

Self-regulation: A New Perspective on Learning Problems Experienced by Children Born Extremely Preterm

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ABSTRACT

Survival rates are increasing for children born extremely preterm, yet despite the majority of these children having IQ scores within the average range, 50-70% of these children have later school difficulties. This paper reviews factors associated with academic difficulties in these children, emphasizing the contributions of executive functions (EF) and self-regulation. The roles of EF are examined separately, and also under the unifying construct of self-regulation; that is, the integration of various behavioural, cognitive, and affective elements. Improving self-regulatory skills could moderate the negative effects of EF deficits and inform interventions to improve the educational outcomes of these children

Keywords: Preterm, Premature, Extremely Low Birth Weight, Self-regulation, Executive functions, Learning difficulties

Survival rates for extremely premature (less than 28 weeks gestation) and/or extremely low birth weight (ELBW, i.e. less than 1000g) infants are increasing across the Western world (Doyle, Anderson, & VICSG, 2005; Saigal & Doyle, 2008). In general, the evidence suggests that these children do surprisingly well in their early years, with the majority of children having IQ scores within the average range (Anderson & Doyle, 2004; Harvey et al., 1999; O’Callaghan et al., 1995). Nevertheless, school difficulties have frequently been reported among these children (Saigal et al., 2000), with as many as 50-70% having academic and/or behavioural problems (Aylward, 2002; O’Callaghan et al., 1996). These findings suggest that something other than intellectual ability may be responsible for poorer learning outcomes for these children.

A number of investigations have identified deficits in specific executive functions (EF) that affect learning outcomes among children born extremely premature/ELBW (Anderson & Doyle, 2004; Bayless & Stevenson, 2007; Marlow et al., 2007). A focus on self-regulatory capacities may also be helpful as there is some evidence that those born extremely premature/ELBW have difficulty with self-regulation (Blair, Granger et al., 2005) and skills in self-regulation may offer ways to compensate for deficits in EF.

The purpose of this article is to present a new framework identifying possible contributing factors to school difficulties for children born extremely premature/ELBW, with a view to directing research and ultimately, informing intervention. As many research studies that focus on children born extremely premature /ELBW base their participant criteria on birth weight rather than the degree of prematurity, from this point forward these children will be described as ELBW. This paper will begin

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with examining aspects of development including EF and self-regulation in this population. This will be followed by a discussion of factors likely to influence this development: language, temperament, and attentional and behavioural problems, and elements of parenting; and will conclude with recommendations for future research.

Executive Functions

The executive functions are a collection of individual but interrelated psychological processes involved in the intentional management of action and thought that contribute to cognitive performance, behaviour, emotional expression, and social relations (Aylward, 2005; Riggs et al., 2003). These individual processes include: planning, strategy use, cognitive flexibility, management of attention, inhibitory control, and the incorporation of feedback (Anderson, 2002; Aylward, 2005). Although the specific relationships among these functions are not well understood, the rarity of global executive impairment, and individual variations in EF profiles, suggest a complex pattern of abilities that should be examined both separately, and as a more unified construct. Self-regulation provides such a construct as it can be understood as the ability to integrate these elements in pursuit of a valued goal (Anderson, 2002; Aylward, 2005).

The development of EF and self-regulatory capacities continues to expand and mature throughout childhood (Aksan & Kochanska, 2004; Blair, Zelazo et al., 2005), with progressions in the ability for planning, organization, and focused attention facilitating later success at school (Blair, 2000). Deficits in these areas in the presence of otherwise normal cognitive functioning may be a contributor to learning disorders (Blair, Granger et al., 2005; Riggs et al., 2003).

Executive dysfunction (Anderson, 2002) describes a range of impairments that have the capacity to interfere with effective adaptation to changing developmental demands for behavioural regulation, and the achievement of social and cognitive competency (Aylward, 2005; Blair, Zelazo et al., 2005). These impairments - that is, impulsivity, poor planning, organizational and reasoning difficulties; problems with self-monitoring and strategic responses; perseveration, and limited working memory - are frequently identified in children born with ELBW (see Anderson & Doyle, 2004; Harvey et al., 1999; O'Callaghan et al., 1996).

