Emotional Regulation Interventions on Developmen for Preterm Children

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Children born preterm (<37 weeks' gestation) show a specific vulnerability for socio-emotional difficulties, which may increase the likelihood of developing behavioral and psychiatric problems in adolescence and adulthood. The significant advances in perinatal and neonatal medicine over the past mean that most of these infants now survive to adulthood. Consequently, the focus of research has shifted from increasing survival rates to enhancing the quality of life and improving outcomes for these infants. It has been noticed that there is an increased risk of cognitive, behavioral, socio-emotional, speech, motor or sensory impairment in the long run. Furthermore, long-term overall function depends on healthy socio-emotional functioning; at the same time, preterm children present more behavioral and emotional problems than their full-term counterparts. The difficulties with the increasing requests, increasingly complex and demanding, will affect the learning, self-esteem and social development of the child and future adolescent.

preterm children emotional regulation

1. Introduction

Children born preterm (<37 weeks' gestation) show a specific vulnerability for socio-emotional difficulties, which may increase the likelihood of developing behavioral and psychiatric problems in adolescence and adulthood. The significant advances in perinatal and neonatal medicine over the past few decades mean that most of these infants now survive to adulthood [1][2][3]. Consequently, the focus of research has shifted from increasing survival rates to enhancing the quality of life and improving outcomes for these infants. It has been noticed that there is an increased risk of cognitive, behavioral, socio-emotional, speech, motor or sensory impairment in the long run [4][5][6][7]. Furthermore, long-term overall function depends on healthy socio-emotional functioning; at the same time, preterm children present more behavioral and emotional problems than their full-term counterparts [8][9][10]. The difficulties with the increasing requests, increasingly complex and demanding, will affect the learning, self-esteem and social development of the child and future adolescent [11].

This leads to emotion regulation, which refers to the ability to modulate emotions in response to people and situations, delay gratification and tolerate changes in the environment using behavioral processes and strategies and enabling appropriate empathic behaviors [12][13]. Then, emotion dysregulation can lead premature children to be unable to handle environmental stimuli, showing hyperactive responses and low tolerance to the slightest stimulation, putting children born prematurely at a disadvantage during social situations [14][15][16]. It has been found that several risk factors such as atypical structural maturation of the brain regions underlying social cognition could

lead to developmental delays or abnormalities [17][18][19]. At age 6, reduced connectivity was found in all emotions except the response to angry faces. However, this issue with reduced connectivity decreases at 8 years, indicating a dynamic period of brain network development. The affected areas are the amygdala and the frontal regions, in particular the superior frontal gyrus and between the orbital frontal cortex and the anterior cingulate [20][21][22][23][24][25]. Other volumetric alterations have been found in samples of preterm infants in infancy and adolescence with changes in both white and gray matter [17]: reduced volume of the fusiform gyrus [26][27], thalamus [19], insula [26] and hippocampus [28][29][30][31]. However, different studies have identified, in addition to emotional dysregulation, an impairment of social cognitive skills related to the Theory of Mind [12][32]. Theory of Mind has been defined as the ability to understand the behavior, the inner state that guided it and the motivations and emotions of others, even when different from one's own [32]. These impairments increase social vulnerability leading to the result of specific alterations of the "Social Brain", which is considered as a neurodevelopmental sequela of preterm birth [33]. The Theory of Mind deficit is reflected in a reduction in the connectivity of a set of brain regions that comprise the "Social Brain". These networks include regions such as the angular gyrus, medial prefrontal cortex, superior temporal gyrus and temporal lobes. This deficit is particularly found in the group of children born very preterm, who showed greater connectivity than controls in a network anchored in the occipital gyrus rather than in the classic regions of social processing [34].

It is known that behavioral problems are frequent as early as 2 years of age and that these deficits found in the preschool age remain stable in early childhood and persist throughout the school, adolescent and adult years [35][36][37][38]. This could evolve into psychiatric disorders, particularly anxiety disorders, which are the most prevalent disorder in this population [39][40]. In fact, during the first 2 years of life, higher rates of insecure attachment with parents were recorded compared to term children and greater difficulties in regulating interactions with primary caregivers [41]. In the following years, on the other hand, greater problems in behavioral and emotional self-regulation, less empathy and lower levels of motivation for the task, social interactions and prosocial relationships between peers were highlighted, also confirmed by the evaluations of parents and teachers. This is particularly true for children born extremely preterm in preschool and school age [12][15][38][42]. Arriving at adolescence, researchers find a developmental period characterized by an increase in cognitive and emotional self-regulation, a greater dependence on peers for socialization and a greater sensitivity to reward and socio-affective stimuli. The neural network continues to develop during this time and supports greater awareness of mental states and intentions. Despite the aspects that promote the growth of adolescents' increased sensitivity to reward and affective stimuli, these changes increase vulnerability to stress and the possibility of making decisions with negative adaptive consequences [15][16]. Nevertheless, it should be noted that regulatory processes vary during development. In addition to time, the effects on regulatory functions of environmental quality, modification of parental interactions and experiences can improve the balance between biological and environmental regulation by shifting in the direction of environmental dispositions, thus modifying developmental outcomes [12][43]. In this way, psychosocial variables such as positive parenting interactions or low parental stress that can potentially protect preterm children from behavioral problems acquire considerable importance [11][44][45]. Furthermore, it is believed that interventions should also aim at recognizing emotions and elaborating on the emotions felt by others [22]. A comprehensive approach inspired by a bio-psychosocial model of health and the International Classification on Functioning

Disability and Health is urgently recommended [46]. Researchers suggest that the behavioral phenotype is characterized by inattention, anxiety and social difficulties, and that these characteristics would remain stable in early childhood and persist throughout school age, adolescence and adulthood [37]. In particular, emotion dysregulation can lead these children to be unable to manage environmental stimuli, showing hyperactive responses and low tolerance to minimal stimulation [14].

