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Is sensory processing an issue for infants with colic?

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ABSTRACT

Objectives: To determine the association between sensory functioning, sleep, cry/fuss, and feeding behaviors of infants with colic younger than 4 months of age.

Methods: Dunn's Infant/Toddler Sensory Profile™ and a modified Barr Baby Day Diary® were used to assess 44 breastfed infants with colic under four months of age. Colic was defined according to Wessel's criteria.

Results: Thirty-four of the 44 infants with colic (77%) scored as atypical for sensory processing. Of these, 56% scored atypical for sensory processing on quadrant one (Q1) (Low Registration), with 24%, 65%, and 18% scoring as atypical for sensory processing on Q2 (Sensory seeking), Q3 (Sensory sensitivity), and Q4 (Sensation avoiding), respectively. All infants demonstrating sensation avoiding also scored as Low Threshold. A moderate statistically significant correlation was found between sensation seeking and time spent sleeping ($r = 0.31$; $p = 0.04$). No other statistically significant associations between infant behaviors and their sensory functioning were demonstrated. Overall, infants demonstrating atypical sensory responses (in any quadrant) slept significantly more than infants demonstrating typical sensory responses (mean difference = -67.8 min/day; 95% CI = -133.6 to -2.1 ; $p = 0.04$).

Conclusion: Very limited associations between infant behaviors and sensory functioning were demonstrated, suggesting that sensory functioning may not be a significant factor in the multifactorial nature of infant colic. Further well-designed studies using validated tools for infants with colic are required to determine whether associations between infant behaviors and sensory functioning exist.

1. Introduction

The neuroscience of sensory processing theory and the investigation of the effects of regulatory disorders in early infancy is a relatively new field of endeavour with early research dating back to the beginning of the 1990's. The notion of self-regulation is central to our understanding of infant behaviour and sensory processing. Self-regulation refers to the infant's capacity to organise a response to sensory input from their environment (Gomez, Baird, & Jung, 2004). Behaviors relating to regulation include: mood regulation; state control; and self-calming (DeGangi, DiPietro, Greenspan, & Porges, 1991; Degangi, Porges, Sickel, & Greenspan, 1993). Excessive crying and/or disturbances in feeding and sleeping, can indicate regulatory dysfunction (DeGangi et al., 1991; Hemmi, Wolke, & Schneider, 2011; Maldonado-Duran and Saucedo-Garcia, 1996). Infants and children exhibiting extreme crying/fussing, sleep or feeding behaviors have been characterised as having a difficult temperament (Cutrona and Troutman, 1986).

With respect to crying, a daily varied amount is considered normal or typical, with the duration increasing and peaking at

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approximately six weeks of age in typically developing infants (Hunziker and Barr, 1986; Barr et al., 1989; St James-Roberts, Conroy, & Wilsher, 1995). However, approximately 20% of infants worldwide experience 'colic' or excessive crying (Vandenplas et al., 2015). Since 1954 colic has been defined as 'crying for more than three hours per day, for more than three days per week, for a period of three weeks or longer in otherwise healthy infants'; known as Wessel's 'rule of threes' (Wessel, Cobb, Jackson, Harris, & Detwiler, 1954). Infant colic can be very distressing to both parent and infant, it is among the most common disorders in early infancy (Heine, 2008) and results in high utilisation of health services (Morris, St James-Roberts, Sleep, & Gillham, 2001; McCallum et al., 2011). Whilst seemingly self-limiting, the well documented negative impact on family relationships (Papousek and von Hofacker, 1998; Reijneveld et al., 2004; Barr, 2012) should not be underestimated. More importantly, infant colic contributes to parent's low self-efficacy, increases risk for postnatal depression (Papousek and von Hofacker, 1998) and has been identified as a cause of child abuse including the head trauma associated with shaken baby syndrome (Reijneveld, van der Wal, Brugman, Hira Sing, & Verloove-Vanhorick, 2004; Barr, 2012).

