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Face memory and face recognition in children and adolescents with attention deficit hyperactivity disorder: A systematic review

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ABSTRACT

This review focuses on facial recognition abilities in children and adolescents with attention deficit hyperactivity disorder (ADHD). A systematic review, using PRISMA guidelines, was conducted to identify original articles published prior to May 2017 pertaining to memory, face recognition, affect recognition, facial expression recognition and recall of faces in children and adolescents with ADHD. The qualitative synthesis based on different studies shows a particular focus of the research on facial affect recognition without paying similar attention to the structural encoding of facial recognition. In this review, we further investigate facial recognition abilities in children and adolescents with ADHD, providing synthesis of the results observed in the literature, while detecting face recognition tasks used on face processing abilities in ADHD and identifying aspects not yet explored.

1. Introduction

1.1. ADHD

Attention deficit hyperactivity disorder (ADHD) is a complex neurodevelopment disorder that has a childhood-onset, but it can affect individuals across the lifespan (Matthews et al., 2014; Tarver et al., 2014). It is characterised by symptoms of inattention (e.g., difficulty to organise tasks or activities with high distractibility), impulsivity, hyperactivity (e.g., tap hands or feet and/or talk excessively), and well-known cognitive impairments, such as poor executive functioning, attention and concentration difficulties and poor response inhibition (American Psychiatric Association (APA, 2013). DSM-5 (American Psychiatric Association (APA, 2013) distinguishes between inattentive, hyperactive–impulsive and combined presentations of ADHD. Children under 17 years old must display at least 6 inattentive and/or hyperactive-impulsive symptoms, whereas individuals 17 years old and above must show at least 5 symptoms. These symptoms must be present across more than one setting (e.g., home and school), and they must result in impairment in several areas such as academic, social or daily functioning (American Psychiatric Association (APA, 2013). The prevalence of the disorder is estimated to be around 1.4–3.0%, and it is more common in boys than girls (Thapar and Cooper, 2016). Although there are a wide number of studies focused on ADHD, it is difficult to establish a precise cause; because symptoms of ADHD likely derive from a complex interaction between emerging neurodevelopment vulnerabilities and aspects of the child's prenatal and postnatal environment (Johnson et al., 2015).

1.2. Facial recognition

The ability of facial recognition is related to the development of different skills, cognitive functions and brain areas; and it seems to be associated with family and social functioning (Collin et al., 2013). According to some studies (Sinzig et al., 2008; Shin et al., 2008; Berggren et al., 2016; Wehmeier et al., 2010; Passarotti et al., 2010), the difficulty in facial emotion recognition could be caused by different mechanism related to cognitive impairments, to a deficit in the processing of social information, to specific alterations in brain systems underlying face processing abilities or to comorbid conditions.

Faces are multidimensional visual stimuli and provide a broad range of information to an individual such as identity, gender, age, race, mood and intentions (Pascalis et al., 2011). They represent a special category of stimuli for our visual system. Research carried out during

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the last years strongly suggests that humans have a face-specific cognitive system from birth (Rivolta, 2014). Three important theories have been elaborated about the maturation of face processing: *face specific perceptual development theory* (Carey and Diamond, 1977) believes that face processing does not mature fully until late in development and that adult levels of expertise are reached only during adolescence; *theory of face recognition* (Bruce and Young, 1986) proposes for a sequential and hierarchical organization of different stages of processing, structural encoding, face recognition units, person-identity nodes and name retrieval; *general cognitive development theory* (Crookes and McKone, 2009) proposes that face processing abilities mature early in development and that the performance of face recognition task measured in childhood also depends on other cognitive abilities like memory, concentration, etc. (He et al., 2015).

It is widely recognised that children show face recognition abilities very early in life. Newborns show a preference for face-like configurations compared to other types of visual stimuli, recognise their mother, discriminate between familiar and unfamiliar faces, prefer faces when presented upright but not when inverted, etc. (Rivolta, 2014; Slater et al., 2000; Crookes and McKone, 2009).

1.3. Neural correlate of facial recognition

In the last years, thanks to advances in the field of neuroscience and the development of more accurate neuroimaging techniques, it has been possible to identify different brain areas that are responsible for facial recognition. Research on patients with developmental prosopagnosia (DP) who have preserved object recognition despite severe face recognition deficits (Dalrymple et al., 2017) and infant research studies (Peykarjou et al., 2013) confirm the existence of distinct neural circuitry and regions within the brain that preferentially process facial stimuli. The key regions of face processing seem to be the fusiform face area (FFA), which responds more strongly to faces than to other visual stimuli such as letter strings, objects and scenes (Kanwisher and Yovel, 2006); the more posterior occipital face area (OFA) that preferentially detects some parts of the face, such as the eyes, nose and mouth (Pitcher et al., 2011); the right anterior temporal lobe (ATL) that is typically activated during the discrimination of familiar and unfamiliar faces and face naming (Collins and Olson, 2014); the right posterior superior temporal sulcus (rpSTS) that seems to be more strongly involved in facial expression recognition tasks (Pitcher, 2014)—the ventromedial prefrontal cortex (VMPFC) that seems to play a critical role in mediating visual attention to the eye region of the face, particularly for fearful expressions (Wolf et al., 2014) and the amygdala that seems to be associated with emotional expressions, including fearful and positive expressions (Pessoa et al., 2006; Todorov, 2012).

