

SECTION 3

Social and psychological basis of paediatric pain



CHAPTER 9

Psychological theories and biopsychosocial models in paediatric pain

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Summary

The purpose of this chapter is to review existing biopsychosocial models of paediatric pain and to examine common key factors across different theoretical conceptualizations. Critical gaps in the empirical and theoretical literature are elucidated. In particular, lack of specific attention to developmental factors in biological, behavioural, and social functioning and the need for models that examine gaps in different types of pain responding (e.g. immediate acute pain response, acute pain responding in the context of chronic pain) are highlighted. Moreover, the need for comprehensive, conceptual models, representative of current knowledge, that readily generate specific hypotheses confirmable by experimentation are also discussed as ways of moving the field of paediatric pain forward, both conceptually and pragmatically.

Introduction

Except in very rare cases of congenital insensitivity, pain is inevitable and ubiquitous in the lives of children. Despite its universality, the complexity of any child or adult's actual experience of pain remains elusive to others, given its subjective nature. Nevertheless, the established deleterious impact of unmanaged pain during childhood on biological, psychological, and social well-being (Anand, 2000; Fitzgerald, 2005; Grunau, 2006; Hohmeister et al., 2010; Taddio et al., 1997) dictates a necessity to better understanding of not only the 'ever-elusive' pain experience but also how the more easily quantifiable 'pain expression' contributes to understanding the experience, assessment, and management of paediatric pain.

The complexity of different pain experiences (e.g. acute, acute-prolonged, chronic) and the varying importance of both broader system factors (medical staff, cultural norms) and more narrow system factors (such as parents and peers) have led to diverse frameworks in understanding the interplay of biopsychosocial factors in paediatric pain. Having biopsychosocial models help scientists and clinicians attempt to discern and integrate the multifaceted pieces to

approximate an understanding of the complex enigma of another's pain. In addition to comprehensiveness of bio-, psycho-, and social variables, ideally good models should represent current scientific knowledge in the field and generate new ideas that can be subjected to empirical validation. This chapter will review key models in the field and discuss their content in terms of comprehensiveness, representativeness, and potential for novel hypothesis generation.

The first biopsychosocial model of pain: gate control theory

A review of theoretical models would be incomplete without mentioning the road the gate control theory of pain paved for modern transdisciplinary models of pain. Moving away from antiquated dualistic conceptualizations of pain as existing in the mind or the body and building upon current knowledge in the field, Melzack and Wall (1965) proposed a groundbreaking model that included testable mechanisms bridging the interplay between psychosocial and biological features of the pain experience. One of the key landmark implications of gate control theory and the subsequent neuro-matrix theory for researchers and clinicians was the central role of the brain in processing and representing noxious stimuli (Melzack, 1996, 1999). Ushering pain research into the modern age, the realization that 'without the brain there would not be pain' became a fundamental principle of pain research. Moreover, with recognition that pain is substantially more than mere sensory experience, theoretical models broadened their scope to include diverse factors implicated in pain experience, i.e. biological substrates, internal cognitive/affective/biological schema, social, and environmental (Craig et al., 1996). Despite minor criticisms that have been put forward including that pain inhibition is much more complicated than laid out in gate control, by recognizing the primacy of the brain as the *active* recipient of noxious input and by specifying testable mechanisms that addressed both biological and psychosocial dimensions, these models set the stage for research proliferation in the field of pain that continues to this day. In addition, it also

fostered the development of more targeted biopsychosocial models of pain. It was recently asserted that the prospects of advances in clinical assessment and management of children's pain are best served by comprehensive models that are inclusive of all determinants (Hadjistavropoulos et al., 2011).

While not biopsychosocial in scope, two other theories should be discussed at the outset due to their integral role in modern theories of paediatric pain. Both operant conditioning and social learning models have set a foundation in which to help operationalize the psychological and the social aspects for current biopsychosocial conceptualizations.

Operant and social learning models of paediatric pain

Operant models of pain have been extensively used to understand chronic pain in the adult pain literature (Fordyce, 1976). The application to paediatric pain came onto the scene later. Turk and colleagues (1987) conducted one of the first reviews on the involvement of the family on child chronic pain. They discussed the concept of 'painful families', which are families where there is an increased incidence of chronic pain problems. Ultimately, they concluded that the family plays a major role as an agent of positive and negative reinforcement. The child's pain behaviours (e.g. crying, moaning) can be strengthened or extinguished depending on environmental responses. Reinforcement may be particularly salient for children with chronic pain since parent behaviours, such as attending to pain behaviours and granting permission to avoid daily activities, are related to higher levels of illness behaviours in children with recurrent abdominal pain (Walker and Zeman, 1992). A more recent review has also highlighted the contribution of operant conditioning on paediatric chronic pain and put forward an integrative model (discussed fully later in this chapter) of factors impacting on paediatric chronic pain, including individual variables such as parental reinforcement and solicitousness (Palermo and Chambers, 2005).

While reinforcement and punishment are key aspects to understanding how paediatric pain responses develop and are maintained, by nature the theory tends to focus on more narrow contributors that are temporally linked to the pain response without expounding other aspects of environmental learning such as through observation and modelling. Social learning theory is a broader approach to learning emphasizing not only child factors related to their appraisal of a painful situation but also familial/larger system influences on how to think about and act when in pain (Williams et al., 2011).

