When, how, and why do we express pain?

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Chapter 6
When, How, and Why Do We Express Pain?

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Abstract The experience of pain is typically accompanied by various verbal and nonverbal behavioral expressions that help to inform our social environment about our pain. These expressions range from verbal reports (e.g., "I feel pain in my shoulder that is quite strong") to nonverbal expressions, like moaning and facial grimacing. Depending on the situational context, however, as well as on previous learning experiences, personality traits and our affective state, the way we express pain can vary substantially. In the present chapter we give an in-depth overview of the complex psychosocial factors that affect when, how and why we express pain.

Keywords Social context · Facial expression of pain · Pain vocalization · Social display rules · Threat

The experience of pain is typically accompanied by a certain set of verbal and nonverbal behavioral expressions. These expressions range from verbal reports (e.g., "I feel pain in my shoulder that is quite strong") to nonverbal expressions, like moaning and facial grimacing. While some pain behaviors (e.g., body posture) may serve a protective function (i.e., by limiting pain or further harm), other forms of verbal and nonverbal pain expressions (e.g., facial expression) mainly serve the purpose of informing our social environment about our inner state, namely the experience of pain. Why we want to inform our social environment about our pain and the way we

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inform them can certainly vary. An illustrative example of *how* and *why* we might express pain can be found at football (or soccer) matches. When football players are hit by an opposing player, one can often observe them falling to the ground, dramatically clutching the affected body part, rolling about, powerfully grimacing and groaning. Despite these dramatic displays of gruesome pain, the players often recover miraculously within a few seconds and continue playing as if nothing had happened. Reasons for the dramatic pain displays might include—besides experiencing strong pain—that football players hope to draw attention to a potential wrong-doing of the opposing player and as a result draw a game-changing free-kick or penalty.

This chapter discusses the different forms of verbal and nonverbal pain expressions and how these different forms are interrelated, underlying motives for why we express pain, and factors which influence the way we express pain to our environment. The main focus is on nonverbal forms of pain expressions which have been shown to be most powerful in signifying pain to others (Hadjistavropoulos et al., 2011).

How Do We Express Pain?

Pain is considered "an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage" (IASP, 1979). Thus, pain is by definition a subjective experience and only becomes accessible by being expressed. But how do we express pain? Pain is expressed via different nonverbal and verbal channels that include facial expressions, body movements, as well as (paralinguistic) vocalizations that can be nonverbal (e.g., moaning) or verbal ("I am in pain"). Indeed, only the expression of pain in its verbal and nonverbal forms makes pain accessible to the social environment or, in other words, to the "audience" of that expression. In clinical settings, the verbal report is the most often used form of pain assessment. In contrast, nonverbal forms of pain expressions often do not play an important role in clinical pain assessment; although nonverbal expressions surely have a great impact on psychosocial interactions and on clinical decision-making.

Verbal Expressions

Clinical pain assessment typically relies on subjective estimates of pain, using numerical or verbal scales (Jensen & Karoly, 2001). For example, when using a numerical scale, individuals might be asked to estimate their pain by providing a rating on a scale from 0 to 10, where 0 equals "no pain" and 10 is the "worst pain you can imagine." When using such a scale to express one's pain, one has to quantify as well as average one's pain experience over time (e.g., the last hours or previous week) and over situations (e.g., walking, sitting down, picking something up or

doing the household). These numerical rating scales are easy to administer and are often used for clinical pain assessment, especially for the assessment of acute pain intensity (e.g., post-surgery). In case of more complex chronic pain conditions, the McGill Pain Questionnaire (Melzack, 1975; Melzack & Katz, 2001) is frequently used. Here, patients can describe not only the intensity but also the quality of their pain experience, by choosing from a list of adjectives those that best describe their pain (e.g., throbbing, pinching, burning). Given that the expression of pain via verbal report is not only easily accessible, but also allows the person in pain to differentially describe their experience, its potential causes and options for dealing with the pain, it is not surprising that self-report is viewed as the gold standard for pain assessment. However, despite all its advantages, self-report of pain also has several disadvantages. For one, it is dependent on cognitive, especially language capability and thus not available to individuals with language deficits, like patients with dementia (Kunz, Scharmann, Hemmeter, Schepelmann, & Lautenbacher, 2007), patients with aphasia, infants and toddlers (see Chap. 17) as well as individuals with intellectual disabilities (Defrin et al., 2015). Moreover, the verbal report is less reflexive/automatic compared to nonverbal pain expressions (e.g., facial expression) and therefore, might be more prone to self-report biases (Schiavenato & Craig, 2010) (see also Chap. 5). Accordingly, nonverbal forms of pain expression are not only of relevance when self-report is not available but also in situations when the credibility of the self-report might be questionable or when more reflex-like responses are of interest (Craig, Versloot, Goubert, Vervoort, & Crombez, 2010).