Marlow et al. (2007) studied EF in children born with ELBW at six years of age (without established neurological abnormality), and found more difficulties with attention span, planning, and inhibition for children born with ELBW in comparison to their normal birth weight peers. Children born with ELBW identified as experiencing such difficulties with EF were also reported to have poor academic achievement by their teachers, irrespective of their cognitive abilities. Anderson and Doyle's (2004) study of EF in children born with ELBW at ages eight to nine years recorded similar results, with significantly lower scores on all measures of EF for children born with ELBW, with the greatest differences noted for planning ability, organizational skills, and monitoring actions. Behavioural impairments were recorded for the ELBW group in both their ability to start, organize, and sustain problem solving in pursuit of a goal, and in tasks requiring shifting attention.

Another explanation for the learning problems demonstrated by children born with ELBW is that these children have difficulties with self-regulated functioning (Davis & Burns, 2001). To use an analogy, EF processes make individual contributions to self-regulation, just as woodwind, strings and percussion instruments can contribute unique musical sounds to an orchestra. When EF processes are combined in self-regulatory processes, it is akin to different instruments playing the same piece of music arranged by a conductor, with distinctive sounds blending to create orchestral music. Examining self-regulation as an over-arching construct in conjunction with investigations of relevant EF may provide useful explanations of the difficulties faced by these children, and better inform interventions designed to improve their learning outcomes.

Self-regulation

Despite considerable research in the field, definition of self-regulation remains a difficult issue. As a multidimensional construct composed of motivational, cognitive, behavioural, and affective functions (Grolnick & Farkas, 2002), self-regulation incorporates several EF processes, yet few research studies have utilized a broad range of measurements that correspond to each of these functions, instead focusing on different combinations of specific EF processes. In addition,

conceptualizations of self-regulation differ according to the theoretical viewpoint of the researcher, leading to the assessment of different aspects of this important construct.

Behavioural learning theories of self-regulation, for example, focus on learned self-control, where motivation by rewards, and children's development of strategies to manage their reactions to gain such rewards, lead to self-regulated behaviour (Bronson, 2000).

Bandura's (1997) social learning perspective suggests children progress from reliance on externally imposed direction to being guided by intrinsic motivation through the acquisition of personal standards of performance. Individuals then engage in self-rewarding behaviour when these personal standards are met. Vygotsky (1987) emphasised the role of scaffolding from those in the care-giving environment, which provides assistance for children to self-regulate their behaviour. Vygotsky also considered language to be the primary factor in voluntary self-regulation, with children using private speech to guide their thoughts and actions. In contrast, information-processing models of self-regulation use the biological maturation of the brain to describe how attentional, perceptual, and memory processes combine to strengthen cognition and analytical functions (Siegler, 1989).

From a developmental perspective, no single theory sufficiently explains all aspects of self-regulation. All of these theoretical points of view have merit, and all rely to some degree on individual motivation and/or environmental support and experience. Children must firstly have adequate physiological wellbeing and biological maturation of the brain to enable higher-order cognitive processes to function successfully. The infant-carer relationship then creates a secure and supportive foundation for the development of self-regulation (Feldman et al., 1999), with the optimal care-giving environment providing later opportunities to develop autonomy and self-direction (Davis et al., 2004). Children need opportunities to practice and develop self-regulatory capacities, and this occurs by being exposed to a range of challenges (Feldman et al., 1999; Young & Hauser-Cram, 2006). As these self-regulatory skills emerge and strengthen, the child develops additional strategies to reach self-imposed standards, and becomes capable of achieving goals without direct assistance from others.

Kopp (1991) described a developmental progression of self-regulation, beginning in infancy at the neurophysiological stage, where behaviour is regulated according to states of stimulation, and the caregiver assists the infant to soothe. In the sensorimotor stage, occurring between the ages of three and nine months, the infant is able to modify behaviour in accordance with environmental situations and stimuli. Between nine and 18 months of age, the child becomes more responsive to social demands, and by the end of this period is developing self-control (without external monitoring by others). By 36 months and beyond, the child's growing abilities to use representation and symbols lead to increasingly flexible and adaptive control of behaviour and facilitate greater self-regulation. Failure to acquire adequate self-regulatory abilities results in problems managing attention, emotional lability, poor behavioural control, and other regulatory impairments.

Early deficits in self-regulatory capacities have been linked to childhood disorders such as attention deficit hyperactivity disorder (ADHD), and oppositional defiance disorder (ODD) (Barkley, 1997). Deficits in aspects of attention have been reported both in children with ADHD, and learning disorders (Martel et al., 2007); and as discussed earlier, children born with ELBW are more likely to experience these difficulties. Yet some children with deficits in attention may be able to employ other aspects of self-regulatory capacities such as self-monitoring, to better cope with these problems. From this perspective, improvements in self-regulatory skills may not be the solution to EF difficulties and subsequent learning disorders, but could, nevertheless, be a resource to assist moderation of the negative effects of EF deficits.

