Associations between attachment and pain: From infant to adolescent

Alessandro Failo, Michele Giannotti and Paola Venuti

Abstract
Pain experience is a negative complex phenomenon influenced by several mechanisms. Attachment processes may affect the way in which individuals experience and signal pain. Hence, in the last two decades, the role of attachment quality has drawn attention in pain research and practice. However, previous reviews on this topic focused on adulthood and/or specific types or pain. We conducted a narrative review examining the association between attachment and different pain conditions from infancy to adolescence. Two independent researchers searched scientific databases for relevant papers. A total of 17 articles were included. Results highlight the following: (a) children and adolescents with chronic idiopathic pain showed low rates of attachment security compared to control groups; (b) pain conditions are consistently associated with elevated rates of at-risk pattern of attachment and information processing; and (c) the presence of unresolved trauma or loss is higher in children and adolescent who experienced pain compared to healthy controls. Despite the significance of these empirical evidences, the impact of caregiving environment and interpersonal context on pain experience in infancy and preschool age is poorly investigated compared to adulthood. Research on pain and attachment needs to be extended since the majority of the studies are limited to specific pain conditions. Future research should investigate the role of anxious attachment on procedural pain and transition from acute to chronic pain, testing new conceptual models. These findings shed light on the importance of relational factors and psychosocial vulnerabilities in pain clinical practice. An attachment-informed approach to pain will help health professionals to offer adequate support during procedures and to increase effectiveness of interventions. A developmental perspective is needed to integrate familial and relational contribution into a multimodal assessment and treatment of pain. Longitudinal studies are recommended.

Keywords
Acute pain, anesthesia/pain, attachment, chronic pain, infants, children, adolescents

Date received: 28 January 2019; accepted: 23 August 2019

Background
Due to its clinical significance, the study of pain intensity has dominated pain research and practice, although it constitutes only a partial aspect of this multidimensional phenomenon. In fact, pain is a complex negative experience which is influenced by several dynamic factors related to the child’s developmental context, including family, community, and culture. Children and adolescents experience pain from a number of different sources and reasons. Therefore, it is essential to make proper use of specific definitions in order to recognize and address different types of pain. In this regard, Varni et al. proposed a useful four-category classification: (a) pain associated with medical and dental procedures (e.g. lumbar punctures, bone marrow aspirations, surgery, injections, and extractions); (b) pain related to observable physical injuries or traumas (e.g. burns, lacerations, and fractures); (c) pain associated with chronic diseases (e.g. arthritis, sickle cell disease, and cancer); and (d) pain not associated with a well-defined or specific chronic disease as well as an identifiable physical injury (e.g. migraine and tension headaches, and recurrent abdominal pain syndrome).

Among the different types of pain, acute pain is one of the most common adverse stimuli experienced by children and it is often associated with increased anxiety, avoidance,
somatic symptoms, and parental distress. Acute pain experiences usually subside with physical recovery and may also lead to a chronic pain condition. By comparing data across studies, pain is defined as recurrent when frequency varies considerably from about once a month up to at least once a week. Whereas, although no consensus exists on its definition, chronic pain is typically described as a condition persisting longer than 3 months or beyond the expected healing time. Chronic pain in children has a significant impact on several domains of life and it can occur continuously on a recurrent basis. Moreover, idiopathic chronic pain (without apparent organic causes) is more frequent in adolescence compared to earlier stage of development. Given that previous reviews have exclusively focused on adulthood and/or chronic pain, in this article, we will include different types of pain. With the aim of covering a broader spectrum of pain conditions, it is well known that the main distinction between acute and chronic is common to compare the studies and communicate the results easier.

Attachment behaviors and representations

Attachment is a relevant construct in developmental psychology, offering a robust conceptual and methodological framework to the study of human interpersonal relationship across the lifespan. It is defined as the innate predisposition to form an enduring, selective, and affectionate bond with a primary caregiver who is asked to recognize, interpret, and respond to child’s signals. Parental sensitivity and responsiveness, along with other caregiving dimensions, play a fundamental role in determining the quality of parent–child attachment. Concurrently, children’s attachment behaviors shape parental responses, including pain signaling, enabling caregiver to offer protection and comfort. This complex bidirection contributes to the organization of individual self-protective strategies and the formation of attachment mental representations. Specifically, representational models of self and others have a crucial impact on human expectations and guide protective behaviors, particularly in dangerous and threatening circumstances as well as in the interpersonal context. Experimental research on pattern of attachment has found a significant link between attachment security and positive developmental trajectory. By contrast, empirical data also support the significant association between attachment insecurity and the increased risk for psychopathology in childhood and adolescence. Nevertheless, it is widely acknowledged that attachment insecurity does not constitute an equivalent of disorder or maladaptation.

Ainsworth’s ABC attachment classification distinguishes three specific categories: Type A (insecure avoidant), Type B (secure), and Type C (insecure ambivalent/resistant). By extending the pioneering work of Mary Ainsworth, several authors offer new conceptual and methodological framework. Other authors, using self-reported attachment measurement, emphasized the association between attachment insecurity and emotion regulation linking avoidance with deactivation and anxiety with hyperactivation pattern. In addition, Maunder and Hunter confirmed the negative contribution of insecure pattern of attachment on stress and health outcomes.

Aims

According to a developmental perspective, regardless of the approach, heterogeneous age-appropriate methods for the assessment of individual differences in quality of attachment have been used in pain research. In the last decades, there is a growing interest in studying the potential link between pain subjective experiences and attachment behaviors and representations. Following this direction attachment theory could provide a meaningful framework to shed light on child’s needs of protection and comfort in the context of pain. These data supported the hypothesis that quality of attachment relationship may affect the way in which individual protect themselves in the case of acute (invasive medical procedure and treatment) and chronic pain, as well as the management and recurrence of pain.

However, to date, the key findings on this topic have only been reviewed considering chronic pain in children, adolescent, and adult samples. Thus, a comprehensive review covering different types of pain (e.g. acute, recurrent, and chronic) through a developmental perspective (from infancy to adolescent) could provide a more extensive picture of this complex phenomenon, adding relevant information to the field. A comprehensive approach may help to clarify the contribution of attachment to the experience of acute and recurrent pain across different developmental stages. In addition, extending the focus to different types of pain starting from early infancy might generate new insights among researchers and health professionals, enriching the scientific debate. Keeping in mind the theoretical and methodological divergences, we will discuss findings from different approaches including data collected using disparate methods (e.g. self-reported and interview).