1.4. Anomalies of facial recognition in neuropsychiatric disorders

The research about facial memory and recognition in childhood psychiatric disorders focuses mainly on autism spectrum disorder (ASD). Most studies have shown face recognition deficits in children with ASD, and these finding are in line with the fact that children with ASD have great problems in social relationship and eye contact (Tehrani-Doost et al., 2012; Harms et al., 2010). Recent research also reported that youth with bipolar disorder (BD) have a specific difficulty in identifying facial emotion (McClure et al., 2005). It would seem that the ventrolateral prefrontal cortex- striatum-amygdala circuit, involved in the pathophysiology of BD, is crucial to facial emotion processing (Brotman et al., 2008). Schepman et al. (2012) reported that children with depression showed no overall or specific deficits in facial expression recognition accuracy, but they have biases affecting the processing of low-intensity expressions, more often perceiving facial expression as sad. Anxious children with generalised anxiety disorder (GAD) showed an attentional bias toward both angry and happy faces, which according to Waters et al. (2008) may reflect differing threat appraisal processes or emotion regulation strategies. Seiferth et al. (2009) found a dysfunction in cerebral circuits relevant for emotion and face processing in adolescent patients with schizophrenia. The authors observed in these regions a decrease in activation accompanied by hyperactivation in areas related to emotion regulation and attribution.

Since ADHD and schizophrenia share attentional and social impairments, Marsh and Williams (2006) compared facial affect recognition in an ADHD group and a schizophrenia group, finding different dysfunctions in the perception of facial expressions of emotion. These distinct impairments might help to distinguish these disorders in childhood and adolescence. Castro et al. (2010) showed that discrimination accuracy of sad faces presented for 500 ms was significantly associated with anorexia nervosa and body mass index; and the comorbidity with obsessive- compulsive symptoms was the strongest predictor of a poor discrimination of briefly presented sad faces.

Given that some research has detected specific social deficits in children and adolescents with ADHD (Da Fonseca et al., 2009) and that impaired recognition of facial emotion expressions is a potential cause of poor social competence, peer relationship and interaction with others (Collin et al., 2013; Demirci and Erdogan, 2016). It is very interesting to analyse the face processing abilities of children and adolescents with ADHD.

Few studies have evaluated face processing in children and adolescents with ADHD and, as the face recognition process (and in particular the ability to read and respond in a proper way to the facial expression of others) is critical in social interaction and in everyday social life (Berggren et al., 2016), the majority of the research in this field has focused on the ability to recognize emotional facial expressions (with inconsistent results). On the one hand, these studies have suggested that children with ADHD have similar levels of facial recognition and facial expressions as healthy controls. Moreover, the results of some studies support the hypothesis that not only ADHD but also a comorbid oppositional defiant disorder (ODD) (Noordermeer et al., 2015) or a comorbid conduct disorder (CD) negatively affect empathy skills, emotion recognition and face processing abilities (Gumustas et al., 2017).

On the other hand, the majority of works report a worse performance in children with ADHD than in children with typical development (TD), especially in detecting facial expressions of emotion (Da Fonseca et al., 2009; Demopoulos et al., 2013).

The aim of this study is to explore facial recognition abilities in children and adolescents with ADHD, providing a synthesis of the results observed in the literature, detecting face recognition tasks used on face processing abilities in ADHD and identifying aspects not yet explored. It is important to study face recognition because this ability is related to the development of different skills, cognitive functions, brain areas and it seems to be associated with family and social functioning (Collin et al., 2013). Furthermore, studying facial recognition abilities in children with ADHD it is highly challenging because the difficulty in this competence could be caused by different mechanisms related to core deficit of the disorder, to a deficit in the processing of social information, to specific alterations in brain systems underlying face processing abilities or to comorbid conditions. Therefore, we choose not to include studies on ADHD and comorbidities because the studies about face recognition in complex samples (ADHD + comorbidities) do not allow to circumscribe the neuropsychological profile properly associated with ADHD. Furthermore, the presence of a comorbidity would be unlikely to enable a clear distinction whether the difficulties in facial recognition are due properly to the core deficit of ADHD or to an associated condition.

2. Objective

Following the PRISMA guidelines, in this literature review, we analysed different studies, highlighting the different aspects of face recognition and the instruments used in children and adolescents with