Nonverbal Expressions

Nonverbal expressions of pain are usually divided into three groups, namely body postures/movements, paralinguistic vocalizations and facial expressions (Craig et al., 2010). This division into three distinct groups of nonverbal expressions is also apparent in observational pain assessment scales used to assess pain in nonverbal individuals (e.g., patients with dementia), like PAINAD (Warden, Hurley, & Volicer, 2003), PACSLAC (Chan, Hadjistavropoulos, Williams, & Lints-Martindale, 2014), or PAIC (Corbett et al., 2014). Among the three groups, the facial expression of pain has been studied most extensively. This mirrors research activities in the field of emotion expressions, with extensive research having been conducted in the field of facial expressions of emotions, whereas body postures and vocalizations during emotions have just recently become of research interest (Kunz, 2015).

Expressing Pain via Body Movements

Although it is unquestionable that the experience of pain is typically accompanied by body movements (Walsh, Eccleston, & Keogh, 2014), little research has thus far been conducted to classify or describe body movements accompanying pain.

Reasons for the lack of research might stem from the complexity and great interindividual variability of bodily movements accompanying pain as well as from the lack of instruments to objectively assess them. Within the group of nonverbal behavioral responses to pain, body movements are believed to primarily serve a pain management or pain protection function (Prkachin, 1986; Williams, 2002). For example, rubbing and holding the affected body part or cautious, rigid approaches to movement mainly serve the purpose of protecting the self from further noxious input and to promote pain relief as well as healing. In contrast, the other two forms of nonverbal pain expression (facial expression and vocalization) are believed to primarily serve a communicative function (Prkachin, 1986). Given that bodily movements accompanying pain may not primarily serve a communicative function, the variability and complexity of body movements seems less surprising. In other words; because body movements associated with pain may not mainly serve a communicative purpose, they may not need to be as distinct or as definable as facial expressions of pain or pain vocalizations. In line with this, Walsh et al. (2014) found that pain is not expressed via one single prototypical movement but rather via a combination of different movements that when paired with contextual cues can become a distinctive indicator for pain. This lack of a single pain-prototypical body movement is not surprising considering that the origin of pain, the quality of pain and the body areas/body parts being affected can vary immensely and therefore, body movements aiming at reducing or controlling the pain should also vary greatly. Nevertheless, although body movements are assumed to primarily serve protective functions, they can also be communicative, since they can be picked up as pain-indicative behaviors by others thus, serving the potential to also communicate (voluntarily or involuntarily) to others that one is in pain (Walsh et al., 2014).

Given the diversity of pain-indicative body movements, several authors have used an approach, where they do not try to define an overall pain-typical set of body movements, but instead tried to characterize body movements that are indicative for one specific type of pain (e.g., lung cancer pain (Wilkie, Keefe, Dodd, & Copp, 1992), back pain (Keefe & Block, 1982), and rheumatoid arthritis (McDaniel et al., 1986)). However, despite the enormous diversity among pain-indicative body movements, there seem to be some body movements that have repeatedly been observed across different types of pain and that might be pain-indicative for various types of pain. These body movements are guarding (abnormally slow, stiff, interrupted or rigid movement), bracing (a stiff, static position), and rubbing the painful area (Walsh et al., 2014).

Expressing Pain via Vocalization

So far, very little is known about paralinguistic vocalization changes occurring during pain. Although it is acknowledged that pain experiences are accompanied by nonverbal vocalizations and although vocalization items—such as crying, shouting, groaning—are included in nearly all observational scales for pain assessment in patients with dementia (Herr, Bjoro, & Decker, 2006; Zwakhalen, Hamers,

Abu-Saad, & Berger, 2006), studies that have tried to investigate these pain-indicative vocalizations using specialized tools are lacking. Around three decades ago several attempts were made to analyze and characterize pain vocalization in infants, with a special focus on pain cries (see overview by Craig, Gilbert-MacLeod, & Lilley, 2000). It was reported that pain cries could be differentiated from cries due to anger or fear because pain cries were longer, the intensity was greater and there was a higher percentage of dysphonation (blurring of harmonies) (Johnston & O'Shaugnessy, 1987). However, it has been questioned whether pain cries indeed have discrete features that help to differentiate them from cries due to other types of negative affective states. It seems that pain cries in infants are not really qualitatively different from other types of cries but just differ quantitatively, due to a higher level of arousal due to pain. Thus, it remains unclear whether the observed features of pain cries in infants are indicative of a distinct type of affective state (namely pain) or only of different degrees of a negative affective arousal (Craig et al., 2000).