Social learning theory puts forward that children learn within a social context, which is facilitated by modelling and observation (Bandura, 1977). According to social learning theory children learn behaviour by observing others and imitating what they have observed. Moreover, whether the behaviour is imitated and learned depends on the salience of the model and the consequence of the behaviour. The child is also more likely to exhibit the learned behaviour if he or she believes that the pain behaviour will lead to a specific response from their support network (Osborne et al., 1989). An example of social learning was demonstrated in a study that found that children of chronic low-back pain patients exhibited a higher frequency of similar pain behaviours when they had a parent with a chronic pain condition versus when they had parents who were healthy or diabetic (Rickard, 1988).

While much social learning literature has focused on paediatric chronic pain, Page and Blanchette argue that social learning theory is also a useful perspective from which to understand paediatric procedural pain (2009). For example, work by Chambers and colleagues demonstrated that positive reinforcement and modelling of pain behaviours by parents during an acute pain task had an impact on child pain behaviour, particularly for girls. Girls whose mothers demonstrated pain-promoting behaviours reported more pain than girls whose mothers did not react in the same manner (Chambers et al., 2002). Social learning theory is also relevant to paediatric procedural pain because of the roles anticipatory anxiety and avoidance play in pain responses (Page and Blanchette, 2009). Children may display anticipatory anxiety or avoidance because they believe they will be unable to manage the procedure. Social learning theory is a useful model through which to understand the development and maintenance of child pain behaviour in both acute and chronic pain contexts. As will become apparent, social learning contributes, either overtly or covertly, to the psychosocial foundation for all biopsychosocial models presented in this chapter.

The current review found that biopsychosocial models of paediatric pain fell into two broad categories: (1) a small and relatively recent literature specifically addressing chronic pain and (2) a much more developed literature examining acute procedural pain. The following examines these two broad categories, including a more detailed section on the social communication model (SCM) of pain as this model is one of the most widely cited explanatory models in the field of paediatric pain. We begin our discussion of biopsychosocial models by tackling paediatric chronic pain.

Biopsychosocial models of paediatric chronic pain: theoretical beginnings

Rather than defining chronic pain in terms of duration, current conceptualizations base the distinction between chronic and acute pain on functionality (Woolf, 2010). Acute nociceptive pain serves to warn the organism of real or imminent tissue damage, whereas persistent pain diminishes or prevents movement and can promote healing. Within the broad domain of persistent pain one can identify chronic pain that is pathological because it serves neither function and would appear to be the consequence of an abnormally functioning or damaged nervous system. Neuropathic pain best illustrates the latter. A recent epidemiological review of chronic pain during childhood and adolescence described many different types of chronic pain (e.g. headache, back pain, musculoskeletal pain), with median reports of prevalence ranging between 11% and 38% of the populations studied (King et al., 2011). However, most of the studies reviewed used 'duration of pain' to classify children's reports of pain as chronic. A commentary on this review suggested that probably 5% to 15% of children suffer from chronic pain that is disabling and requires professional intervention (von Baeyer, 2011).

Clearly significant numbers of children suffer from chronic pain, thus, models of this pain type need to assist clinicians and researchers in understanding why a subsample of children come to report disabling chronic pain when others do not. One must turn to formulations of how biological endowment and maturation interact with the physical and social environment to appreciate the emergence of individual differences in the experience and expression of pain and disability.

An integrative conceptual model for understanding paediatric chronic pain and disability

There have been recent attempts to describe interactions among biological, psychological, and social features and/or determinants of children's chronically painful conditions. In their 'integrative model of parent and family factors in paediatric chronic pain and associated disability', Palermo and Chambers (2005) focused on the psychosocial component of the biopsychosocial perspective. They describe operant-behavioural perspectives of parent-child interaction within the broader framework of family systems theories. Individual parenting variables, such as parenting style or parental reinforcement of child pain behaviours, are recognized as important within the context of dyadic interactions with the child. For example, the quality of the parent-child interactions, which in turn are nested within broader family-level variables, such as family cohesion or overall functioning, were outlined. Specific child variables, such as the level or nature of pain or disability, or moderating/mediating variables, such as the child's gender, age, emotional status, and coping, are hypothesized to influence the family, dyadic, and individual variables. In this model, complex bidirectional relationships are proposed between the aforementioned nested variables and paediatric chronic pain, such that not only do parenting, dyadic, and family-level variables influence paediatric chronic pain, but paediatric pain would have an impact on family dyadic interactions and overall functioning. This model emphasizes the developmental context of these complex and bidirectional relationships and the dynamic, progressive nature of changes in relationships. Thus, there is an emphasis on recognizing that the specific variables of interest would vary with the developmental status of the child and contribute to developmentally appropriate care. Ultimately, the model emphasizes the mutually influencing relationship between the family unit's functioning (both the whole system and multiple subsystems within) and the child's pain, functional disability and the variables that moderate or mediate the relationship between the two. In this model, psychosocial factors within the narrow family system are handled well because the model accurately reflects current knowledge on this topic. This is clearly seen in the specification of potential mediators/moderators that may influence the relationship between pain and functional disability. However, although not its set out purpose, in terms of comprehensiveness, it does not go beyond immediate family factors (such as medical systems and cultural norms) and does not look at the interplay with biological factors within the child. Moreover, the actual relative relationships among individual, parent, and family factors on chronic pain/functional disability are vague.