Thus, the main aims of this article are (a) to provide a brief overview on the association between attachment organization and different pain experience from infancy to adolescence using a developmental lens and (b) to determine potential critical issues or unaddressed areas of investigation in the field of attachment and pain.

Method

Due to the broad scope of this review, formal meta-analytic and systematic methods were precluded. Instead, this article is a qualitative synthesized information from the existing good-quality systematic reviews, when available, and other relevant sources of data (randomized clinical trial (RCT) or observational studies). Thus, our main aim is to summarize
Infants usually organize inhibitory strategy when caregivers predictably do not respond to their emotional distress or show incongruent and aversive responses. Thus, when parents positively reinforce inhibition, infant downregulate his or her own arousal minimizing the display of negative affect. By contrast, infants who develop excitatory strategy exaggerate and alternate the display of negative affect to increase parental predictability. In these cases, caregivers intermittently respond to infant negative states, showing ambivalent responses which do not permit the child to clearly predict parental behaviors. Although attachment quality is not completely defined during the first year of life, it is important to consider dyadic pattern of interaction observing bodily contact, emotional synchrony, and the use of temporal contingencies in response to pain expression. Therefore, it could be useful for professional in the context of pain to obtain information concerning parental attachment (for a review of valid self-report measures, see Ravitz et al.) and emotional states with reference to child’s pain. As Page and Blanchette have found in their review, the impact of parent’s anxiety on child distress is highlighted by a large number of studies. A longitudinal investigation confirms the predictive effect of caregiver sensitivity in infancy on infant pain responses in the context of immunization.

Together with an accurate assessment of pain (for a review, see Ruskin et al.), observational method could orient professionals, providing new insight about the contribution of interpersonal interactions on infant’s pain experience and communication. Therefore, observational procedures for the coding of adult–child interaction in infancy are strongly recommended, such as the Infant CARE-Index (ICI).

Type A toddler (avoidant) may also use a more complex strategy in case of severe danger, adopting compliance or caregiving (role inversion) to please their parents. As suggested by Kozlowska, these children “silence the body,” showing a restricted non-verbal and verbal communication of pain at interpersonal level. Looking the developmental pathways of these children, it is essential to consider the risks connected to the long-term affective inhibition. Another risk for Type A children (avoidant) is the possibility to express emotional distress through the body since the display of physical pain could be more tolerated and better understood by the caregiver. Importantly, professionals often underestimate the risks associated to this type of functioning due to child’s compliance, protest and fear minimization, vigilance, and preparation to follow adults’ directions.

Whereas, in cases of higher dangers, Type C (ambivalent) could show a more intense display of anger, fear, and/or desire of comfort. As in the case of Type A (avoidant), this process leads to restrained ability to properly recognize and communicate discomfort interpersonally. Despite young children slowly acquire the ability to understand painful experiences, the high occurrence of painful episodes could increase learning opportunities. Nevertheless, the alteration of regulatory system related to anxious attachment (both Types A and C)
### Table 1. Study design, characteristics, and outcomes of the 17 studies included in the review.