These findings on pain vocalizations in infants are difficult to transfer to adults or even to children, given the anatomical maturing of the vocal chords, vocal tract, throat, mouth, lips and tongue. Studies on pain vocalizations in adults are mostly missing so far. In one recent pilot study, Lautenbacher, Salinas-Ranneberg, Niebuhr, and Kunz (2017) have investigated objective acoustic-phonetic characteristics like loudness (i.e., acoustic-energy level) and pitch (i.e., F0, Hz) and whether they qualify to detect and grade different pain intensities. More precisely, they studied the production of different vowels while participants immersed their hand in hot water that elicited non-painful as well as painful sensations. The authors found that those vowels that were best approximations to moaning and groaning (vowels "u" and the central vowel "schwa") showed a significant increase in pitch and loudness during pain. Moreover, changes in these vocal parameters also significantly predicted concurrent changes in subjective pain ratings. These are promising results; however, more studies are needed that study a broader set of voice parameters, like further acoustic parameters of source (i.e., voice-quality exponents like spectral emphasis/tilt) and filter (i.e., formant) characteristics during pain, in order to provide a more precise characterization of vocalizations due to pain. Likewise, further research is needed to examine the specific communicative value of discrete pain vocalizations and whether these are truly discriminatively indicative of pain or just indicative of a stronger intensity of a negative affective state; as has been suggested for pain vocalizations in infants.

Expressing Pain via Facial Responses

As stated above, facial expressions of pain have been studied most extensively. Especially in the last two decades a considerable number of studies have been conducted that tried to capture the prototypical facial expression of pain and examine which biopsychosocial factors affect the extent and specific ways in which we facially express pain. Reasons why research on pain behavior has predominantly focused on facial expressions of pain include that facial expressions are readily

accessible, highly plastic and are believed to be the most specific pain behavior in humans (Williams, 2002). Research endeavors on facial expression of pain also mirror research activities in the field of emotion expression which have largely focused on facial displays.

When investigating facial responses to pain, nearly all studies have employed the Facial Action Coding System (FACS; Ekman & Friesen, 1978), which is based on anatomical analysis of visible facial movements. These facial movements are categorized as so-called Action Units (AUs). The FACS lists 44 different AUs; each AU being based on discrete movements of specific muscles or, in a few cases, on groups of muscles of the face. FACS analyses of facial expressions are not carried out in real-time but instead the videotaped facial expressions are coded in slow-motion and stop-frame feedback. FACS-coders, who undergo approximately 100–200 h of training (Ekman & Friesen, 1978), identify which AUs are displayed, their onset and offset and their intensity during specified time intervals. Not only is FACS training rather long but FACS coding itself is also very time-consuming, thus making FACS analyses difficult to use in clinical settings. For research purposes, however, the FACS has enabled us to better describe and understand specific facial responses occurring during the anticipation or experience of pain.

Using the FACS, it has been shown that facial activity during pain is not unspecific grimacing but conveys pain-specific information (Hadjistavropoulos et al., 2011; Williams, 2002). Evidence for this can be mainly taken from two sources. First, despite some variability, there seems to be a subset of facial movements that repeatedly occur across different types of pain (ranging from different types of experimental pain induction procedures to clinical pain (Prkachin, 1992; Prkachin & Solomon, 2008)) as well as across individuals (male/female (Kunz, Gruber, & Lautenbacher, 2006); young/old (Kunz, Mylius, Schepelmann, & Lautenbacher, 2008)). This subset of facial movements indicative of pain includes the following facial movements: tightening of the muscles surrounding the eyes (AU6_7), furrowed brows (AU4), raising the upper lip/nose wrinkling (AU9_10), opening of the mouth (AU25_26_27) and eye closure (AU43) (Kunz & Lautenbacher, 2014; Prkachin, 1992; Prkachin & Solomon, 2008). Images of these facial movements are displayed in Fig. 6.1. The combination of these facial movements is often referred to as the "prototypical facial expression of pain." Second, when actors are taught to display this subset of "pain-prototypical" facial movements, observers can recognize pain among other emotions above chance level (Simon, Craig, Gosselin, Belin, & Rainville, 2008).