Palermo (2012) extended the theoretical foundation proposed by Palermo and Chambers (2005) by explicitly adding in new components to the model, namely: (1) biological processes, (2) the dimension of psychological factors influencing health habits, and (3) social factors that go beyond consideration of parents and the family. The 'guiding conceptual model for understanding paediatric chronic pain and disability' (see Figure 9.1) is therefore more comprehensive in its scope. In terms of the biological levels of influence, consideration was given to ontogenetic maturation, including genetic factors, central nervous system functioning, sex, and pubertal status. Psychological variables proposed as important in paediatric chronic pain include individual beliefs, coping, mood/affect, anxiety, and fear. Broader social variables, such as culture,

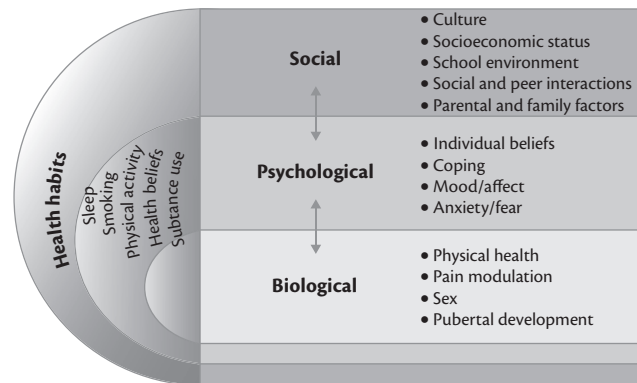


Figure 9.1 Guiding conceptual model for understanding paediatric chronic pain and disability. Reproduced with permission from Tonya M. Palermo, *Cognitive-Behavioral Therapy for Chronic Pain in Children and Adolescents*, Oxford University Press, Inc., New York, USA, p. 13, Copyright © 2012.

socioeconomic status, school environment, and characteristics of the health care system, were recognized as providing context for the more proximal family and parent social factors. A novel aspect of this model is close examination of the role of health habits (such as sleep, physical activity, substance use) play in paediatric chronic pain and disability. Explicitly making stable health habits salient highlights the importance of assessing these peripheral but fundamental behaviours because of their potential role in moderating pain and disability, particularly in older children and adolescents. This model posits bidirectional relationships among biological, psychological, and social factors with biological factors nested within the psychological context of the child, which in turn is nested within social contexts. Health habits would develop on the basis of the interplay of all three factors. Developmental considerations are advanced in this model, with the biology of pubertal development highlighted as particularly important. Reflective of current research in the broader field of paediatric psychology, the innovation of including health habits are noted as particularly relevant in adolescent populations. The model is broad in scope and describes an interplay of different aspects of the systems. However, while the comprehensiveness and representativeness of the model facilitates a broad inventory of potential factors in chronic pain, this appears to come at the cost of its specific predictive power. Specific hypotheses about how factors within different systems interact for empirical validation purposes (e.g. mood, culture, and puberty) and the directionality of these relationships are not readily evident from the model descriptions.

As discussed earlier, integrative models in the area of paediatric chronic pain are still in their early stages, with modelling typically representing the product of a particular investigative group. In contrast, paediatric models of acute pain began proliferating about a decade earlier and have had the benefit of diverse viewpoints on the topic. The following section addresses a number of recent models.

Biopsychosocial models of paediatric acute pain

Contrary to the dearth of theoretical literature on paediatric chronic pain, several models that specifically address acute or procedural paediatric pain have been advanced in the paediatric pain



literature. In all of these models, the proposed relationships and interplay between variables are presented in the context of a particular painful episode (e.g. a specific immunization or other painful medical procedure).

A social-ecological framework for understanding procedure pain

Informed and laid out similarly to Bronfenbrenner's (1977) social-ecological framework, Kazak and Kunin-Batson's (2001) model situated the child in pain at the centre of a series of nested concentric circles representing the increasingly broad social settings that have an impact on a child in pain and that exert bidirectional influences on the child. Contained in the first circle of influence, the microsystem, are child-specific, or intrapersonal, factors such as age, biology, coping, health, and the pain experience itself. In the mesosystem, or second circle of influence, are social factors in the child's immediate life contexts, such as those relating to family, peers, school staff, and hospital staff, and the interrelationships between these social units. Finally, broader social environments are represented by the largest circle of influence or the exosystem, such as social networks of parents, ethnocultural influences, including cultural beliefs and practices, health care systems, and public policy. The interpersonal meso- and exosystems are hypothesized to exert a direct and indirect impact on the child in pain (the microsystem) and all three systems are expected to interact, a position this perspective shares with other models discussed. Once again, the model, while comprehensive in its scope and grounded in current research, has limited impact beyond providing a comprehensive description of potential variables related to procedural pain. In essence, specific hypothesis testing of the dynamic interplay of nested spheres is impossible because of the large number of interactive possibilities that different factors within different spheres present.

Stimulus–response model of (paediatric) pain

The 'stimulus–response model of (paediatric) pain' (Cohen et al., 2008) takes a different perspective by structuring the model around a linear sequence of events that follow a specific painful stimulus (e.g. injection, inflammation). First, there is a short-term response phase in which pain, distress, and anxiety can be experienced, but also in which the opportunity to learn, practice, cope, or be coached exists. The link between the painful stimulus and the short-term response is hypothesized to be modulated by child factors (e.g. coping behaviours, prior experiences), parent factors (e.g. coaching behaviours, parent anxiety), medical staff factors (e.g. coaching behaviours, staff anxiety), and contextual factors (e.g. environmental factors, culture). Following this short-term response phase is the long-term response phase in which health attitudes/behaviours, distress memories, and expectations can develop, physiological changes can occur, and the opportunity to cope or be coached exists. Similar to the link between the painful stimulus and the short-term response phase, the link between the short-term response phase and the long-term response phase is hypothesized to be modulated by the same child, parent, medical staff, and contextual factors discussed earlier. In line with a biopsychosocial approach to understanding paediatric pain, this model addresses biological, psychological, and social spheres of influence, as well as the interplay between the specific variables that subsume these three levels. Compared to earlier models discussed previously, this model does not overtly hypothesize a transactional, or bidirectional, relationship

among features and determinants of the pain experience choosing rather to specifically outlay the directionality of certain relationships. However, with this model we see a different type of limitation in that while specific mechanisms are readily identifiable and testable, potential gaps in the conceptualization of relationships between variables are evident. For example, whereas it is hypothesized that child factors (such as coping behaviours) or parent factors (such as anxiety) can modulate the child's short-term pain response or long-term distress memories, the model does not explicitly propose that the child's short-term pain response or long-term distress memories would exert influence on the child's coping behaviours or the parent's anxiety. Moreover, it provides only a surface treatment of biological variables and a more comprehensive integration of biological factors would improve its conceptual value.