| Author          | Purpose/aims                                                                 | Sample characteristics                                                                 | Research design                                                                 | Key findings                                                                                                                                                                                                 |
|-----------------|-----------------------------------------------------------------------------|----------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Horton et al.   | To examine the relationship between attachment and temperament on pain-related distress during infants' 12-month immunization appointments. | N = 130 (aged 12.06–20.70 months, M = 13.74, SD = 1.34), 58 F and their mother (M = 34.70 years, SD = 5.05). | Observational: caregiver and infant behaviors were videotaped for up to 3-min pre-needle, during procedure, and up to 5-min post-needle. Modified Behavioral Pain Scale (MBPS), Strange Situation Procedure (SSP), The Infant Behavior Questionnaire-Revised (IBQ-R). | Avoidant infants exhibited significantly less baseline distress than secure infants, probably because they may have minimized distress signals pre-needle, in keeping with an avoidant strategy. High temperamental fear predicted slower regulation for avoidant infants and faster regulation for secure infants. Results support that the attachment system appears to be triggered following a painful stimulus and secure infants actively use their caregivers to help them to regulate distress by initiating close physical contact with them. None of the pre-needle behaviors predicted attachment. Proximity-seeking post-needle significantly discriminated attachment categorizations. The interaction of disorganized attachment and fearful temperament was significantly associated with distress; fear predicted an increase in distress only in infants with a disorganized attachment classification. The main effects of attachment insecurity and temperament were not associated with increased infant distress. |
| Horton et al.   | To determine whether specific infant behaviors, particularly proximity- and contact-seeking behavior, exhibited during immunization predict attachment. | N = 130 (M = 13.74 months, SD = 1.34), 58 F and their mother (M = 34.70 years, SD = 5.05). Same sample of the precedent study. | Observational: both pre- and post-needle. Four scales of the Scoring System for Interactive Behaviors (SSIB by Ainsworth) during the SSP. |  |
| Wolff et al.    | To examine the effects of attachment and temperament on infant distress during venipuncture (blood sample). | N = 246 (aged 13.1–17.5 months, M = 14.5, SD = 0.8), 49.2% F and their caregiver. | Observational: 1 h before, during, and after venipuncture. SSP was videotaped; Infant Behavior Questionnaire (IBQ-R); Generation R Infant Distress Scale. Caregiver: General Functioning of the Family Assessment Device, Global Severity Index of the Brief Symptom Inventory. | The interaction of disorganized attachment and fearful temperament was significantly associated with distress; fear predicted an increase in distress only in infants with a disorganized attachment classification. The main effects of attachment insecurity and temperament were not associated with increased infant distress. |
| Pritchett et al.| To explore observational correlates of attachment patterns during immunization. | N = 19 parent–child pairs (probably aged 3–8 years, no other data available). | Observational: both pre- and post-needle. Manchester Child Attachment Story Task (MCAST), Mellow Parenting Observational System (MPOS). Each immunization video was coded for the presence and/or absence of both pain-reducing and pain-promoting behaviors. | Parents of securely attached children engaged in pain-reducing behaviors significantly more often than parents of insecurely attached children. |
| Walsh et al.    | To examine the relationship between attachment dimensions and child pain behaviors following both an everyday pain incident (e.g. bumps and scrapes) and acute pain incident (e.g. immunization) | N = 66 (M = 5.07 years, SD = 0.35), 30 F and their mother. | Observational. Separation Anxiety Test (SAT), Pain and Relationship Task (PART), Parent/Child Reunion Inventory (PCRI), Emotion Regulation Checklist (ERC), Children's Facial Coding Scale (CFS), Faces Pain Scale (FPS). | Secure base phenomena extend to pain situations. The ambivalence and controlling attachment dimensions were differentially related to child pain behavior. |
| Barone et al.   | To evaluate the extent to which behavioral problems in children with headache were associated with maternal stress and how the child's perception of security moderates this association. | N = 71 (aged 7–12 years, M = 9.8, SD = 1.3), 38 F and their mother vs N = 71 (control) and their mother. | Observational: clinical group vs healthy controls. Child Behavior Checklist (CBCL), Parenting Stress Index (PSI), Security Scale. | In children with headache, the perception of attachment security decreased the strength of the association between maternal stress and externalizing behavioral problems. |
| Author                        | Purpose/aims                                                                                              | Sample characteristics | Research design                                                                                           | Key findings                                                                                                                                                                                                 |
|------------------------------|-----------------------------------------------------------------------------------------------------------|------------------------|-----------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Williams et al.              | (a) To compare children and adolescents with migraine without aura and healthy control group on perceived attachment security and anxiety and (b) to test whether child’s perceived security of attachment to mother and father mediated the association between migraine and anxiety. | N = 100 (M = 10.64 years, SD = 2.85), 52 F vs N = 100 (control). | Observational: case-control study. Psychiatric Scales for Children and Adolescents-anxiety (SAFA-A), Security Scale. | Attachment mediates the association between pediatric headache disorders and anxiety. This model also suggested that there are differences between the roles played by perceived maternal and paternal attachment security. |
| Tarantino et al.             | To investigate the role of attachment style on headache severity and psychological symptoms in children/adolescent migraineurs and association between attachment style, migraine severity, and psychological symptoms. | N = 90 (aged 8–18 years, M = 12.2, SD = 2.6), 54 F | Observational. SAT + SAFA | Ambivalent attachment style may be a common vulnerability factor that impacts pain severity, anxiety, depression, and somatization symptoms in young migraineurs. |
| Tarantino et al.             | To explore the role of maternal attachment style and alexithymia on (a) child’s headache severity (intensity and frequency) and (b) child’s attachment style and psychological profile (anxiety, depression, and somatization). | N = 84 (aged 8–18 years, M = 11.8, SD = 2.4), 45 F and their mother. | Observational. SAT, SAFA battery, maternal alexithymia (TAS-20), Attachment Style Questionnaire (ASQ). | No relationship was found between maternal alexithymia levels, attachment style, and children’s migraine features (severity and frequency). Maternal alexithymia shows a relationship with child insecure attachment style, while attachment does not. There are significant correlations between maternal alexithymia and anxiety symptoms. |
| Esposito et al.              | (a) To assess the prevalent attachment style in school-aged children affected by migraine without aura and (b) to test its putative relationship and correlation with the main characteristics of migraine attacks. | N = 219 (aged 6–11 years, M = 8.96, SD = 2.14), 116 F vs N = 381 healthy controls. | Observational: clinical group vs healthy controls. SAT, Visual Analogue Scale for pain (VAS), daily headache diaries. | Higher prevalence among MoA children of the avoidant attachment style (Type A) and significantly lower rates of secure attachment style (Type B) compared with the control group. |
| Bolat et al.                 | To investigate the relationships among psychological problems, attachment characteristics, and the unexplained chest pain (UCP) in a group of adolescents. | N = 73 (aged 12–18 years, M = 14.15, SD = 1.8), 49 F and their mother vs N = 71 healthy group. | Observational: clinical group vs healthy controls. Adolescents: Inventory of Parent and Peer Attachment (IPPA), Strengths and Difficulties Questionnaire (SDQ), Parents: SDQ-Parental. | No significant association between total attachment levels and UCP was found. Adolescents with UCP have high levels of emotional and behavioral problems. |
| Kozlowska and Williams       | To test the proposition that conversion reactions are the motor-sensory components of two distinct human emotional (one inhibitory, one excitatory) responses to threat in a sample of children experiencing different somatoform pain disorder. | N = 28 (aged 3.75–17.66 years, M = 10.6 years), 17 F | Observational. Age-appropriate assessment of attachment, (PAA, SAA, AAI) including observational procedure, semi-projective interview, and semi-structured interview. | Type A and Type C self-protective were associated to overwhelming threat. The behavioral and somatosensory components of these emotional responses can be activated automatically, and individuals can present with unwanted and medically unexplained pain or neurological symptoms. |
### Table 1. (Continued)

| Author | Purpose/aims | Sample characteristics | Research design | Key findings |
|--------|--------------|------------------------|-----------------|--------------|
| Kozlowska et al.46 | To examine patterns of emotion processing in children and adolescents with high rate of comorbidity between conversion symptoms and pain and to determine whether those patterns are related to their specific sensorimotor (conversion) symptoms. | N = 76 (aged 6–18 years, M = 12.83, SD = 2.6), 53 F vs N = 76 control. | Observational: clinical group vs healthy controls. School-aged Assessment of Attachment (SAA). Transition to Adulthood Attachment Interview (TAAI). | Unlike controls, who were able to balance temporal and affective information, children with conversion disorders (medically unexplained pain, depression, anxiety, mixed anxiety and depression, and dissociative symptoms) used one of the two strategies: (a) extreme psychological inhibition or (b) psychological coercion preoccupation. |
| Kozlowska and Khan47 | To describe an individual intervention—one component of a multimodal treatment program—whose aim is to help children find skills to manage their chronic, medically unexplained pain. | N = 17 (aged 6–15 years), 9 F. | Single case series. Individual intervention, including examples of specific techniques. | Two key factors were identified that contribute to the subjective pain experienced: the presence of other negative body states that are subsumed under the label of pain and a clinical history of cumulative family stress. |
| Tremblay and Sullivan48 | To examine the relations between attachment styles and pain severity/depression in adolescents with different subtypes of pain (severity and frequency). | N = 382 (aged 12–17 years, M = 14.43, SD = 1.34), 223 F. | Observational. Pain Catastrophizing Scale for Adolescents (PCS-Ado), STAI, CDI, Pain Experience Interview (PEI). | Anxiety and the helplessness dimension of pain catastrophizing mediated the relations between secure, preoccupied, and fearful attachment styles and pain severity. Moreover, anxiety and the rumination dimension of pain catastrophizing mediated the relation between secure, preoccupied, and fearful attachment styles and depression. |
| Ratnamohan and Kozlowska49 | To explore patterns of attachment in children and adolescents with chronic functional pain. (a) To compare attachment type between children and adolescents with migraine without aura (MoA) and healthy controls and (b) to assess whether attachment system or the exposure to trauma affect significantly the clinical manifestations of migraine. | N = 48 (aged 9–17 years, M = 13.43, SD = 2.08), 32 F + N = 48 (control). N = 101 (aged 8–15 years, M = 10.84, 55.4% F vs N = 101 healthy controls. | Observational: clinical group vs healthy controls. Structured attachment interviews. Patterns of attachment were identified using the DMM. Observational: clinical group + healthy controls. Headache Questionnaire, Children's Impact of Event Scale, SAT. | Children and adolescents with chronic functional pain were classified into at-risk patterns of attachment and had higher rates of unresolved loss and trauma. Correlation between migraine, insecure attachment, and exposure to the trauma was found. Insecure attachment would amplify both the perception of the traumatic event experienced throughout life and the evolution of migraine. |
undermines this potential learning process. This mechanism decreases the opportunity to receive a sensitive response from the caregiver (explanations and labeling) by which children recognize and describe their own pain experience.\textsuperscript{13,62}