However, it is important to keep in mind that despite the evidence that these key facial movements reliably occur during pain, this by no means implies that a fixed uniform facial expression of pain can be observed across diverse situations within and between individuals (Craig, Prkachin, & Grunau, 2011). Instead, the frequencies of occurrence of these key movements during pain usually range from 10 to 60% (Kunz, Chen, Lautenbacher, Vachon-Presseau, & Rainville, 2011; Kunz & Lautenbacher, 2014; Kunz, Rainville, & Lautenbacher, 2011). Therefore, the likelihood that all four key facial movements occur simultaneously or in other words the likelihood that an individual experiencing pain displays the complete "prototypical

Fig. 6.1 Examples of facial expressions of pain

expression of pain" is very low. Rather, individuals often display only parts of this subset, sometimes even blending it with a limited range of other facial movements (e.g., smiling (Hale & Hadjistavropoulos, 1997; Kunz, Peter, Huster, & Lautenbacher, 2013; Kunz, Prkachin, & Lautenbacher, 2009)). We recently demonstrated in a training study that observers were better in detecting facial expressions of pain after they learned about different facial activity patterns of pain compared to a group that was only trained to recognize the "prototypical expression of pain" (Kunz & Lautenbacher, 2015). These different facial activity patterns are composed of different combinations of facial movements (Kunz & Lautenbacher, 2014). These are tightening of the

muscles surrounding the eyes that is either paired (1) with furrowed brows or (2) with wrinkled nose, (3) or with an opened mouth. These different facial activity patterns all have one facial movement in common, namely the tightening of the muscles surrounding the eyes (AU6_7). This facial movement is indeed the most frequent and thus possibly the most important facial movement occurring in the context of pain (Craig et al., 2011). Moreover, the tightening of the muscles surrounding the eyes is also the single facial movement that helps observers to differentiate the very similar facial expressions of pain and disgust; which is critically important for clinical assessment since facial expressions of pain and of disgust are very frequently mistaken for each other (Kunz, Prkachin, & Lautenbacher, 2013).

Last but not least, it is also important to mention that a considerable percentage of individuals (approximately 15–25%) do not show any visible facial responses during the experience of pain although they do report moderate to even strong pain intensities (Kunz & Lautenbacher, 2014). Overall, the threshold of facial expressions of pain is much higher than the subjective pain threshold (Craig et al., 2011). Prkachin and Craig (1995) referred to the facial expression of pain as a late signaling system since we tend to only express pain when it has reached a moderate or strong intensity, and even then individuals might not facially express it. Reasons for stoic expressions (e.g., social display rules) are discussed below. Interestingly, individuals are often not aware of their stoic facial responses during pain (as well as other facial expressions of emotions (see for example Barr & Kleck, 1995)), and overestimate the degree to which they express pain via the face. This is important to keep in mind when judging pain based on facial expressions, since this indicates that individuals might be experiencing pain although they do not show any pain-related facial activity and that a "stoic-face" is not necessarily incompatible with the experience of pain.

Correlation Between the Different Pain Expression Forms

One might ask why we express pain via so many different channels and whether these different channels transmit exactly the same type of information content to our social environment. When clinicians started to be interested in using nonverbal forms of expression to assess pain in nonverbal individuals (e.g., patients with dementia), many believed that the facial expression of pain might serve as a 1:1 substitute for the compromised self-report (Lautenbacher & Kunz, 2017). However, empirical as well as theoretical reasons speak against the assumption that each form of pain expression simply mirrors another form. The term "facial expression of pain" is actually already misleading because it suggests a unidirectional processing—with the subjective experience evolving first and the facial expression following after. However, the pain response system mostly runs in parallel, with mutual influences between the subjective experience and its different forms of verbal and nonverbal expressions. Moreover, each form of pain expression is only able to capture certain aspects of the multidimensional pain experience. Neither can a pain rating on a scale

from 0–10 capture the complex multidimensionality of pain (Schiavenato & Craig, 2010), nor can a few facial muscle movements or few vocal parameters. Thus, it is not surprising that correlations between self-report ratings and facial expressions of pain are small in most studies (Kunz, Mylius, Schepelmann, & Lautenbacher, 2004). It seems that each form of pain expression constitutes an independent source of information for observers, which might help them to identify certain aspects of the multidimensional pain experience (Craig et al., 2011; Kunz, Chen, et al., 2011; Kunz, Rainville, & Lautenbacher, 2011). Which aspect of pain is conveyed via which communication channel has yet to be unraveled. Accordingly, disregarding nonverbal pain expressions as valid pain indicators simply because of a weak correlation with self-reported pain ratings is based on an erroneous conclusion.