Young's model of paediatric procedural pain

Similarly to Cohen's model, Young's (2005; see Figure 9.2) biopsychosocial model contextualizes paediatric procedural acute pain by first breaking the time sequence of a procedural pain event into three phases: (1) pre-procedure, (2) procedure, and (3) post-procedure. This framework acknowledges that while acute pain occurs in a distinct episode of time (procedure), it is substantially influenced by pre-procedural factors, such as the mindset the child brings to the procedure (memories of past pain, fear/anxiety, temperament), unique biological dispositions (such as pain receptor density, endogenous opioids), and social influences (such as parental modelling, cultural beliefs, media attention, peer influences). Furthermore, the cumulative impact of both pre-procedural and procedural factors would continue to influence the child after the procedure has been completed. Similar observations must apply to acute pain arising from injury. Importantly, this model stands alone from models reviewed thus far by including a specific feedback loop postulating that after the procedural pain response, long-term effects of pain and distress (such as memories of the acutely painful experience) will in turn directly impact on an individual's cognitive control and coping skills in the next painful experience.

In addition, the model explicitly incorporates Melzack and Wall's (1965) gate control theory by noting that both individual (such as age, sex, development, and temperament) and other systemic factors (such as ethnicity/psychobiological factors, cultural/familial factors, and societal/environmental factors) impact on central cortical control processes and descending inhibitory mechanisms of the pain gate, which in turn determine the pain response (sensory, affective, and physiological).

Given such a broad array of factors and clearly laid out interrelationships, the potential for contributing to the development of the field becomes readily apparent. When critically appraising the model, questions quickly arise regarding interactions among specific subunits of the model. For example, why is a child's pain and distress presumed to only impact on individual factors but not psychobiological factors such as pain thresholds? Additionally, given the integral role of ongoing threat appraisals in the actual pain response, pain responding (in particular physiological responding) would also be directly impacted upon by pre-procedural factors such as previous pain experiences, rather than solely being mediated by a child's cognitive abilities and schemas. It is notable that the various mechanisms and constructs describing the pain response are laid out explicitly. Hence, this model provides clear avenues for empirical validation and its in-depth empirical basis is clearly



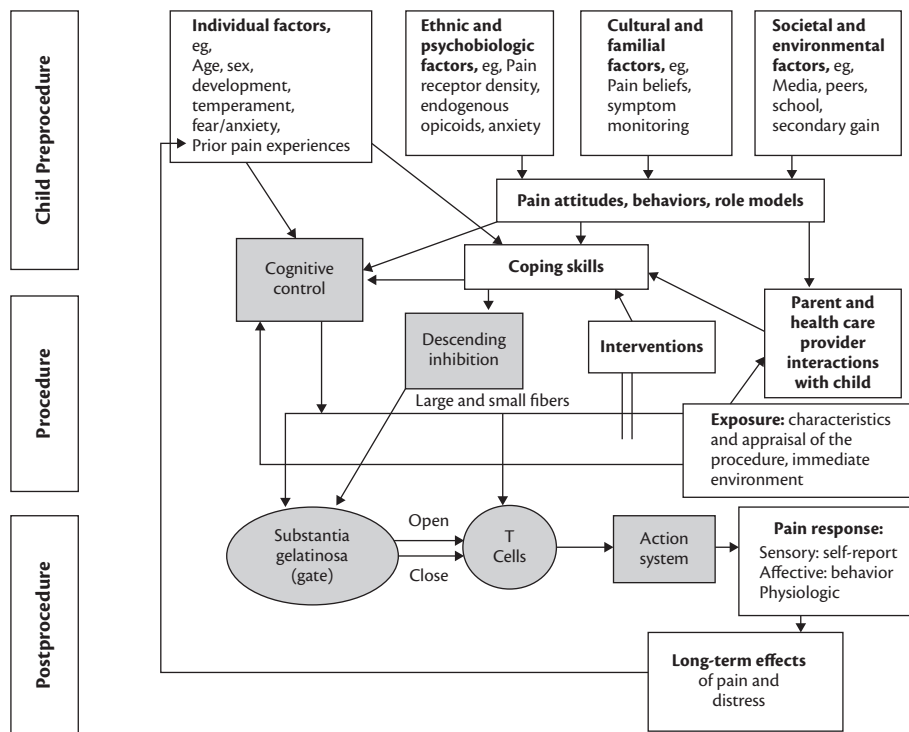


Figure 9.2 Model for conceptualizing and studying paediatric procedural pain (Young, 2005). Reprinted from *Annals of Emergency Medicine*, Volume 45, Issue 2, Pediatric Procedural Pain, pp. 160–171, Copyright © 2005, with permission from Elsevier. DOI: 10.1016/j.annemergmed.2004.09.019

laid out in the paper. One conceptual criticism of the model is that the caregiver of child in pain appears to be relegated to a peripheral role during the procedural phase and is not acknowledged as having a direct impact on the child's construction of previous pain experiences.