Furthermore, children’s beliefs about self-efficacy and control over pain may partially determine their coping efforts and long-term adjustment,\textsuperscript{63} which can be adversely affect by high risk attachment strategies. In fact, poor emotional awareness in early childhood might increase the likelihood of using more maladaptive coping\textsuperscript{64} and unbalanced physiological regulation.\textsuperscript{30,65}

In the field of acute pain in pediatric population, much attention has been paid to procedural pain. From early infancy, needle-related procedures (e.g. heel prick, vaccine injections, venipunctures, and venous cannulation) are a common source of pain and distress.\textsuperscript{66,67} Diagnostic and monitoring procedures are the most feared and painful events in this developmental stage.\textsuperscript{68} Horton et al.\textsuperscript{34} studied susceptibility to acute pain using the Strange Situation Procedure (SSP) showing that avoidant infants exhibit lower distress than secure infants before routine immunization, with temporal fear moderating this association. The same research group also highlighted positive correlation between proximity-seeking behaviors post-needle and in the context of SSP in children with secure attachment. By contrast, negative associations were found in case of avoidant and disorganized attached infants.\textsuperscript{15} Consistently, higher venipuncture distress was also found in disorganized children in a population-based study using the SSP.\textsuperscript{36} Moreover, despite results on the impact of parental presence during child’s procedure are mixed, a recent study focused on toddlerhood\textsuperscript{67} revealed that pain-reducing behaviors are more common in parents of securely attached children, suggesting the potential role of attachment in clarifying caregiving contribution in the context of acute pain. In addition, there are other attachment-related factors that influence child’s pain response during pain procedures.\textsuperscript{69} For example, parent’s emotional availability,\textsuperscript{70} coping and assessment of children’s pain,\textsuperscript{63} as well as the ability to provide adequate explanations focused on both positive and negative aspects of the pain experience may help in diminishing children’s distress level.\textsuperscript{71-73} Moreover, the use of a limited language of Type A and inability to talk about feelings of Type C could mislead professionals representing a conspicuous challenge.

**Attachment and pain in school age and adolescence**

Although extra-familial contexts have a crucial impact from school age (e.g. peers and teachers), family still play a key part in the adolescent daily life, remaining a reference point for psychological comfort and identity formation. Several studies suggested that dysfunctional family relationships are associated with greater pain and disability.\textsuperscript{74,75} In particular, attachment insecurity represents a risk factor for several pain experiences in school age and adolescence, especially in conditions where emotional distress could trigger pain, such as headache, abdominal,\textsuperscript{48,76} and unexplained chest pain.\textsuperscript{44} A study on school-age children with headache pointed out that perception of attachment security moderates the association between maternal stress and externalizing behavioral problems.\textsuperscript{39} However, no differences in terms of attachment security rates were found between clinical and control groups. A possible explanation of this result is the limited significance of self-reported measure (SS; Security Scale)\textsuperscript{77} in measuring implicit mental representations related to child’s attachment experiences with the caregiver. Nevertheless, a recent study using the SS showed lower level of perceived attachment security in children and adolescent with migraine compared to the control group.\textsuperscript{40} In particular, a complex interaction within familial variables was found: (a) children anxiety was mediated by maternal attachment and (b) attachment insecurity with father adversely affected child’s perception of security with mothers. This result suggests the prominent impact of paternal role on family of adolescent with migraine, confirming the need to consider family system as a whole. An investigation of attachment quality in school-age children found high rates of Type A pattern using the Separation Anxiety Test (SAT),\textsuperscript{78,79} a semi-projective interview.\textsuperscript{43} Tarantino et al.\textsuperscript{41} also assessed the security of attachment using SAT in adolescent with migraine, revealing a strong association between anxious ambivalent attachment, severity of pain (frequency of attack), and several psychological symptoms, including somatization. In addition, the role of maternal alexithymia was investigated in a similar sample with mothers of ambivalent attached adolescent showing higher score compared to their avoidant counterpart.\textsuperscript{42}

Interestingly, Laird et al.\textsuperscript{30} also proved the negative predictive role of anxious attachment in children with functional abdominal pain. This study, based on the Attachment-Diathesis Model of Chronic Pain in adolescents and young adults,\textsuperscript{12} showed that insecure attachment was associated with poor physical and mental health through its effect on cognitive appraisals and coping strategies. Similarly, as confirmed by preliminary findings, discrepancies between physiological activation and reported reactivity to stressors are significantly associated with adverse health outcomes in school-age children and adolescents.\textsuperscript{81}

Moreover, Kozlowska and Williams\textsuperscript{85} found that 86% of children and adolescents with conversion and somatoform disorders, including functional pain syndromes, exhibit pattern of information processing related to inhibitory and/or excitatory self-protective strategies. Both anxious attachment developmental pathways (Types A and C) seem to contribute to adolescent and young adult conversion pathophysiology.\textsuperscript{46}