Why Do We Express Pain

The main reason why we express pain is to solicit help, support, and empathy responses from our social environment in a situation of distress and potential danger. Moreover, it is also believed that the expression of pain (especially via facial responses and nonverbal vocalizations) serves the purpose of alerting others (Hadjistavropoulos et al., 2011; Williams, 2002) to potential danger. Given that both the gaining of help and support from others as well as warning others of potential danger seem crucial for survival (of the person in pain or his/her social environment) it is believed that evolution played an important role in bringing about the expression of pain (Williams, 2002; see also Chap. 1). Indeed, at least with regard to the facial expression of pain, it has been shown that is not a learned but a mostly inborn behavior that is already displayed by infants (Grunau & Craig, 1987; Grunau, Johnston, & Craig, 1990) as well as by congenitally blind individuals (Kunz, Faltermeier, & Lautenbacher, 2012).

Evidence supporting the assumption that the expression of pain serves the purpose of eliciting empathy and social support from one's social environment can be found in various studies. For instance, multiple studies have examined the impact of observing another's facial pain expressions on the observer (see also Chaps. 11 and 12). Using imaging studies, it has been repeatedly shown that the observation of pain behaviors, and particularly observation of facial expressions of pain, activates largely similar brain responses in the observer as the direct experience of pain itself (see Chap. 8). This suggests that observing pain automatically references the self, potentially signaling threat to one's own physical integrity (Yamada & Decety, 2009) and motivates avoidance behavior. However, this motivation for avoidance behavior is counterbalanced by social roles and social rules (e.g., as a health care professional it is my role to care for the patient) as well as by social bonds (e.g., between parents and the child) that make caregiving behavior more likely than not.

Three different but related dimensions have commonly been distinguished when depicting the impact of pain expression upon observing others: first, the *detection and discrimination* of available (pain) information; second, the *meaning* attached to

what has been observed; third, the *behavioral responses* of the observer (Prkachin & Craig, 1995; Prkachin, Solomon, & Ross, 2007). Specific characteristics of the observer (e.g., parent) may influence both attention to pain cues and interpretation of these pain cues, thereby having an impact upon caregiving behavior (Hadjistavropoulos, Craig, Grunau, & Whitfield, 1997). In line with the cognitive-affective model of pain, in which the interruptive function of pain is central (Eccleston & Crombez, 1999), evidence has shown that individuals who perceive pain as highly threatening (i.e., engage in high levels of catastrophizing) are more attentive to the pain signals of others, estimate the pain of others to be more severe and/or interpret others' experiences more negatively (Goubert, Vervoort, Cano, & Crombez, 2009), and engage in various helping behaviors aimed at reducing, avoiding or escaping the other's pain. This dynamic is particularly evident in parent-child dyads, where parental attention towards child pain and associated distress when anticipating/observing their child's pain motivates behaviors to restrict the child's pain exposure (Caes, Vervoort, Eccleston, & Goubert, 2012; Caes, Vervoort, Eccleston, Vandenhende, & Goubert, 2011). Research with healthy school children (Caes et al., 2012) and children with chronic pain (Caes et al., 2011) finds that parental distress contributes to increased restriction of experimentally induced child pain and painful physical activity. Although empathetic observer behaviors that aim at restricting or controlling the others' pain exposure might be adaptive in the short term, evidence suggests these responses have, particularly in the context of long term or inescapable pain, maladaptive consequences for the person in pain; catastrophizing thoughts in caregivers, such as parents (but also spouses) are associated with higher levels of functional disability, pain intensity, and emotional distress in the person suffering pain (Cano, 2004; Goubert, Eccleston, Vervoort, Jordan, & Crombez, 2006).

When Do We Express Pain

The ability to solicit support from others in the social environment may have stress-, pain- or fear-reducing properties and hence serve protective social functions (Prkachin & Craig, 1995). Facial expressions of pain may be particularly salient in this regard (Hadjistavropoulos et al., 1997; Williams, 2002). However, while the expression of pain seems to have mostly positive consequences; there are individuals or certain situations when pain is not expressed but when the experience of pain is accompanied by stoic expressions. How can that be? Why do we sometimes tend to not express our pain and/or why does pain expression vary across different situations and within and between individuals? In the following, we will discuss different psychosocial factors that have been found to impact "when" we express pain. Especially the impact of learning via observation and operant conditioning will be described. Moreover, the role of social rules (social display rules) that govern when (in which social context) and how we express pain will be discussed. And lastly, we will touch upon the impact of interpersonal/social threat.