The social communication model of pain

In a hybrid approach that incorporates the sequencing of events in acute pain and yet acknowledges larger spheres of both inter- and intrapersonal influence, Craig and colleagues have taken a broader perspective that emphasizes social learning theory in how the child, the caregiver, and the relationship function in the pain context (see Figure 9.3). The focus is upon dyadic interactions between the child and others, but consideration is given to the broader social ecological systems within which child pain is suffered. Having had the benefit of over a decade of development, including exploration of its empirical and theoretical ramifications (e.g. Craig, 2009; Craig et al., 1996; Hadjistavropoulos et al., 2011), the conceptual framework now provides by far the most developed biopsychosocial formulation of paediatric acute pain. It predates other models described here with the first paediatric version released in the early 1990s when the importance of the social context to understanding children in pain was only beginning to be established.

Important and relatively unique features of the SCM include the impact of socialization on child pain experience and expression as well as the inclusion of persons other than the individual experiencing the pain, caregivers in particular. This is particularly important in paediatric pain because vulnerable infants and children are heavily reliant on family, other adults, and professionals for caregiving, including assessment and relief from pain (Pillai Riddell and Racine, 2009). The SCM as it relates to paediatric pain includes processes whereby the subjective pain experience of the child is transduced into a pain expression that can be assessed by

caregivers who, when deemed necessary, will take action to manage the pain.

These transactions between the child and persons in the social environment are explicitly examined during four sequenced, conceptually distinct but interactive stages following an initial painful event: (1) the child's pain experience, (2) the child's pain expression, (3) assessment of pain by a caregiver, and (4) actions taken (or not taken) by others that would impact on the child's pain.

Thus, when tissue damage or trauma occurs, the noxious input is transduced into the child's perception of pain. The biological dispositions triggered are the outcome of the biological, personal, and social history of the child, not only the nociceptive sensory input. The experience includes both automatic/reflexive features as well as higher level processing reflecting the learning history of the child. Thus, an understanding of the reaction to a noxious event, whether acute tissue trauma or exacerbation of chronic pain, requires consideration of both immediate and personal history events.

The second stage concerns the complexities of how painful experience becomes manifest in the expression of pain. Pain expression may be observed in infants vocally through crying or screaming, as well as through non-vocal expression, including facial expression and body actions. Depending on the developmental stage of the child, they may be able to use language to communicate pain. There are bidirectional relationships between pain experience and pain expression, whereby the child's pain experience will impact on pain expression, and a child's expression of pain will impact on how it is experienced. The distinction between the experience and expression of pain implicitly acknowledges they may be discordant. This complicates the challenge caregivers confront when attempting to assess a child's distress, with decisions about an appropriate course of action depending upon this judgement.

Pain expression and caregiver assessments mutually influence each other. Pain expression primarily, but not exclusively,

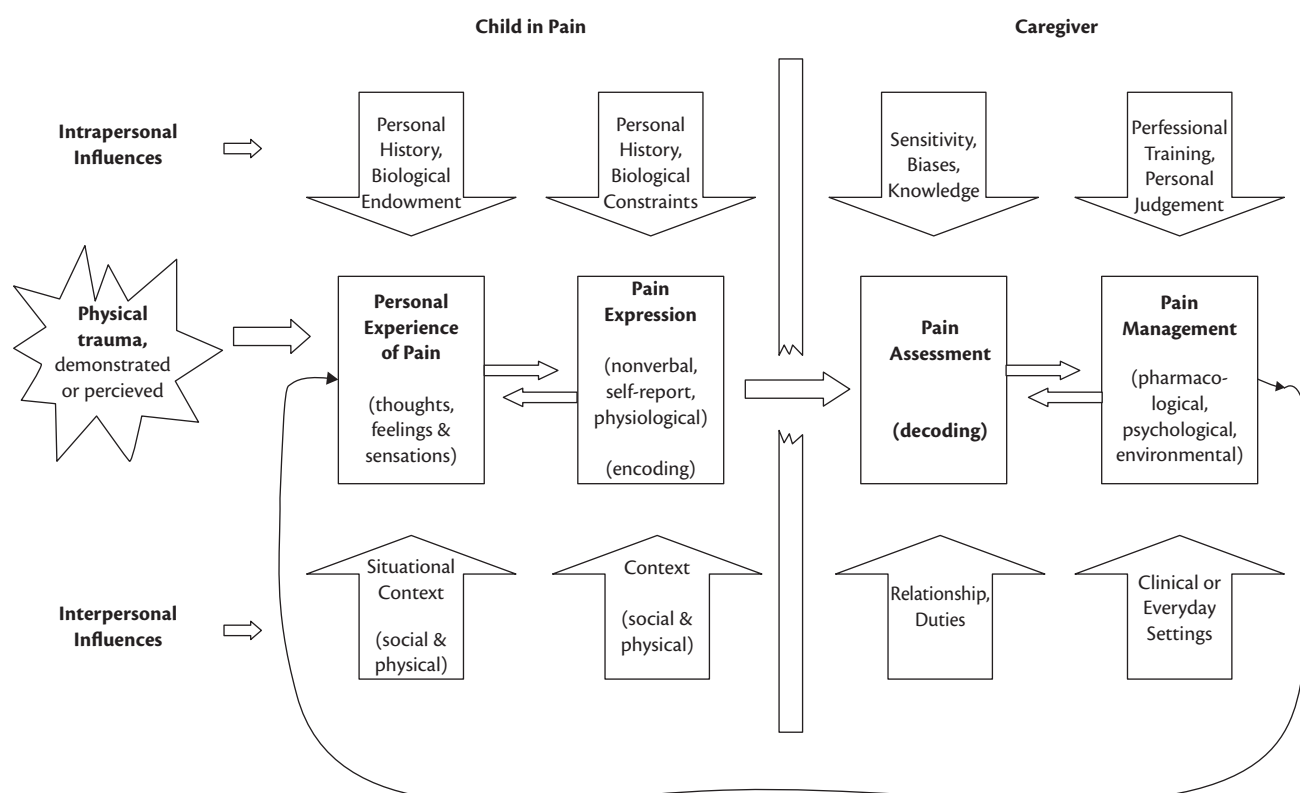


Figure 9.3 The social communication model of pain. A conceptual biopsychosocial model depicting the interaction between the child in pain and their caregiver. Reprinted with permission from Craig, K. D., The social communication model of pain, *Canadian Psychology*, Volume 50, pp. 22–32, Copyright © 2009, American Psychological Association. DOI: 10.1037/a0014772.