In this developmental stage, it is also useful to analyze the mechanisms through which the transition from acute to chronic may occur. Previous studies underline that parental pain management behaviors (e.g. protectiveness and solicitousness) and psychological responses (e.g. parental distress) significantly
interact with child/adolescent psychological responses such as catastrophizing, acceptance, anxiety sensitivity, and escape/avoidance behaviors.\cite{82,83} Empirical findings have also documented higher level of anger and dysfunctional problem solving in adolescents with insecure attachment characterized by deactivating/hyperactivating strategies.\cite{64} Hence, adolescents with chronic pain and insecure attachment showed dysfunctional coping, greater psychological symptoms, and pain severity.\cite{54,80}

In the field of pediatric chronic pain, professionals should put more emphasis on patient’s and parents’ experience-based perspective considering the dynamic interplay within the dyad.\cite{45} Indeed, relational factors may have negative consequences on children’s recurrent/chronic pain and disability.\cite{85} Despite research on school age and adolescent is still limited, adult literature has largely demonstrated the detrimental role of insecure attachment for the development of chronic pain condition.\cite{46} Kozlowska and Williams\cite{45} tested a conceptual model for the assessment and treatment of chronic pain focused on family system, providing encouraging data on management of pain in child and adolescent. Notably, the implementation of a multimodal and developmental intervention for medically unexplained chronic pain has shown positive outcomes not only in the family but also at school level.\cite{47}

Furthermore, studies focused on pain experience in children and adolescents underlined higher rates of unresolved trauma or loss in these clinical groups compared to the normative sample.\cite{55,46} In particular, the majority of the unresolved trauma was related to family environment (parental illness, separation, or conflict) rather than child’s direct experience.\cite{45} Familial aspects connected to traumatic experiences play a key role for child’s adjustment to chronic pain and symptoms maintenance.\cite{50,46} At interpersonal level, peer relationship can likewise represent a protective or risk factor for children who experienced acute or chronic pain. Retrospective studies showed that higher ratings of pain in adults are associated with a history of bullying during childhood,\cite{87-89} suggesting the potential traumatic impact of negative experiences with peer. Given the inability to elaborate information related to this specific event, these children have an increased risk to activate inappropriate protective responses and regulatory pattern. The study of chronic pain and post-traumatic stress disorder (PTSD) comorbidity in pediatric population is often undervalued and need to be addressed using a well-validated multimodal approach.\cite{50,91}

Importantly, unresolved traumas also encompass single or multiple experiences of unrelieved acute or chronic pain. Negative consequences of unresolved pain can be permanent and may have a strong impact on individual’s memories and information processing, especially in case of painful procedures or interventions. During medical procedures, individuals have often fewer available resources to accurately give meaning to their own experience and elaborate properly these adverse stimuli.\cite{92} Subjective memories of pain are multidimensional and include several aspects—somatosensory (e.g. pain intensity), affective (e.g. fear and unpleasantness), and contextual (e.g. people, time, and place)\cite{93} which are strongly associated with the quality of attachment representations. Indeed, previous studies have documented that memories of painful events in infancy and childhood are associated with long-term changes of pain perception and other related behaviors.\cite{72,94} Thus, early negative learning experiences related to pain procedures may lead to medical nonadherence and other psychiatric comorbidities. As Pao and Bosk\cite{95} highlighted, memories of painful procedures may generate (a) anticipatory fear and anxiety before subsequent procedures and (b) anxiety disorders such as specific fear of blood or needle phobia. Fear and/or anxiety are commonly focused on specific objects or experiences, and it may also be extended to the perceptions of self-worth and identity formation.\cite{96} For instance, especially for children who frequently undergo painful procedures such as bone marrow aspirations and lumbar punctures for the treatment of cancer or other serious immune deficiencies, the memory of a painful procedure may affect pain and psychological distress associated with future procedures.\cite{95} Moreover, parental state anxiety has been associated with higher levels of pain, anxiety, and distress in children undergoing anesthesia induction before surgery and also in later development.\cite{97} Therefore, to adequately process and organize these memories related to pain experience, it is essential to consider the effectiveness of management of pain as a top priority,\cite{72} taking into account possible disruption of nurturing attachment relationship (family and peers) and adverse childhood experiences.

**Discussion and conclusion**

Linking the contribution of attachment could represent an additional source of information to understand child’s history of development and psychophysiological functioning with reference to pain (e.g. emotion regulation and coping). With respect to our first aim, we found that from infancy, caregiving and relational environment may constitute a vulnerable or protective factors for children pain experience, adjustment, and maintenance. In general, children who experienced acute, recurrent, and chronic pain showed at-risk attachment pattern and information processing, lower level of security, and higher rates of unresolved traumatic events compared to healthy control group. Attachment system appears to be triggered by painful stimuli in toddlerhood (immunization or venipuncture), with literature suggesting a potential interaction between attachment and fearful temperament.\cite{38,46} When child age increases, the focus shifts dramatically on chronic pain, especially on primary headaches, whereas few studies on recurrent pain are available.\cite{38,48} Among the relevant factors that may contribute to the maintenance of the chronic pain condition, insecure attachment seems to play a prominent role, intensifying the pain experience or hindering effective rehabilitation.\cite{41} Importantly, trauma is a critical issue that should be better addressed by health professional in the field of acute and chronic pain. Hypo- or hyperactivation associated with at-risk attachment
and unresolved trauma may lead to maladaptive physiological, psychological, and behavioral responses in the context of acute, recurrent, and chronic pain.

According to our secondary aim, we identified specific area or research related to attachment and pain that needs to be extended. First, there are a limited number of studies on attachment and pain in infancy and early childhood compared to later developmental stage. Furthermore, studies in infancy are mainly focused on immunization pain or venipuncture. Second, literature linking attachment and functional pain conditions is scarce (e.g. abdominal and musculoskeletal pain) compared to other types of pain.

In summary, starting from infancy, distinguishing between inhibitory, excitatory pattern will help health professionals to offer adequate support during procedures and to increase effectiveness of interventions. Observational procedures from infant to preschool age and narrative from middle childhood to adolescence are suggested for an appropriate assessment of attachment, information processing, and unresolved loss or trauma. In addition, promoting education on pain conditions at school level may reduce bullying fostering supportive peer relationships.

Limitations and directions for future research

It is essential to also point out the limitations of this review. The qualitative approach of this article is limited and does not provide quantitative outcomes concerning the association between attachment and several pain conditions. Thus, this methodological approach does not permit a specific reproduction of data or answer to a quantitative research question.