Berger et al. (2007) described self-regulation as 'the ability to monitor and modulate cognition, emotion, and behaviour, to accomplish one's goals and/or to adapt to the cognitive and social demands of specific situations' (p.257). This definition encompasses all aspects of regulatory behaviours, and importantly, includes both motivational and adaptive elements in conjunction with environmental influences. Comprehensive assessment of self-regulation in young children requires measures related to cognition, emotion, and behaviour, in addition to investigations of individual factors such as specific EF, temperament and cognitive ability; and with attention given to environmental influences such as aspects of parenting. As children born with ELBW frequently experience deficits associated with language production, motor skills, and visuospatial abilities, any comprehensive assessment would incorporate consideration of these areas.

Factors Related to Self-regulation

Language. Children born very prematurely are at greater risk of both language delay and language disorder (Foster-Cohen et al., 2007). Language delay is characterized by later acquisition of language competencies in comparison with typically developing peers, whereas language disorder refers to abnormal achievement of developmental language skills (Zimmerman & Castilleja, 2005). Although the fetal auditory system is functional between 24 and 28 weeks gestational age (Chapman, 2000), the full implications for language development when birth takes place during this period are not clear.

In a developmental progression, children's actions are initially guided by verbal instructions from others, before they begin to use self-talk or private speech to manage their own behaviour. Audible self-instruction becomes quieter over time; gradually changing to subvocalization, and then to internalized silent instruction, whereby the child uses thoughts to control his or her actions (Winsler et al., 2006). As the successful development of self-regulatory skills is suspected to be associated with the use of private speech (Vygotsky, 1987; Winsler et al., 2006), both language delay and language disorder may contribute in different ways to difficulties with self-regulation.

Temperament. Temperament influences an individual's capacity for emotion regulation, which, in turn, assists the development of social competence and subsequent attentional and behavioural control (Bronson, 2000), all elements of self-regulation. While definitions of temperament vary, the review of temperament by Hubert et al. (1982) found the dimensions of activity, approach, and mood to be common across the majority of conceptualizations of this construct. Although these dimensions of temperament continue to be studied, more recent research has found that these dispositional characteristics contribute to a dynamic interplay with parental interactions and environmental experiences to shape the more specific aspects of temperament related to self-regulation (see Bagnato, 2007; Stifter & Wiggins, 2004; Sullivan & Msall, 2007). Individual temperament, for example, dictates emotional response and choice of strategy (Zimmerman & Stansbury, 2003), and influences emotional reactivity, sociability, and impulsivity; which in turn affect the successful engagement of effortful control, response inhibition, and the ability to delay gratification (Shonkoff & Phillips, 2000).

The contribution of birth weight and gestational age (GA) to temperament has not yet been established. Although some researchers have found more difficult temperaments among premature infants at six months of age (Weiss et al., 2004), other comparisons with full-term peers have reported no differences in children less than 18 months of age (Honjo et al., 2002) and easier temperaments at two years of age for premature children (Oberklaid et al., 1991). Direct comparisons between these studies are difficult due to the inclusion of cohorts from different time periods and the categorization of prematurity used for participants. Premature children have been described as passive and showing less initiative than their full-term peers (Sajaniemi et al., 1998), yet these findings may be an indication of problems with integrating sensory information from the environment, whereby low persistence and attentional difficulties combine with environmental demands to overwhelm premature children, and interfere with the development of goal-directed behaviour.

Attentional and Behavioural Problems. The management of attention is a foundation of EF, and underpins the development of self-regulatory capacities that include the planning and organization of behaviour (Shonkoff & Phillips, 2000). Attentional processes involve different mechanisms: orienting, alertness or sustained attention, and selective attention; and can be considered to be the principal foundation for other aspects of self-regulation such as inhibitory control, problem solving, and self-monitoring (Berger et al., 2007; Grolnick & Farkas, 2002; Horwood et al., 1998; McClelland et al., 2007). Attention and inhibitory control also provide the basis for developing age-appropriate skills in classroom environments (McClelland et al., 2007); however, children born prematurely often have deficits in these underlying abilities (Anderson & Doyle, 2004). The failure to successfully develop these attentional capacities can lead to problems managing behaviour, so understanding the effects of difficulties with attention may also help to explain the complex relationships among attention, behaviour, and self-regulation.