determines the observer's pain assessment, and this reaction in turn will have an impact on the pain expression (and experience) depending upon the reaction. The component of the model encompassing child expression and caregiver assessment is at the heart of the model and exemplifies the belief that pain is fundamentally a social experience. Pain was evolutionarily conserved as a biological adaptation, with expression and adult reactions to the child playing no small part. Children modulate signals of pain and distress contingent upon perception of the immediate context, including receptivity of the caregiver, and the caregiver would also attune sensitivity to signals based on their interpretation of the child's expressivity. Parental and health practitioner sensitivity as social determinants of children's pain expression seem obvious and would not seem to require further illustration here.

Finally, the caregiver's assessment of the urgency, intensity, and necessity of the pain signal determine whether the caregiver will take action and attempt to control pain. As with all phases of the process, caregiver judgements and decisions to provide care are mutually influential. The actions a caregiver takes may also impact on their assessment (e.g. if the actions are effective, the assessment might be that the pain is lower). Moreover, how a caregiver manages a child's pain will also feed back to the beginning of the sequence and impact on how a child's pain experience is constructed. These four steps delineate the dynamic interaction between children and caregivers in the paediatric pain context.

Upon review, four key features of the model contribute to its explanatory value. First, the model characterizes important

interactions between the child in pain and her/his caregivers. Social learning approaches to child development in a pain context, including both operant (e.g. Gatzounis et al., 2012) and observational learning (e.g. Goubert et al., 2011) processes have proven particularly useful in model refining. Second, the model examines a progression of four stages following onset of painful events that first concern the child and then the caregiver (see later). Third, the SCM recognizes dynamic reciprocal relationships between the infant's or child's experience and communication of pain and the caregiver's interpretation and reaction to the pain-related distress. Finally, as the model developed, intrapersonal and interpersonal factors unique to the biological and environmental history and current status of the individual child and caregiver were shown to be crucial to understanding the child and the caregiver, separately and interactively.

As aforementioned, the SCM has provided rich fodder for empirical work in the field trying to elucidate the psychosocial influences on paediatric pain. However, in contrast to more focused models of paediatric procedural acute pain (such as Young's model), the SCM is not ideally suited to provide detailed guidance regarding specific mechanisms subsuming the interplay between components. It provides broader conceptual guidance postulating the general sequence of acute pain from painful trigger to caregiver management and outlining the spheres of influence with specific mention of potential variables on each step of the sequence. The differing approaches, while overlapping, tend to generate different types of hypotheses. For example, while both models suggest previous



pain history impacts on a child's pain response, the SCM postulates that it impacts on the experience of pain which in turn impacts on expression, while the Young model suggests a more specified feedback loop such that previous experience impacts on current experience via the child's cognitive control exerted over the pain gate pathways and via the child's coping skills, which both in turn impact on current pain experience and then, subsequently, future pain experience. One final criticism of all paediatric pain models presented to date, whether they focus on the sequence of events, the larger spheres of influence, or both, is the lack of specific attention to the developmental stage of the child—a key variable in understanding paediatric pain.

A biopsychosocial model specifically for infant pain: the DIAPR model

An appreciation of the unique developmental stage of infancy in terms of both the inter- and intrapersonal influences inspired the creation of a new biopsychosocial model specifically constructed to provide a framework for understanding acute pain over the first year of life: The 'development of infant acute pain responding' or DIAPR model (Pillai Riddell, 2009; see Figure 9.4). Acknowledging the SCM innovation of the primary role of the dynamics between caregiver and child, this new model incorporates novel components that have not been seen in other models of paediatric acute pain to date, including the separate conceptualization of the initial pain reaction and ongoing pain regulation, the *indirect* influence of larger social contexts, and the hypothesis of three specific feedback loops involving either the infant, the caregiver, or both. The model is based on evidence gathered from a growing literature base generated by the OUCH cohort (e.g. Ahola Kohut 2012; Pillai Riddell et al., 2011, 2013; Racine et al., 2012). The OUCH cohort is an ongoing cohort sequential sample of over 750 healthy children and parents being followed through routine immunization injections at 2, 4, 6, 12 months and/or most recently preschool age (with a subsample of 130 infants that was also followed at 12–18 months during a non-painful yet distressing parent–child interaction procedure).

The model begins with the chain of events arising from an acutely painful incident, typically conceptualized in terms of triggering biological processes related to a nociceptive threshold. The tissue stress

or damage is then transduced into an initial pain reaction via nociceptive afferents exceeding noxious sensory thresholds. Rather than pursuing the infinite challenge of operationalizing the non-verbal infant's subjective experience of the noxious stimulus, the model focuses on overtly measurable pain behaviours. After an immediate automatic/reflexive peak response is manifest following the painful event (observable via measures such as physiological or overt behavioural pain responses like cry, facial actions, or body movements), the infant begins the process of self-regulation towards re-establishing homeostasis (measurable via the decrease in overt pain responding as the immunization appointment progresses). Using complex, multifactorial modelling, emerging research on the OUCH cohort has clearly shown that the largest studied determinant of infant initial pain reactivity and pain regulation is the infant's earlier pain behaviour, either earlier in the specific immunization appointment or earlier in the life of the child.