Despite these limitations, there are sufficient empirical evidences on the association between attachment, trauma, and pain across development and it would be useful to reconsider the existing good practices for pain management, proposed by well-recognized expert practitioners (see Supplement Material).

Future research on pain in childhood should consider the role of parenting and attachment, testing their potential moderation or mediator on child’s outcomes. New conceptual model that considers the role of attachment organization on procedural pain and transition from acute to chronic pain should be proposed and tested. Moreover, due to the higher number of retrospective or cross-sectional studies, longitudinal investigations are needed. Finally, according to the studies included in this review, we recommend the implementation of a developmentally attachment-informed approach for the assessment and treatment of pain.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article:

Alessandro Failo was supported by a Postdoc Fellowship from the University of Trento by the main grant from Fondazione Trentina per la Ricerca sui Tumori (FTrT); Michele Giannotti was supported by a Doctoral Scholarship from the University of Trento.

ORCID iD

Alessandro Failo https://orcid.org/0000-0002-9316-0091

Supplemental material

Supplemental material for this article is available online.

References

1. Birnie KA, Chambers CT, Fernandez CV, et al. Hospitalized children continue to report undertreated and preventable pain. Pain Res Manag 2014; 19: 198–204.
2. Turner JA and Turk DC. The significance of clinical significance. Pain 2008; 137: 467–468.
3. Twycross A and Finley GA. Children’s and parents’ perceptions of postoperative pain management: a mixed methods study. J Clin Nurs 2013; 22: 3095–3108.
4. Varni JW, Blount RL, Waldron SA, et al. Management of pain and distress. In: Roberts MC (eds) Handbook of pediatric psychology. 2th ed. New York: Guilford Press, 1995, pp. 105–123.
5. Srouji R, Ratnapalan S and Schneeweiss S. Pain in children: assessment and nonpharmacological management. Int J Pediatr 2010; 11: 1–11.
6. Katz J, McCartney CJL and Rashiq S. Why does pain become chronic? In: Taenzer P, Rashiq S, Schopflocher D, et al. (eds) Health policy perspectives on chronic pain. Weinheim: Wiley-Blackwell, 2008, pp. 69–84.
7. Treede RD, Rief W, Barke A, et al. A classification of chronic pain for ICD-11. Pain 2015; 156:1003–1007.
8. von Baeyer CL. Understanding and managing children’s recurrent pain in primary care: a biopsychosocial perspective. Paediatr Child Health 2007; 12: 121–125.
9. Merskey H and Bogduk N. Classification of chronic pain. 2th ed. Seattle, WA: IASP Press, 1994.
10. Riddell R, Racine N, Craig K, et al. Psychological theories and biopsychosocial models in paediatric pain. In: Megraith PJ, Stevens BJ, Walker SM, et al. (eds) Oxford textbook of paediatric pain. Oxford: Oxford University Press, 2014, pp. 85–94.
11. Donnelly TJ and Jaaniste T. Attachment and chronic pain in children and adolescents. Children 2016; 3: 1–14.
12. Meredith P, Owensworth T and Strong J. A review of the evidence linking adult attachment theory and chronic pain: presenting a conceptual model. Clin Psych Rev 2008; 28: 407–429.
13. Bowlby J. Attachment and loss. Vol. 1: attachment. New York: Basic Books, 1982.
14. Bowlby J. Attachment and loss: retrospective and prospect. Am J Orthopsychiatry 1982; 52: 664–678.
15. Ainsworth MDS, Bell SM and Stayton DF. Infant-mother attachment and social development: socialization as a product of reciprocal responsiveness to signals. In: Richards MPM (ed.) The integration of a child into a social world. New York: Cambridge University Press, 1974, pp. 99–135.
16. De Wolff MS and Van IJzendoorn MH. Sensitivity and attachment: a meta-analysis on parental antecedents of infant attachment. Child Dev 1997; 68: 571–591.
17. Crittenden PM. Attachment theory, psychopathology and psychotherapy: the dynamic maturational approach. Psicoterapia 2005; 30: 171–182.

18. Kozlowska K. Attachment relationships shape pain-signaling behavior. J Pain 2009; 10: 1020–1028.

19. Bretherton I and Munholland KA. Internal working models in attachment relationships: elaborating a central construct in attachment theory. In: Cassidy J and Shaver PR (eds) Handbook of attachment: theory, research, and clinical applications. 2nd ed. New York: Guilford Press, 2008, pp. 102–127.

20. Crittenden PM. Raising parents: attachment, representation, and treatment. 2th ed. London: Routledge, 2015.

21. Fearon RP, Bakermans-Kranenburg MJ, Van IJzendoorn MH, et al. The significance of insecure attachment and disorganization in the development of children’s externalizing behavior: a meta-analytic study. Child Dev 2010; 81: 435–456.

22. Grossman KE, Grossman K and Waters E. Attachment from infancy to adulthood. New York: Guilford, 2005.

23. Rutter M, Kreppner J and Sonuga-Barke EJ. Attachment in the preschool years: theory, research, and intervention for children and adolescents with medically unexplained chronic pain. Clin Child Psychol Psychiat 2010; 8: 1020–1028.

24. Ainsworth M. Infant-mother attachment. Am Psychol 1979; 34: 932–937.

25. Crittenden PM. A Dynamic-maturational approach to continuity and change in pattern of attachment. In: Crittenden PM and Claussen AH (eds) The organization of attachment relationships: maturation, culture and context. Cambridge: Cambridge University Press, 2000, pp. 343–357.

26. Crittenden PM. Attachment and psychopathology. In: Goldberg S, Muir R and Kerr J (eds) John Bowlby’s attachment theory: historical, clinical, and social significance. New York: The Analytic Press, 1995, pp. 367–406.

27. Crittenden PM. A dynamic-maturational model of attachment. Aust NZ J Fam Ther 2006; 27: 105–115.

28. Crittenden PM. Attaccamento in Età Adulta (L’approccio dinamico maturativo all’Adult Attachment Interview). Milano: Cortina, 1999.

29. Main M and Solomon J. Procedures for identifying infants as disorganized/disoriented during the Ainsworth strange situation. In: Greenberg MT, Cicchetti D and Cummings EM (eds) Attachment in the preschool years: theory, research, and intervention (the John D. and Catherine T. Macarthur Foundation Series on Mental Health and Development). Chicago, IL: The University of Chicago Press, 1990. pp. 121–160.