Learning of Social Display Rules

Based on empirical findings, it is acknowledged that facial expressions of pain are a product of both innate (hardwired) as well as of social learning effects (Hadjistavropoulos et al., 2011). This means that facial responses become modifiable across early and late childhood through social learning experiences (Hadjistavropoulos et al., 2011). In line with this notion, studies have indicated that children, from an early age on, are able to modulate their expression of pain and distress (Buss & Kiel, 2004) and that they do so for a variety of reasons. Children's pain expression may vary, in part by the way a child is socialized to think about pain and behave when in pain (Craig, Stanford, Fairbairn, & Chambers, 2006; Fearon, McGrath, & Achat, 1996; Zeman & Garber, 1996)—learning that may be influenced by a broader set of cultural display rules (Gnepp & Hess, 1986). Facial expression of pain is particularly susceptible to social learning effects. Whereas young children tend to show vigorous facial expressions of pain, older children and adults seem to have learned to effectively downregulate their facial expressions of pain (Larochette, Chambers, & Craig, 2006). In line with this finding, a functional imaging study demonstrated that a low degree of facial expressiveness to pain was associated with higher activation in frontostriatal structures (Kunz, Chen, et al., 2011; Kunz, Rainville, & Lautenbacher, 2011). Given that these frontostriatal structures are known to be involved in motor inhibition, this finding suggests that low expressive individuals actively suppress their facial expression of pain (Kunz, Chen, et al., 2011; Kunz, Rainville, & Lautenbacher, 2011). A similar suggestion stems from a recent study that showed a close correlation between facial expressions of pain and the ability to inhibit automatic motor movements (Anti-saccade task), with low inhibitory ability being associated with stronger expressions of pain (Karmann, Lautenbacher, & Kunz, 2015). When trying to interpret these findings, it seems reasonable that individuals learn to intentionally suppress the facial display of negative affect (including pain) following culturally/socially learned "display rules." These display rules represent social norms about when, where, and how one should express affective states (Ekman, Sorenson, & Friesen, 1969). These social display rules are learned already at a young age. Children are aware of the interpersonal ramifications of expressing their pain and base their decisions to express, hide or even dissemble their pain on the type of response they expect to receive following a pain disclosure. For example, children as young as 9 years old report being less likely to express pain in front of a peer than in presence of their parent because they perceive peers to be less accepting of pain displays and responding more negatively than parents (Zeman & Garber, 1996). Children may also hide their pain because of other-protective reasons (Crombez & Eccleston, 2002) like not wanting to worry or upset their parents (Larochette et al., 2006). Accordingly, facially responding to pain would be the "default" which individuals learn to suppress due to social/cultural demands (e.g., "big boys don't cry," "don't be a sissy").

Further evidence for the assumption that social learning impacts the degree to which we express pain was found in a study on operant conditioning of facial

expressions of pain (Kunz, Rainville, & Lautenbacher, 2011). In a within subject design, participants were in one block reinforced over a series of trials whenever they displayed facial expressions of pain and in another block were reinforced for not expressing their pain via the face (stoic expression). The operant conditioning led to strong changes in the expression of pain. Positive reinforcement of facial expressions of pain resulted in a significant increase in facial expression, whereas the positive reinforcement of a stoic expression resulted in a strong decrease in facial expressions during noxious stimulation. Thus, it is plausible that we learn when to express pain based on the reactions of our peers, parents, family and friends (responding by reinforcing or punishing our expression of pain) when and how we should express our pain. See also Chap. 13 for more details on the effect of operant reinforcement on pain.

Social Presence

Regardless of the social situation (i.e., who is present when experiencing pain), it has been shown that pain is expressed via the same set of facial movements. Thus, the elements of the facial language used to express pain remain unaltered by social situations and thereby stay constantly recognizable (Karmann, Lautenbacher, Bauer, & Kunz, 2014). However, the *degree* of facial expressiveness is strongly affected by the social situation, social presence in particular.