Accordingly, over the first year of life in a standard immunization setting where almost all younger infants were immunized on an examining table and older infants were being held during immunization, specific caregiver factors (e.g. verbal reassurance, emotional availability, proximal soothing) have no to small relationships with infant pain behaviour, thus, the relegation of caregiver factors to peripheral determinant roles (compared to actual infant behaviour) in this infant-specific model. Moreover, all larger spheres of social influence, such as the family (e.g. the spouse or siblings), hospital ecology, or culture are speculated to exert influence *indirectly* through influencing the primary caregiver at the time the infant is in pain. For example, during an immunization, the parent's internal cognitive schema for pain will be influenced by cultural beliefs, availability/acceptability of pharmaceuticals, general pain knowledge and beliefs, skills for coping with the child's pain, and societal expectations for an infant's pain response. This schema in turn will influence caregiver pain assessment and management which then directly influences infant pain regulation and reactivity. Previous work confirming that a parent's recall of their child's painful immunization experiences was significantly determined by potential cultural stress (Pillai Riddell et al., 2007) add credence to this hypothesis regarding the influence of larger spheres on pain assessment.

There are three feedback loops inherent in the model. Consideration of the infant responding self-regulatory loop (see interrelationships between boxes in the model in Figure 9.4) suggests that within an appointment, the actual stimulus and the infant's sensory thresholds (influenced by previous pain experiences and genetic nociceptive thresholds) triggers an infant's initial pain reaction and that the initial pain reaction will contribute to determining regulation from the initial pain reaction. Moreover, it is postulated that future pain responding, through modification of pain thresholds, will be impacted upon by past pain responding (both initial pain reaction and the infant's regulation from it). Examination of the infant–caregiver regulatory feedback loop (see interrelationships *between* the boxes and the ovals in Figure 9.4) suggests that not only will a caregiver's initial assessment and management of an infant's acute pain be predicted by immediate pain reactivity, a feedback loop occurs relating to infant regulation and subsequent caregiver assessment and management. Thus, how an infant is regulating following the pain event will impact ongoing assessment and management in a cyclical fashion until the distress is no longer evident (i.e. infant regulation re-establishes homeostatic balance).

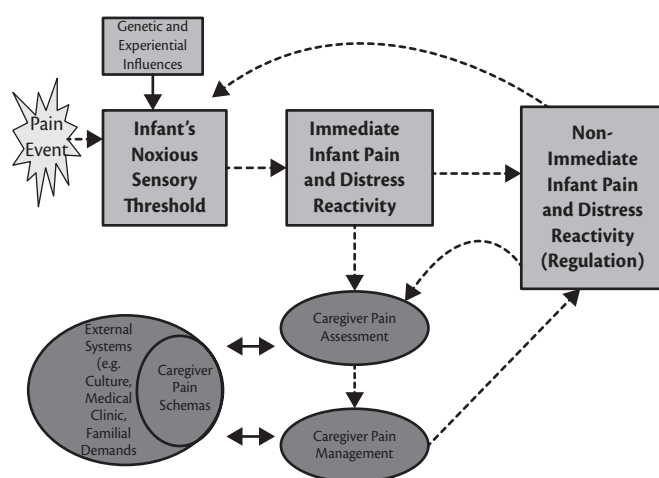


Figure 9.4 The development of infant acute pain responding model (the DIAPR model).

Finally, unique consideration must be given to the broader psychosocial systems of infancy. A parent feedback loop (see relations between ovals in the model in Figure 9.4) acknowledges that while an infant's pain responding (i.e. initial reactivity and regulation) contributes to caregiver assessment and management of the infant's pain, information arising directly from the infant is accommodated within existing parental schemas of the situation, based on influences such as cultural norms, medical institution guidelines, and the familial demands.

Finally, to attempt to bring further awareness to the steep trajectory of development during infancy, in Figure 9.4 dashed lines were used to portray those relationships that are hypothesized to change in strength over the course of infancy. For example, simply comparing infants at 2 months versus 12 months, OUCH cohort research indicated that the influence of parental factors, such as sensitivity or verbal reassurance, on pain responding was stronger at 12 months of age than at 2 months of age. Moreover, the transition and relationships between pain responses (i.e. pain reactivity and pain regulation) changes according to developmental stages within infancy. Solid arrows suggest that while changes may occur over time, this is likely to be not as strongly linked to the infant's development. Thus, the model attempts to capture the interplay between and among infant and caregiver factors as they change over the first year of life.

While attempting to capture observable inter- and intrapersonal factors to generate specific testable hypotheses regarding the infant, the model does not yet specifically outlay specific caregiver schemas that may be filtering influences from larger spheres of culture, medical norms, etc. Understanding patterns regarding how these larger systems influence the parental schemas which in turn impact on their behaviour towards their child in pain is crucial in trying to target interventions.

Critical review of paediatric pain models to date and future directions

Paediatric pain emerged as a distinct area of study in its own right relatively recently. There has been a proliferation of conceptual models over the past two decades. Generally speaking, these models share similar explanatory purposes in trying to understand the interplay among biological, psychological, and social processes during children's painful events. They postulate and emphasize different dimensions in seeking features of children's pain that are potentially modifiable to reduce pain and suffering in this vulnerable sector of society. Rather than conflicting with each other, the models reflect a remarkable degree of concordance concerning the key factors involved. However, one stark difference is the primacy of the caregiver. Most models embed the influence of the caregiver in a social dimension—only the SCM assigns caregivers a central role.