30. Mikulincer M and Shaver PR. Attachment orientations and emotion regulation. Curr Opin Psych 2019; 25: 6–10.

31. Mikulincer M and Shaver PR. Attachment in adulthood structure, dynamics, and change. New York: Guilford Press, 2016.

32. Maundler RG and Hunter JJ. Attachment and psychosomatic medicine: developmental contributions to stress and disease. Psychosomat Med 2001; 63: 556–567.

33. Maundler RG and Hunter JJ. Assessing patterns of adult attachment in medical patients. Gen Hosp Psychiatry 2009; 31: 123–130.

34. Horton RE, Riddell RP, Flora D, et al. Distress regulation in infancy: attachment and temperament in the context of acute pain. J Dev Behav Pediatr 2015; 36: 35–44.

35. Horton R, Pillai Riddell R, Moran G, et al. Do infant behaviors following immunization predict attachment? An exploratory study. Attach Hum Dev 2016; 18: 90–99.

36. Wolff NJ, Darlington ASE, Hunfeld JAM, et al. The influence of attachment and temperament on venipuncture distress in 14-month-old infants: the generation R study. Infant Behav Dev 2001; 34: 293–302.

37. Pritchett R, Minnis H and Puckerin C. Can behaviour during immunisation be used to identify attachment patterns? A feasibility study. Inter J Nurs Stud 2013; 50: 386–391.

38. Walsh TM, McGrath PJ and Symons DK. Attachment dimensions and young children’s response to pain. Pain Res Manag 2008; 13: 33–40.

39. Barone L, Lionetti F, Dellagiulia A, et al. Behavioural problems in children with headache and maternal stress: is children’s attachment security a protective factor? Inf Child Dev 2016; 25: 502–515.

40. Williams R, Cerutti R, Leone L, et al. The role of attachment insecurity in the emergence of anxiety symptoms in children and adolescents with migraine: an empirical study. J Headache Pain 2017; 18: 62–70.

41. Tarantino S, Capuano A, Fruscianti R, et al. Role of the attachment style in determining the association between headache features and psychological symptoms in migraine children and adolescents: an analytical observational case–control study. Headache 2017; 57: 266–275.

42. Tarantino S, Papetti L, Battan B, et al. Maternal alexithymia and attachment style: which relationship with their children’s headache features and psychological profile?. Front in Neurol 2018; 8: 1–10.

43. Esposito M, Parisi L, Gallai B, et al. Attachment styles in children affected by migraine without aura. Neuropsychiatr Dis Treat 2013; 9: 1513–1519.

44. Bolat N, Eliaçik K, Yavuz M, et al. Adolescent mental health, attachment characteristics, and unexplained chest pain: a case-control study. Psychiatr Clin Psychoph 2018, https://www.tandfonline.com/doi/full/10.1080/24750573.2018.1454374

45. Kozlowska K and Williams LM. Self-protective organization in children with conversion and somatoform disorders. J Psychosom Res 2009; 67: 223–233.

46. Kozlowska K, Scher S and Williams LM. Patterns of emotional-cognitive functioning in pediatric conversion patients: implications for the conceptualization of conversion disorders. Psychosom Med 2011; 73: 775–788.

47. Kozlowska K and Khan R. A developmental, body-oriented intervention for children and adolescents with medically unexplained chronic pain. Clin Child Psychol Psychiat 2011; 16: 575–598.

48. Tremblay I and Sullivan MJL. Attachment and pain outcomes in adolescents: the mediating role of pain catastrophizing and anxiety. J Pain 2010; 11: 160–171.

49. Ratnamohan L and Kozlowska K. When things get complicated: at-risk attachment in children and adolescents with chronic pain. Clin Child Psycho Psychiat 2017; 22: 588–602.

50. Faedda N, Natalucci G, Piscitelli S, et al. Migraine and attachment type in children and adolescents: what is the role of trauma exposure? Neu Sci 2018; 39: 109–110.

51. Riddell PR and Racine N. Assessing pain in infancy: the caregiver context. Pain Res Manag 2009; 14: 27–32.

52. Page LO and Blanchette JA. Social learning theory: toward a unified approach of pediatric procedural pain. Int J Behav Cons Ther 2009; 5: 124–141.
53. Palermo TM and Chambers CT. Parent and family factors in pediatric chronic pain and disability: an integrative approach. *Pain* 2005; 119: 1–4.

54. Palermo TM. *Cognitive-behavioral therapy for chronic pain in children and adolescents*: Oxford: Oxford University Press, 2012.

55. Birnie KA, Boerner KE and Chambers CT. Families and pain. In: Megrath PJ, Stevens BJ, Walker SM, et al. (eds) Oxford *textbook of paediatric pain*. Oxford: Oxford University Press, 2014, pp. 111–118.

56. Crittenden PM. Quality of attachment in the preschool years. *Dev Psychol* 1992; 4: 209–241.

57. Ravitz P, Maunder R, Hunter J, et al. Adult attachment measures: a 25-year review. *J Psychosom Res* 2010; 69: 419–432.

58. Ruskin D, Laloo C, Amaria K, et al. Assessing pain intensity in children with chronic pain: convergent and discriminant validity of the 0 to 10 numerical rating scale in clinical practice. *Pain Res Manag* 2014; 19: 141–148.

59. Kozlowska K. The body comes to family therapy: utilizing research to formulate treatment interventions with somatising children and their families. *Aust NZ J Fam Ther* 2016; 37: 6–29.

60. Crittenden PM, Claussen AH and Kozlowska K. Choosing a valid assessment of attachment for clinical use: a comparative study. *Aust NZ J Fam Ther* 2007; 28: 78–87.

61. Craig KD. Implications of concepts of consciousness for understanding pain behaviour and the definition of pain. *Pain Res Manag* 1997; 2: 111–117.

62. Ainsworth MDS. Object relations, dependency, and attachment: a theoretical review of the infant-mother relationship. *Child Dev* 1968; 40: 969–1025.

63. Liotti C. *Procedure-related cancer pain in children*. Oxford: Radcliffe Medical Press, 2002.

64. Rieffe C, Miers A, Terwogt M, et al. Psychometric properties of the emotion awareness questionnaire for children. *Pers Indiv Diff* 2007; 43: 95–105.

