infant numerical cognition is well-developed. Specifically, they cite studies showing that infants can discriminate between figures containing two dots versus three dots, regardless of the order of presentation, provided habituation of one kind has first been done.

In [2] the authors suggested that ephaptic synchronization leads to the selection of the 'greater entropy' stimulus. Ephaptic coupling, which was brought to scientific attention by Arvanitaki in the 1940s [3], is the setting where extracellular return path currents lead to synchronized firing between closely spaced axons. In this setting, the faster action potential slows down and a slower one speeds up until they travel in-step. When analyzed information theoretically in the time or rate coding setting [4] this devolves into a downstream preference for the greater entropy stimulus. This means that if the infant is habituated to two dots, then two dots presentation has very low entropy or 'surprise-value' for his/her brain. In this situation the brain will choose to attend to the three dots stimulus over the two dots stimulus because three dots are not habituated, meaning that their concomitant entropy value is higher.

In summary, our investigations on ephaptic coupling via theory, analysis and simulation [5, 6] suggest that the effect observed by [7] might be closely linked to (current-mediated) ephaptic synchronization or other settings [6] that have similar synchronization dynamics.

References

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