Interestingly, the biopsychosocial models presented here have chosen by design to either focus on acute or chronic pain. However, the formulations overlap. The models that examine the sequence of events involved in an acute pain episode acknowledge that previous pain experiences impact on current pain experiences. This provides an opportunity to examine relationships between acute and chronic pain. As Palermo and colleagues' models of chronic pain (2005, 2012) suggest, very similar aspects of the biology, psychology, and social environment (such as physical health, coping mechanisms, and culture) come into play, yet no models to date have attempted

to explicitly bridge the theoretical gap that currently separates acute and chronic pain. The opportunity may be available in the study of biopsychosocial factors that are involved with the transition from acute to chronic pain. In children this must give consideration to the developing nervous system.

A problematic tendency of most paediatric models has been to treat pain expression as a unitary construct. Yet, as others have acknowledged in the more adult-centric theoretical literature (e.g. Hadjistavropoulos et al. 2011), there are both automatic-reflexive components and more controlled-cognitively mediated components to pain, with both reflecting ontogenetic and socialization features of pain experience and expression. Pragmatically, one also could acknowledge this divide using a similar dichotomy based on pain reactivity (a child's immediate response to a painful event) versus pain regulation (a child's pain and distress temporally distal to the actual painful event as the child moves toward re-establishing homeostasis). It would follow that the strength of impact of biopsychosocial factors would vary, with more innate/reflexive factors (e.g. pain receptor density, temperament) likely more prominent with pain reactivity and psychosocial factors (such as attachment, cultural beliefs about the value of pain, gender biases) likely more important determinants of how the child self-regulates subsequent to the painful event.

The most important limitation of existing biopsychosocial models of paediatric pain arises from how development is handled. With a few focused exceptions, we know little about the developmental transformations in biological, psychological, and social bases of pain through infancy, childhood, and adolescence, particularly through longitudinal study. While all existing models acknowledge the importance of development, it is argued here that in biopsychosocial models the interplay of these dimensions must be recognized as different across childhood (defined here as from birth to adolescence).

Taken from the larger field of child development, Arnold Sameroff's unified theory of development (2010) provides an exemplar for this position. At the core of this model is the tenet that while biological, psychological, and social factors are important in understanding all stages of the developing child, the magnitude of influence varies through infancy, childhood, adolescence, and adulthood. Factors external to the child increase in prominence with age and exposure to ecological systems, such as those provided by parents, the family, peers, and the community (including health care system and geopolitical contexts). One can then discern that to the newborn infant larger psychosocial contexts (culture, community norms, institutional practices, etc.) outside the self are not directly consequential (they likely indirectly impact on the infant through a caregiver's mediation of these factors). These influences change over time as attachment bonds are formed with primary caregivers over early infancy and childhood and then as the child enters into new systems of psychosocial influence such as daycare, elementary, or university spheres.

Although challenging, given the crucial nature that developmental stage plays in paediatric pain, it is imperative that this role is acknowledged more specifically because the relative weight of related factors change over time. One alternative would be to create models specific to unique stages of life as in the DIAPR model. Biopsychosocial models could then be more explicit and clearly elaborate on key factors involved within the specified age range, without fear of becoming convoluted. Potential developmental 'phases', based on key

Case example

Leah is 4 years old and her parents would describe her as being 'sensitive' to tactile and noxious stimulation. She is about to have her preschool immunization. Her mother and 1-year-old brother are waiting with her in the examination room. She told her mother earlier that she did not want to go to the doctor today because she hates needles. Her mother reminded her to behave because 'good girls don't make a fuss'. Her mother also reminded her that when she was a young girl her mother gave her a spanking if she embarrassed the family by overreacting in public. Adding to her dismay about the appointment, Leah had to miss her favourite period in junior kindergarten, music, to come to the doctor. The minute the doctor entered the room Leah started crying, which triggered her younger brother's tears. Her mother soothed her young son and apologized to the doctor for Leah's outburst. By the time the doctor could restrain Leah and quickly insert the immunization needle, Leah expressed maximal pain behaviours and took a long time to calm down after the needle.

Acute immunization pain is just one type of pain that children face over the span of childhood. As Leah's case helps illustrate, to best understand her pain experience and responding, one must take a biopsychosocial perspective.

areas of development (e.g. reliance on parents versus peers, ability to self-report, biological/physical changes), could be birth through infancy (0–2 years), early childhood (3–6 years), middle childhood (7–12 years), and adolescence (13–18 years) would allow for models that more precisely outline the relative contributions of features and roles of biology, psychology and the social environment.

Conclusion

A child's experience of pain is an important area of focus within the broader pursuit of understanding human suffering. Developing biological and psychological capacities and social interactions distinguish infant, children, and adolescent experiences from those of the mature adult. The social contexts of pain, which interact with the child's biological and psychological action tendencies, are defined strongly by the impact of direct caregivers such as parents. Existing models in the field primarily describes these relationships separately for acute and chronic pain—integration is necessary. Future models could benefit by careful consideration of developmental stage factors.

Key recommendations

Having reviewed current biopsychosocial models of paediatric pain, key recommendations stemming from this work can be made:

- (1) Biological, psychological, and social dimensions are useful constructs that encapsulate the key factors influencing paediatric pain.
- (2) These dimensional influences are not static, but rather are dynamic, not only over the child's development, but also over the course of a discrete painful event or episode.
- (3) More work that acknowledges how factors within a dimension impact on the child differentially over different developmental stages will prove theoretically and pragmatically beneficial.

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