2. Group Physiotherapy Intervention

The RCT study performed by Brown et al. (2017) investigated behavioral and emotional regulation changes that task-oriented group physiotherapy intervention, combined with a home-based program, can determine over 6 weeks. Specifically, the task-oriented approach emphasizes motor performance and incorporates it into cognitive and attentional processes. Included activities addressed postural control and balance, sensorimotor skills and upper girdle strength, as well as behavior such as increasing attention to tasks. Fifty four-year-old children born extremely premature were recruited and randomized into the experimental (n = 24) and control (n = 26) groups. The latter received standard treatment through Best Practice advice and an informal booklet of general age-appropriate activities. There were no significant differences between groups over time on CBCL internalizing, externalizing or total problems scores. The intervention group showed a mean difference in total problems score of −3.8 (CI [1.5, 9.1]) between times, with standard care group values being −4.4 (CI [1.6, 7.1]). Males had higher total problems scores than females ($p = 0.026$), although still performed within the “normal” range. At the end of the treatment and the follow-up, carried out after one year, the authors recorded an improvement in both groups at the behavioral level, but no significant differences were identified between the two groups at the behavioral level of internalizing ($p = 0.621$), externalizing ($p = 0.804$) and problematic ($p = 0.596$).

3. Computerized Intervention in Executive Functions

Van Houdt and colleague (2019) studied the effects of a computer-based intervention focused on executive functions (EF) in eighty-five children born very preterm between the ages of eight and twelve. Twenty-nine children were assigned to the experimental group and twenty-six to the placebo group; the remaining thirty were assigned to the waiting group. The experimental intervention and placebo involved a 6-week intervention, with 25 sessions ranging from 30 to 45 min. The experimental intervention applied the BrainGame Brain Training, a highly motivated computerized intervention that can be carried out independently by the child and which consists of exercises focused on executive functions. In the working memory task, children are asked to repeat a sequence of dots on a grid. In the inhibition task, children are asked to press a button in a specific time window (target), but to refrain from pressing that button when a visual stop signal is presented. In the cognitive flexibility task, children are asked to sort objects according to either its shape or its color, with the sorting rule changing every three to five trials. The difficulty level of each training task is automatically adjusted to the child’s level of performance. The placebo group carried out the same activities without reinforcing cognitive skills; furthermore, the difficulty level was non-adaptive, constantly remaining low. The authors found that the intervention group improved in performing all tasks ($p <$

0.001); however, these skills were not generalized across attention (p = 0.25), parent (p = 0.19)- or teacher (p = 0.62)-assessed behavioral and emotional functioning, or self-perceived competence (p = 0.12).

4. Parent Training

Two articles reported the results obtained from an RCT of parent training [47][48] involving twenty-eight children born preterm with an externalizing behavior disorder and their mothers. Fourteen mother–child pairs were assigned to the experimental group and the other fourteen were on the waiting list. The parent–child interaction therapy (PCIT) is a parent training intervention focused on enhancing the interaction of the mother–infant dyad; it consists of one session per week for a total of four months. Treatment progresses through two distinct phases: child-directed interaction (CDI) resembles traditional play therapy and parent-directed interaction (PDI) resembles clinical behavior therapy. Bagner et al. (2010) report that the PCIT group had fewer attention problems (p = 0.11), but most of all less aggressive behaviors ($p < 0.05$) and externalizing and internalizing behavior problems ($p < 0.05$) at the end of the sessions ($F = 24.2$, $p < 0.05$). The study by Rodriguez et al. (2014) reported how the PCIT group increased global regulation ($p < 0.05$); in particular, the resulting t-tests indicated that both low and high global regulation was significantly different from zero, $t(26) = -7.38$, $p < 0.01$, $b = -100.72$, and $t(26) = -3.51$, $p < 0.01$, $b = -48.71$.

5. Mindfulness Intervention

The cross-over RCT performed by Siffredi et al. (2020) investigates the effects of a mindfulness intervention on the emotional regulation of 56 adolescents born very preterm. The experimental group followed a mindfulness-based intervention (MBI) (n = 29) and was compared to a waitlist group (n = 27). The MBI intervention consisted of eight weekly sessions in groups of up to seven participants, lasting ninety min, plus an indication to practice daily at home. For each session, one theme was addressed, such as attention and the stabilization of the focus of attention, bodily sensations, emotions, thoughts, stress and coping strategies. Different formal meditation practices were introduced. Groups were evaluated at the end of the intervention and a follow-up at one and three months. The authors concluded that mindfulness improved day-to-day executive life and reduced SDQ scores ($t = -2.423$, p = 0.017); however, these improvements were not globally maintained at follow-up, except for information processing ($t = -3.341$, p = 0.001).

6. Methodological Quality and Risk of Bias

The methodological quality of the selected studies was assessed by applying the Jadad and PEDro scores to each of them. Three of the studies included in the present review, Brown et al. (2017), Siffredi et al. (2020) and Rodriguez et al. (2014), were considered low quality as they achieved a Jadad score of two and exceeded the PEDro scale cut-off. The remaining RCTs scored equal to or greater than the cut-off values and were rated as good quality. The main problems with the articles receiving low scores were the impossibility of applying a double-blind

study due to the nature of the treatment, the inadequate description of the drop-out and the withdrawals. Quality assessments were initially completed by a single reviewer and then verified for accuracy by the second reviewer.

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