A study conducted by Sykes et al. (1997) of children born at very low birth weight (VLBW, i.e. less than 1500g) aged between seven and eight years, found these children had more problems with

school performance, working hard, displaying appropriate behaviour and learning when compared to their full-term peers; with girls more inattentive and withdrawn, and boys exhibiting more disruptive behaviours, more often talking out of turn, being inattentive, and showing social problems. Although relatively few children born with VLBW scored within the clinical range, teachers associated the children's combinations of deficits with their poor school performance.

Another study that linked behavioural problems and school performance found clinical levels of behavioural problems, including aggression and attention problems have been reported as twice as likely among children identified with verbal learning difficulties as their peers with non-verbal learning disorders and peers without any learning difficulties (Yu et al., 2006). As discussed earlier, this result supports the notion that internal or private speech contributes to behavioural control, and may bolster self-regulatory capacities. Successful applications of verbal self-regulation strategies have been reported among recent research on interventions for the treatment of ADHD, now considered to involve deficits in self-regulation as much as inattention (Barkley, 2007). In addition, private speech may also be used to help control physical actions, such as when children sit on their hands to succeed in tasks involving delay of gratification or inhibition (Jones et al., 2003; Peake et al., 2002).

Parenting and Family Environment. Although Hall, Elias, and Crossley (2006) identified dispositional differences in each individual's capacity for self-regulation, the impact of genetic inheritance appears to be moderate (Goldsmith & Gottesman, 1981; Sameroff, 2004; Sameroff, 2010). Therefore, understanding the effect of environmental factors on self-regulation is of great importance. For young children, the most salient environmental factors related to self-regulation are connected to their parenting. Parent-child attachment and interactions, disciplinary actions, behavioural expectations, and parental stress are likely to be involved in reciprocal influences with child temperamental characteristics that together, and separately, contribute to differences between children (Dibble, & Cohen, 1974; Sameroff, 2010).

The unexpected and often traumatic experience of parenting an ELBW survivor may result in these children being cosseted by family members, who restrict their participation in early self-care and interactions with others (Kalmár, 1996; Stevenson Barratt, Roach, & Leavitt, 1996). Parents of children born with ELBW also experience greater stress than parents of full term children (Sutcliffe, & Derom, 2006), often extending well beyond the period of birth and initial hospitalization, and having long term effects on parent/child interactions (Jepsen, 2007). Differences in the interaction styles of parents with their children born with ELBW may include extended guidance and increased supervision, as well as greater sensitivity to the effects of emotional and sensory overload (Jepsen, 2007). In other cases, parents may become disconnected and less directive, and focus on allowing the child to determine how interactions occur (Stevenson Barratt et al., 1996).

Specific patterns of parental behaviour towards their child born with ELBW may persist into middle childhood, having long-term effects on the development of self-regulatory capacities, the parent-child relationship, and how the child relates to others (Kalmár, 1996; Kochanska, 2001). If parents provide insufficient opportunities, and show a lack of support for the emergence of self-control in young children, frustration may lead to problem behaviours (Bagnato, 2007). Similarly, highly directive parenting strategies have been linked to limitations in the development of effortful control (Aksan, & Kochanska, 2004) and poorer independent goal-directed abilities (Davis et al., 2004) in children.

Baumrind's (1971) typology of parental authority described three distinct parenting styles: authoritarian (detached and controlling); authoritative (high control balanced with encouragement of autonomy); and permissive (non-demanding and warm). Baumrind found authoritative parents, who provided an enriched environment and encouraged their children to set and achieve goals, were more likely to promote independence and self-reliance in their children. Assertive and self-confident parents also provide a positive role model for successful self-regulation, and may support their child's autonomy with warmth and responsiveness to further promote self-reliant behaviour (Baumrind, 1971). Although Baumrind's findings must be interpreted cautiously in relation to the different social constraints and expectancies of the era (especially for girls), more recent research largely supports associations between imposed parental directives without unnecessary limitations on the child's actions, and self-regulatory success in children (Bronson, 2000; Davis et al., 2004).

