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## REVIEW ARTICLE

# Near-infrared spectroscopy as an auxiliary tool in the study of child development

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Received 28 April 2014; accepted 7 August 2014

### KEYWORDS

Child development;  
Spectroscopy near-  
infrared;  
Hemodynamics

### Abstract

**Objective:** To investigate the applicability of Near-Infrared Spectroscopy (NIRS) for cortical hemodynamic assessment tool as an aid in the study of child development.

**Data source:** Search was conducted in the PubMed and Lilacs databases using the following keywords: “psychomotor performance/child development/growth and development/neurodevelopment/spectroscopy/near-infrared” and their equivalents in Portuguese and Spanish. The review was performed according to criteria established by Cochrane and search was limited to 2003 to 2013. English, Portuguese and Spanish were included in the search.

**Data synthesis:** Of the 484 articles, 19 were selected: 17 cross-sectional and two longitudinal studies, published in non-Brazilian journals. The analyzed articles were grouped in functional and non-functional studies of child development. Functional studies addressed the object processing, social skills development, language and cognitive development. Non-functional studies discussed the relationship between cerebral oxygen saturation and neurological outcomes, and the comparison between the cortical hemodynamic response of preterm and term newborns.

**Conclusions:** NIRS has become an increasingly feasible alternative and a potentially useful technique for studying functional activity of the infant brain.

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DOI of original article: <http://dx.doi.org/10.1016/j.rpped.2015.03.003>

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**PALAVRAS-CHAVE**

Desenvolvimento infantil;  
Espectroscopia de luz próxima ao infravermelho;  
Processos hemodinâmicos

## Espectroscopia de luz próxima ao infravermelho como ferramenta auxiliar no estudo do desenvolvimento infantil

**Resumo**

**Objetivo:** Investigar a aplicabilidade da espectroscopia de luz próxima ao infravermelho (NIRS) para avaliação da hemodinâmica cortical como ferramenta auxiliar no estudo do desenvolvimento infantil.

**Fontes de dados:** Revisão integrativa de literatura feita nas bases de dados PubMed e Lilacs, a partir da combinação das palavras-chave: “psychomotor performance/child development/growth and development/neurodevelopment/NIRS/spectroscopy/near-infrared” e seus correspondentes em português e espanhol. A pesquisa seguiu protocolo adaptado dos critérios estabelecidos pela Cochrane e teve como limite temporal de 2003 a 2013. Foram incluídas publicações nos idiomas inglês, português e espanhol.

**Síntese dos dados:** Foram localizados 484 artigos, dos quais 19 foram selecionados, 17 transversais e dois longitudinais, todos publicados em periódicos estrangeiros. A análise dos artigos permitiu agrupá-los, quanto à sua abordagem, em estudos funcionais e estudos não funcionais do desenvolvimento infantil. Os estudos funcionais abordaram o processamento de objetos eo desenvolvimento de habilidades sociais, da linguagem e cognitivo. Os estudos não funcionais discutiram a relação entre a saturação de oxigênio cerebral e o desfecho neurológico e a comparação entre a resposta hemodinâmica cortical de recém-nascidos prematuros e a termo.

**Conclusões:** A NIRS se torna, cada vez mais, uma opção viável e uma técnica potencialmente útil para estudos de atividade funcional do cérebro infantil.

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**Introduction**

Near Infrared Spectroscopy (NIRS) represents a breakthrough in techniques used for brain function assessment. This tool has been considered promising for the evaluation of children’s cerebral cortex function, contributing to the increase in knowledge related to neurodevelopment and cognition in children.<sup>1-4</sup>

The action mechanism of spectroscopy is based on the fact that neural activity is accompanied by changes in blood oxygenation, cerebral blood flow and volume. Thus, different wavelengths within the near infrared spectrum (780-2,500 nm) are used, capturing different characteristics of light absorption and dispersion in biological tissue. The light originates from a source, migrates through the tissue and is captured by a detector. Considering that tissue dispersion is a constant, the attenuation of the amount of light captured by the detector can be calculated, providing an indirect measure of activity in this tissue. That is, variations in the concentration of oxyhemoglobin (HbO<sub>2</sub>), deoxyhemoglobin (HHb) and total hemoglobin (HBT) are calculated, which allows a quantitative and qualitative assessment of hemodynamics and neuronal activation.<sup>5,6</sup>

Compared with other neuroimaging techniques, NIRS has the advantage of being a noninvasive, portable, quiet, relatively low-cost and safer method, less sensitive to motion artifacts, as it does not require a tracer or carrier substance to be injected into the blood stream and does not

require irradiation.<sup>1</sup> Additionally, it allows children to move on their caregiver’s lap, where they remain more comfortable and, therefore, more likely to complete the examination (Fig. 1). Another advantage is that as newborns and infants tend to have fine hair and their skulls are thin and small, the ratio of loss of signal due to dispersion is less than that for participating adults.<sup>6</sup>

Although the assessment of cerebral hemodynamics seems to be advantageous, it is important to identify how the methodology has been used and in what kind of research in child-related areas. The aim of this study was to carry out an integrative review of the literature published in indexed journals in the period of 2003-2013, on the use of NIRS to assess cerebral hemodynamics as an auxiliary tool in the study of normal childhood development.

**Method**

An integrative review was carried out following an adaptation of the Cochrane criteria, which included: definition of the study databases, definition of target audience, time limit, definition of keywords, inclusion criteria for the selection of studies, study quality assessment, synthesis and interpretation of results.

The search was carried out in the PubMed and Lilacs databases, using a combination of the following keywords: “Psychomotor Performance”/“Child Development”/“Growth and Development”/Neurodevelopment, “NIRS”/“Spectroscopy,

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