The importance of understanding 'typical' behaviors within the context of sensory functioning cannot be understated. Dunn's theory of sensory processing describes sensory capacities as a continuum, akin to a normal distribution curve. Infants demonstrating typical sensory responses are in the majority and are represented in the middle of the continuum, while hypersensitive and hyposensitive infants are at either end of the distribution (Dodrill, 2015). Hypersensitive infants may exhibit an exaggerated response to stimuli due to their reduced threshold to sensory input, whereas, hyposensitive infants may exhibit a reduced response to stimuli due to their increased threshold for sensory input (Dodrill, 2015).

Infants who cry excessively have been found to demonstrate low neurological thresholds (Stein, 1996; McGeorge et al., 2015; DeSantis, Coster, Bigsby, & Lester, 2004), where they may react easily to low levels of stimuli, i.e. they are hypersensitive. A low neurological threshold is associated with difficulties of self-regulation (McGeorge et al., 2015; DeSantis et al., 2004), where disorganised responses to sensory input manifest as crying, fussing and difficulty settling. This impacts on the infant's capacity to respond to sensory stimuli (Dunn, 2007), for example, an infant with a low neurological threshold may become easily overstimulated in the home environment and respond frequently to incoming stimuli such as cars driving past, a dog barking, or the radio playing in the background. In addition, previous studies have found that infants experiencing excessive crying had poor or fragmented sleep patterns (Rautava, Heleneius, & Lehtonen, 1993). Such infants, for example, may have difficulty falling and staying asleep, and these dysregulated sleep behaviors may persist into early childhood (Rautava et al., 1993).

Evidence is emerging about the long-term negative sequelae of infant colic. Children at age 3–8 years who experienced colic in infancy were found to have poorer coping skills and were more likely to have attention deficit hyperactivity disorders compared with children of the same age who did not have colic as infants (DeSantis et al., 2004). Additionally, there is a multitude of evidence to suggest that excessive crying in infancy has long-term problematic consequences for emotional regulation and behavior in early to middle childhood (Hemmi et al., 2011; DeSantis et al., 2004; Degangi et al., 1993; Canivet, Jakobsson, & Hagander, 2000; Neu and Keefe, 2003; Schmid et al., 2010; Canals, Hernandez-Martinez, & Fernandez-Ballart, 2011; Kim, 2011; Korja et al., 2014; Hyde, O'Callaghan, Bor, Williams, & Najman, 2012; Dale et al., 2011), for cognitive functioning in early childhood (Wolke, Schmid, Schreier, & Meyer, 2009; Rao, Brenner, Schisterman, Vik, & Mills, 2004), and is linked to eating problems in early childhood (Schmid, Schreier, Meyer, & Wolke, 2010).

The aim of this paper is to examine the relationships between sensory functioning in a cohort of infants with colic younger than four months of age and three key behaviors: time spent crying/fussing; time spent sleeping; and time spent feeding.

2. Methods

This study was carried out in Brisbane, Sydney and the Canberra/Southern NSW region, Australia, between July 2012 and December 2015. The data presented here represents cross-sectional baseline data from a larger study, the Colic, Irritability, Reflux, Intolerance and Allergy Study (CIRIAS), describing the sensory characteristics of 44 fully breastfed infants with colic. Infants were eligible to participate if they were fully breastfed, younger than 4 months of age, fulfilled the Wessel's colic criteria, that is, crying for more than three hours per day, for three days per week or more, and for more than three weeks, as assessed with a modified Ames Cry Score (Ames and Bradley, 1983; Elliott, Pedersen, & Morgan, 1997), and were medically certified as having no obvious pathology as the cause of their excessive crying.

2.1. Demography

Key demographic and social characteristics for each family were collected via an online survey developed for the CIRIAS project, including age; gender; birth order; mode of delivery; family medical history of atopy; allergy; autoimmune disease; and food intolerance.

2.2. Crying, sleeping and feeding behaviors

A modified Ames Cry Score (Ames and Bradley, 1983; Elliott et al., 1997) was used to assess study eligibility. The Ames Cry Score, a subjective measure, consists of three questions about duration and intensity of crying episodes, and was modified by the addition of a question about the number of weeks the crying had persisted for, which reflected Wessel's criteria.

Prospective crying, fussing, feeding and sleeping behaviors were assessed through a modified version of the Barr Baby Day Diary[®] (Barr, Kramer, Boisjoly, McVey-White, & Pless, 1988; Barr et al., 1989; Hunziker and Barr, 1986); a validated method of capturing

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