Social presence affects pain displays from an early age on. For instance, when studying facial expressions of pain in children it was found that children facially display pain to a higher degree in the presence of their parents, whereas they suppress their communication of pain in the presence of a stranger (Vervoort et al., 2008; Zeman & Garber, 1996). Similar findings in pediatric samples have been observed when comparing parental presence to situations where no one is observing (Vervoort et al., 2011). Studies in adults reveal comparable findings. In particular, studies have demonstrated that the expression of pain is much more stoic when individuals are tested in the presence of an unfamiliar observer compared to being alone or being in the presence of a loved one (Karmann et al., 2014; Kleck et al., 1976; Vlaeyen et al., 2009). The more stoic expression of pain in the presence of a stranger is likely due to the fact that expressing one's pain freely could be interpreted as a sign of weakness and vulnerability (Williams, 2002) and thus, as stated in more detail above—we have learned to inhibit our expression. In contrast, expressing one's pain freely in the presence of a loved one seems beneficial since sympathetic observers might faster be able to identify painful experiences and therefore the possibility of receiving help is elevated. Thus, the learned inhibition of facial expressions of pain seems to be disinhibited/released in the presence of a familiar or loved one.

Interestingly, the effect of the social situation on the expression of pain also seems to be dependent on different *intraindividual* factors. For one, the sex of the person seems to play a role. In the presence of a stranger, women were found to decrease their facial expression of pain much more than men did (Karmann et al.,

2014). This finding is well in line with previous findings on sex differences in social display rules. In front of strangers, females—compared to males—seem to express positive affective states, like happiness, facially, and tend to conceal negative ones like anger (Davis, 1995; LaFrance, Hecht, & Paluck, 2003).

Moreover, the tendency to catastrophize about pain has also been found to play a role, not only in understanding the level of pain expression (see Chap. 5), but also in understanding the impact of social presence. Specifically, the studies described above on child facial pain expression as a function of social presence (Vervoort et al., 2008, 2011) revealed a significant *moderation* effect of the child's pain catastrophizing. In particular, Vervoort et al. (2008) demonstrated that children showed increased facial pain expression in presence of their parent rather than a stranger, but *only* when the child reported infrequent or low levels of catastrophic thoughts about pain. For high catastrophizing children, an *indiscriminate* pattern of facial pain display was found. High catastrophizers' facial pain expression was equally pronounced regardless of the relational status of the observer; they expressed as much pain in presence of their parent as in presence of a stranger. These findings suggest that high catastrophizing children may have difficulty suppressing pain expression and identify others, even those from whom help or care is uncertain, more easily as potential deliverers of care. Similar findings were observed when comparing parental presence with being alone (see Vervoort et al., 2011); high catastrophizing children showed equally high levels of facial display of pain, regardless of social context, whereas low catastrophizing children showed higher levels of facial display in presence of their parent than when alone.

Pain Expression in Unsafe or Threatening Environments

As mentioned previously, one of the main motivations to express pain is to solicit help and support from others and possibly alert them to approaching danger. However, both evolutionary theory and social learning theory would predict that there are certain environments where it is not advantageous to express pain (see also Chap. 1 and Williams, 2002). We would expect that pain expression is reduced when we are surrounded by individuals who are unlikely to offer help or even might take advantage of us when in a state of vulnerability (e.g., someone who intentionally tries to cause harm or take resources from us) as this would be disadvantageous for survival. Above-noted findings that children express less pain in presence of a stranger compared to parental presence are in line with this notion (Vervoort et al., 2008). Furthermore, the above-described findings on operant conditioning of pain expressions (Kunz, Chen, et al., 2011; Kunz, Rainville, & Lautenbacher, 2011) would likewise predict that pain expression is inhibited following punishment (e.g., when expressing vulnerability is met with further harm, see also Chap. 13). In other words, we might expect higher levels of pain expression in a safe social context (e.g., in the presence of family, friends or caregivers) but reduced pain expression

when the social context is perceived to be threatening (e.g., in the presence of adversaries) or in ambiguous situations (e.g., in the presence of strangers).

There is only limited empirical research to date testing this prediction. Some evidence comes from studies in rodents. In one influential study by Langford et al. (2006), pain behavior in mice was investigated when in the presence of either a stranger mouse, a cagemate, a sibling, or in isolation. Findings of this study indicated that mice expressed significantly less pain when in the presence of a stranger mouse compared to all other conditions, most likely because the presence of a stranger is a source of social stress. This result was later replicated in a second study, and seemed to be specific for same-sex male dyads (Langford et al., 2011). What about humans? A study by Williams, Gallagher, Fidalgo, and Bentley (2016) used agent-based modelling to study whether exploitation of injured agents would lead to reductions in pain expression. They found that pain expression indeed was reduced almost to zero when expressing vulnerability was met with exploitation across numerous iterations, providing support for the evolutionary prediction that expressing vulnerability can be associated with costs and if these costs are high enough, expression will be reduced. In addition, there is a single experimental study in humans which investigated the effect of social threat on facial pain expression and pain reports (Peeters & Vlaeyen, 2011). In this study, social threat was manipulated by leading participants to believe that others were willing to inflict varying levels of pain upon them. While an earlier study had found that intentional pain is associated with increased pain reports (Gray & Wegner, 2008), this study was the first to demonstrate that social threat can lead to a dissociation between pain reports and facial pain expression. Specifically, findings demonstrated that while subjective pain reports were indeed higher in the threatening social context, facial display of pain was reduced.