65. Kobak RR, Cole HE, Ferenz-Gillies R, et al. Attachment and emotion regulation during mother–teen problem solving: a control theory analysis. *Child Dev* 1993; 64: 231–245.

66. Uman LS, Chambers CT, McGrath PJ, et al. A systematic review of randomized controlled trials examining psychological interventions for needle-related procedural pain and distress in children and adolescents: an abbreviated Cochrane Review. *J Pediatr Psychol* 2008; 8: 842–854.

67. Ortiz MJ, López-Zarco M and Arreola-Bautista EJ. Procedural pain and anxiety in paediatric patients in a Mexican emergency department. *J Adv Nurs* 2012; 68: 2700–2709.

68. Cummings JAF. Pediatric procedural pain: how far have we come? An ethnographic account. *Pain Manag Nurs* 2015; 16: 233–241.

69. Blount R, Piira T and Cohen L. Management of pediatric pain and distress due to medical procedures. In: Roberts M (ed.) *Handbook of pediatric psychology*. New York: Guilford Press, 2003, pp. 216–233.

70. Osmun LD, Riddell RP and Flora DB. Infant pain-related negative affect at 12 months of age: early infant and caregiver predictors. *J Pediatr Psychol* 2014; 39: 23–34.

71. Cohen LL, Blount RL, Cohen RJ, et al. Children’s expectations and memories of acute distress: short- and long-term efficacy of pain management interventions. *J Pediatr Psychol* 2001; 26: 367–374.

72. Jacobsen PB, Manne SL, Gorfinkele K, et al. Analysis of child and parent behavior during painful medical procedures. *Health Psych* 1990; 9: 559–576.

73. Young K. Pediatric procedural pain. *Ann Emerg Med* 2005; 45: 160–171.

74. Palermo TM, Putnam J, Armstrong G, et al. Adolescent autonomy and family functioning are associated with headache-related disability. *Clin J Pain* 2007; 23: 458–465.

75. Logan DE and Scharff L. Relationships between family and parent characteristics and functional abilities in children with recurrent pain syndromes: an investigation of moderating effects on the pathway from pain to disability. *J Pediatr Psychol* 2005; 30: 698–707.

76. Savi L, Buccheri R, Tambornini A, et al. Attachment styles and headache. *J Headache Pain* 2005; 6: 254–257.

77. Kerns KA, Klepac L and Cole A. Peer relationships and pre-adolescents’ perceptions of security in the child-mother relationship. *Dev Psychol* 1996; 32: 457–466.

78. Attili G. *Ansia Da Separazione E Misura Dell’attaccamento Normale E Patologico*. Milano: Unicopli, 2001.

79. Klagsbrun M and Bowby J. Responses to separation from parents: a clinical test for young children. *Brit J Prog Psychol Pers Stud* 1976: 21: 7–27.

80. Laird KT, Sherman AL, Smith CA, et al. Validation of the abdominal pain index using a revised scoring method. *J Pediatr Psychol* 2015; 40: 517–525.

81. Borelli JL, Pedroza M, Gaskin GE, et al. School-aged children’s cognitive interdependence as a prospective link between their depressive symptoms and physiological stress reactivity. *J Soc Clin Psycho* 2018; 37: 325–355.

82. Asmundson GJ, Noel M, Petter M, et al. Pediatric fear-avoidance model of chronic pain: foundation, application and future directions. *Pain Res Manag* 2012; 17: 397–405.

83. Pagè MG, Huguet A and Katz J. Prevention of the development and maintenance of paediatric chronic pain and disability. In: Megrath PJ, Stevens BJ, Walker SM, et al. (eds) Oxford *textbook of paediatric pain*. Oxford: Oxford University Press, 2014, pp. 39–52.

84. Vetter TR, McGwin G, Bridgewater CL, et al. Validation and clinical application of a biopsychosocial model of pain intensity and functional disability in patients with a pediatric chronic pain condition referred to a subspecialty clinic. *Pain Res Treat*, https://www.ncbi.nlm.nih.gov/pubmed/24251035.

85. Porter LS, Davis D and Keefe FJ. Attachment and pain: recent findings and future directions. *Pain Res Treat* 2012; 2012: 118516.

86. Williams LA and Bailey SJ. Associations between adult attachment ratings and health conditions: evidence from the national comorbidity survey replication. *Health Psycho* 2010; 29: 446–453.

87. Östberg VS, Läftman B, Modin B, et al. Bullying as a stressor in mid-adolescent girls and boys–associations with perceived stress, recurrent pain, and salivary cortisol. *Int J Environ Res Public Health* 2018; 15: e364.

88. Sansone RA, Lam C and Wiederman MW. Being bullied in childhood: correlations with borderline personality in adulthood. *Compr Psychiatry* 2010; 51: 458–461.

89. Voerman JS, Vogel I, Waart F, et al. Bullying, abuse and family conflict as risk factors for chronic pain among Dutch adolescents. *Eur J Pain* 2015; 19: 1544–1551.
90. Noel M, Palermo T, Chambers C, et al. Remembering the pain of childhood: applying a developmental perspective to the study of pain memories. *Pain* 2015; 156: 31–34.

91. Noel M, Wilson AC, Holley AL, et al. Post-traumatic stress disorder symptoms in youth with versus without chronic pain. *Pain* 2016; 157: 2277–2284.

92. Petovello K. Pediatric procedural pain management: a review of the literature. *Int J Child Youth Fam Stud* 2012; 4: 569–589.

93. Noel M, Chambers C, McGrath P, et al. The influence of children’s pain memories on subsequent pain experience. *Pain* 2012; 153: 1563–1572.

94. Brennan-Hunter AL. Children’s pain: a mandate for change. *Pain Res Manag* 2001; 6: 29–39.

95. Pao M and Bosk A. Anxiety in medically ill children/adolescents. *Depress Anxiety* 2011; 28: 40–49.

96. Morley S and Eccleston C. The object of fear in pain. In: Asmundson GJ, Vlaeyen J and Crombez G (eds) *Understanding and treating fear of pain*. Oxford: Oxford University Press, 2004, pp. 163–188.

97. Davidson A, Shrivastava P, Huang G, et al. Risk factors for anxiety at induction of anesthesia in children: a prospective cohort study. *Paed Anaest* 2006; 16: 919–927.

98. Farnfield S, Hautamaki A, Norbech P, et al. DMM assessments of attachment and adaptation: procedures, validity and utility. *Clin Child Psychol Psychiatr* 2010; 15: 313–328.