# Effects of channel displacements vs cortical anatomy on fNIRS sensitivity: A simulation study

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## Background

Functional Near-Infrared Spectroscopy (fNIRS) non-invasively infers cortical activity from localized hemodynamic responses. However, this technique lacks of structural information to assess the origin of recorded signals.[1,2] Based on sensitivity data over Colin27 atlas, this study addresses changes due to channel displacements statistically evaluated over all channels.

## Methods

A whole-head surface system of 102 channels was virtually placed over the Colin27 atlas and a Monte Carlo (MC) simulation at two different NIR-wavelengths provided the sensitivity between each channel and 20,000 cortical elements (CEs). Our aim was to statistically assess the influence on sensitivity of CE displacement from the channel center (CC, average source-detector distance $\Lambda = 40$ mm) and CE depth. By projection of CEs on head surface, the longitudinal $\lambda$ and transverse $\tau$ displacements (normalized by $\Lambda$) were derived. Depths were segmented into 4 quartiles from small (gyri) to high (sulci). All channel sensitivities were overlapped over a common $(\lambda,\tau)$ plane, and divided into $2x2mm^2$ bins, for each CE depth class. Bin median values were taken as Sensitivity vs Displacement Surface (SDS) over the $(\lambda,\tau)$ plane. The Integral Under the Surface (IUS) was taken as overall sensitivity index for the depth class.

## Results

The SDS of the first depth quartile (gyri) presented a bell-shape around CC: broad along $\lambda$ (~20 mm FWHM); narrow along $\tau$ (~10 mm FWHM). IUS was 73.13% and 72.43% for the first and the second wavelength, respectively. The second depth quartile IUS was 25.24% and 25.76%, respectively.

## Conclusions

This post-analysis of MC simulation confirms that fNIRS is mainly sensitive to gyri activity. In addition, it highlights that the signal of a specific channel may experience high sensitivity drops by transverse displacements. Importantly, displacements may be due to optode misplacements and individual variability of gyri and sulci. In future work, efforts will be directed to improve fNIRS interpretation based on subject-specific anatomy.

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