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Face recognition impairment in small for gestational age and preterm children

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ABSTRACT

Background: Infants born prematurely or with low birth weight are at increased risk of visual perceptual impairment. Face recognition is a high-order visual ability important for social development, which has been rarely assessed in premature or low birth weight children.
Aims: To evaluate the influence of prematurity and low birth weight on face recognition skills.
Methods: Seventy-seven children were evaluated as part of a prospective cohort study. They were divided into premature and term birth cohorts. Children with a birth weight below the 10th centile were considered small for gestational age. All children underwent a full ophthalmologic assessment and evaluation of face recognition skills using the Facial Memory subtest from the Test of Memory and Learning.
Results: Premature infants scored worse on immediate face recognition compared to term infants. However, after adjusting for birth weight, prematurity was not associated with worse outcomes. Independent of gestational age, outcomes of low birth weight children were worse than those of appropriate birth weight children, for immediate face recognition (odds ratio [OR], 5.14; 95% confidence interval [CI], 1.32–21.74) and for face memory (OR, 4.48; 95% CI, 1.14–16.95).
Conclusions: Being born small for gestational age is associated with suboptimal face recognition skills, even in children without major neurodevelopmental problems.

What this paper adds?

This study provides the first evidence of impairment in face recognition and face memory skills in children born small for gestational age (SGA). Its main contribution is to report that not only infants born preterm are at increased risk, but also term born SGA infants. Furthermore, these deficits remain stable throughout childhood.

The findings from this research suggest the need of evaluation of certain higher-order visual abilities, such as face recognition, in SGA children, even when born at term and without major neurodevelopmental disorders.

Low birth weight and prematurity may be a possible cause of developmental prosopagnosia in adults.

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1. Introduction

Recognition and interpretation of faces are essential for normal social development. They allow us to differentiate an acquaintance from a stranger, and provide information about the age, gender, or emotional state of other individuals. Every day, children receive much input from faces around them, and they must be able to recognize who is interacting with them and understand the non-verbal language expressed by facial emotions.

A human face is the most distinctive feature to access to a person's identity. Also, is usually the way to present ourselves to others. Image of a face represents a singular view between many other views. Throughout a life time we can distinguish great number of faces, even when the differences among them are few. We become, very early in development, specialists in recognizing faces.

For years, studies around face recognition processes have been based on two hypotheses. The "expertise hypothesis" which proposes that face recognition is not a special process, only people have wider experience individuating one face from another (Diamond & Carey, 1986), and the "domain specificity" hypothesis which suggests that face recognition relies upon brain structures and networks devoted to this skill. This last view has been actually confirmed by clinical and experimental findings (McKone, Kanwisher, & Duchaine, 2007).

Face recognition is a high-order visual ability, separated from other visual recognition tasks. For instance, damage in certain cerebral regions may give rise to isolated disorders in face recognition keeping intact other recognition abilities.

Functional approach also varies depending on the stimulus. When viewing faces, we perceive the global organization of its features, more than an addition of simple elements. This holistic elaboration works with faces, unlike the case of common objects, that are perceived as an addition of parts (Michel, Rossion, Han, Chung, & Caldara, 2006). Many face recognition studies revolve about the so-called "inversion effect", explaining how an inverted view of a face decreases the recognition abilities more than this change of point of view in any other object (McKone et al., 2007). In other words, brain processes in a very different way a face view and an object view.

Additionally, this skill is present in the very early stages of life. As early as 5 days of age, a neonate shows hemodynamic responses in the temporal cortex when viewing dynamic face stimuli (Farroni et al., 2013) even several studies have demonstrated face discrimination abilities in newborns (de Heering et al., 2008; Dupierrix et al., 2014). This is in line with the interest in eyes and facial expressions demonstrated by children: at 3 months of age infants already look at faces throughout approximately 25% of their waking hours (Sugden, Mohamed-Ali, & Moulson, 2014).

As a part of normal development, face recognition skill increases and matures from childhood till early adulthood (Germine, Duchaine, & Nakayama, 2011). So there is a lengthy specialization.

From a structural perspective, one of the first stages of visual information is occipital cortex, where the images are perceived. However, the existence of late visual areas where the information is processed is needed for recognition. Cerebral areas devoted to face recognition have been accurately located in the fusiform face area in the occipito-temporal cortex (Furl, Garrido, Dolan, Driver, & Duchaine, 2011), the occipital face area in the lateral occipital cortex (Jonas et al., 2012) and the superior temporal sulcus (Fox, Moon, Iaria, & Barton, 2009). Specifically, the face-sensitive network activation is wider in the right hemisphere, commonly dedicated to global processing of images (Kanwisher, McDermott, & Chun, 1997).

Severe inability to recognize and remember faces is called prosopagnosia or face blindness. First description of the illness was made in 1947 by Bodamer, who studied three patients who developed inability identifying faces after brain injury, called acquired form of prosopagnosia (Bodamer, 1947). The developmental form was defined as a rare condition in which the child fails to recognize faces in the absence of known neurological damage. Particularly relevant was the first study of this condition, the case of a 12 years old girl with prosopagnosia and without evidence of any other neurologic deficit and no relevant medical history, who was followed throughout nearly 20 years (De Haan & Campbell, 1991; McConachie, 1976).

Subsequent investigations have pointed out that the disorder is common between general population. The studies from Bowles or Kennerknecht established a frequency of 2–3% in adults from different countries (Bowles et al., 2009; Kennerknecht, Plümpe, Edwards, & Raman, 2007). In a sample of primary school children between 5 and 11 years, the prevalence rise up to 4–5% (Bennetts, Murray, Boyce, & Bate, 2017). None of these studies collected medical history from people included, thus our work tries to contribute in clarifying the aetiology of this deficit.

Less severe difficulties in face recognition have been detected in individuals with minor central nervous system abnormalities (Fazzi et al., 2004). This mild face recognition impairment may not be clinically obvious, as affected individuals may be able to compensate for it by using other strategies to recognize individuals, such as voice or other personal features. However, most people with face recognition problems have reported varying degrees of discomfort and difficulties in their daily life because of face recognition impairment (Yardley, McDermott, Pisarski, Duchaine, & Nakayama, 2008).

The risk of visual impairment is greater in low birth weight and premature infants. It is well known that these children have a higher frequency of abnormalities in the afferent visual pathway (e.g., refractive errors, retinopathy of prematurity) (Holmström, el Azazi, & Kugelberg, 1998) or problems with processing visual information (e.g., cerebral visual impairment, low visual spatial skills) (Geldof, van Wassenaer-Leemhuis, Dik, Kok, & Oosterlaan, 2015; Molloy et al., 2013). However, only a few studies have involved face recognition impairment, and all of these have evaluated children with other types of visual dysfunction.