As mentioned in Chap. 1, it is still a matter of debate whether pain expression is actively suppressed in an unsafe environment or whether suppression of pain expression is the norm and is only released when in a safe environment. The finding that pain expression is commonly suppressed in the presence of strangers, who are not actively threatening, seems to indicate the latter. Moreover, we recently conducted a study (Karmann et al., 2016) where we used repetitive transcranial magnetic stimulation (rTMS) to decrease the excitability of the medial prefrontal cortex and to investigate its effect on facial expressiveness during pain. Given the prominent role of the prefrontal cortex in suppressing facial expressions of pain (Kunz, Chen, et al., 2011; Kunz, Rainville, & Lautenbacher, 2011), we expected that reducing the activity of the prefrontal cortex (via rTMS) would result in a disinhibition of facial expressions of pain, and thus in increased facial responses. This is exactly what we found (Karmann et al., 2016). Decreasing prefrontal activity resulted in increased facial expressions of pain, which supports the notion that—due to socialization—suppression of pain expressions seems to be the default; and that this suppression is released when in safe environments.

The idea that pain expression is reduced in threatening or unsafe environments has important implications for clinical practice. For instance, experiences of pain in threatening social environments might create a double burden for the sufferer. One

such example might be bullying, which is highly prevalent and frequently involves not only psychological but also physical assault (Salmivalli, 2010; Vanderbilt & Augustyn, 2010). Based on the arguments outlined above, experiences of bullying are highly threatening social experiences often involving intentional pain by one or more assailants and might lead not only to worsened pain outcomes including a higher chance for the development of chronic pain (Fekkes, Pijpers, Fredriks, Vogels, & Verloove-Vanhorick, 2006; Voerman et al., 2015), but at the same time reduced expression of pain to protect oneself from more bullying. This might have detrimental consequences for the sufferer, as others (including the bullies) would likely underestimate the pain that is caused, thus, further exacerbating the problem.

Along similar lines, if pain is only adequately expressed in safe environments, it should be in our best interest to create safe interpersonal environments in clinical practice to lay the groundwork for adequate treatment of acute and chronic pain. Unfortunately, as is also discussed in Chap. 12, we have ample reason to believe that clinical settings are frequently not perceived as safe. Especially chronic pain patients are often met with doubt, judgment, stigmatization, invalidation and accusations of deception (Cohen, Quintner, Buchanan, Nielsen, & Guy, 2011; De Ruddere & Craig, 2016; Williams, 2016). At the same time, we know that pain is commonly underestimated by lay observers and experienced clinicians (Kappesser, Williams, & Prkachin, 2006; Kappesser & Williams, 2008). Based on the arguments put forward in the present chapter, this underestimation might at least be partly due to suppressed pain expression in an environment that is not perceived as safe. It should therefore be in our best interest to create a supportive and safe environment for individuals suffering from acute and chronic pain, where expression of vulnerability is encouraged rather than questioned (also see Chap. 13 for a discussion of the Intimacy Process Model), as only such an environment will provide a chance for adequate pain assessment and subsequent treatment.

Future Research

In the present chapter we have given an in-depth overview of the complex psychosocial factors that affect when, how and why we express pain. This complexity is further increased by the different channels via which we express pain (verbal, facial expression, vocalizations, body movements/postures) and which are often differently impacted by psychosocial factors. So far, most studies have only focused on one or two pain expression channels, and thus more multichannel approaches are needed that help us to grasp more comprehensively how pain expression is differentially affected by psychosocial factors. Moreover, pain expression is a dynamic communication process. This dynamic nature of it has mostly been neglected in the study designs so far; with the majority of studies focussing either on how social settings affect the expression of pain (focussing on the person in pain) or on how facial expressions of pain affect the observer. However in order to better

understand when, how and why we express pain, we need to study the dynamics of pain expression by studying both the person expressing pain as well as the social interactant, their relationship, their behavioral responses across time, their learning history and their psychological characteristics.

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