According to the transactional model of child development (Sameroff & Fiese, 2000), parental interactions contribute to the environmental and life experiences that act together with the child's individual genetic heritage to influence developmental processes such as self-regulatory functioning. According to this model, the caregiver becomes aware of, and responds to, signals from the infant, assisting the child by helping to manage his or her arousal state. Subsequent communications from the infant then serve to strengthen the quality of the parent-child relationship, and help promote later efforts at self-regulation. In order for these patterns of positive communication to lead to successful regulation of affect, the caregiver must be receptive to the infant's cues, appropriately responsive, and motivated to foster further opportunities for interactions.

These factors are often disrupted in babies born extremely prematurely due to long-term stays in hospital, physical isolation associated with medical interventions, and the more subtle communication styles of premature infants (Kielty & Freund, 2005) and the concomitant impact on parents. Kielty and Freund (2005) investigated caregiver-child interactions for babies born with ELBW in comparison with full-term babies across three age groups; 9-13 months, 21-25 months, and 33-36 months (corrected ages). The frequency of caregiver interactions was significantly lower for ELBW dyads across all age groups. As maternal responsiveness to their child's signals influences later development, this pattern of lower maternal responsiveness with babies born with ELBW suggests poorer outcomes for self-regulatory capacities.

Depression occurs quite commonly in mothers of children with ELBW, particularly in the first year of the child's life (see Miles, Holditch-Davis, Schwartz & Scher, 2007), and is associated with lower maternal responsiveness, thus increasing the likelihood of emotional dysregulation in the child regardless of whether the depression remits or not (Maughan, Cicchetti, Toth, & Rogosch, 2007).

Landry, Smith, and Swank (2006) identified four aspects of responsive parenting that successfully facilitated the development for later self-regulatory capacities. These consist of "contingent responsiveness, emotional-affective support, support for infant foci of attention, and language input that supports developmental needs" (Landry et al., 2006, p.627). Both contingent responsiveness and emotional-affective support provide modelling of socialization practices, and allow the parent to support the management of arousal states in the infant. Supporting the infant's foci of attention assists with promoting later concentration and cognitive abilities; and providing focused language input facilitates early communication and social skills, and assists the child with following parental directions.

Landry et al. (2006) designed a parenting intervention study to examine the effects of increasing maternal responsiveness across groups of children born at full-term and children born with VLBW, aged between six and ten months. Infant competence and cooperation improved as maternal responsiveness increased, with infants born with VLBW showing greater improvements overall and presenting more frequently with positive affect than before the intervention. Responsive parenting progresses from attending to infant cues and providing appropriate models of managing arousal and behaviour to expecting toddlers to show some self-control of behaviour in response to adult demands (Sroufe, 1996). For children born with ELBW, responsive parenting may play an important role in the facilitation of broader self-regulatory capacities.

In summary, growing numbers of children born with ELBW are surviving, yet even those children with intellectual abilities within the average range experience difficulties that persist beyond infancy to interfere with learning at school. Deficits in self-regulation have been noted in children born with ELBW; and in other populations, these deficits have been linked to later problems at school, and behavioural problems, and as contributing factors to childhood disorders such as ADHD and ODD. To date, these difficulties have mostly been examined as EF deficits; however, they may be better understood as problems with self-regulation, a multi-dimensional construct incorporating motivational, cognitive, behavioural and affective functions, and several EF processes including attention, planning, and organization. Self-regulation is supported by language abilities such as private speech, and is influenced by individual temperament and environmental experiences such as parenting style, support for autonomy, and parenting stress.

The successful development of regulatory strategies for behaviour, emotion, and attention enables children to follow teachers' instructions, manage social interactions, and focus on information being taught in class. Without the acquisition of self-regulatory capacities, these children may become disruptive in class, socially excluded, and experience limited academic achievement. As a foundation

for both physiological and behavioural competence, self-regulation is an important capacity relevant to successful early learning. Investigating self-regulation in conjunction with associated EF may not only provide a richer understanding of the later school difficulties faced by children with ELBW, but may allow the implementation of effective interventions to assist the educational outcomes of these children. Further research is needed to identify the influence of both individual and environmental factors on self-regulation, and to examine any differences in self-regulation between children born with ELBW and children born at full term. For example, comparison studies of self-regulatory abilities in children born with ELBW and children born at full term in the important stages of development prior to beginning formal education may provide critical information that may inform effective intervention to alleviate later learning difficulties. Improving our understanding of how to facilitate the successful development of self-regulation in young children, particularly those born very prematurely and/or of ELBW, is a crucial task for further inquiry in order to design interventions to achieve successful learning outcomes for these children.

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