Article

Evolutionary Psychology
April-June 2016: 1–7

DOI: 10.1177/1474704916653964
evp.sagepub.com
SAGE

An Evolutionary Perspective on Pain Communication

Leander Steinkopf[1,2]

Abstract

Pain serves as a signal to elicit care from others. In turn, displaying pain might be attractive because of the benefits it might bring. Additionally, displaying pain is easy, because helpers distinguish poorly between genuine pain and faked pain. Hence, helpers face the problem of distinguishing true sufferers from free riders, while sufferers face the problem of communicating need convincingly. This article will propose solutions to these adaptive problems. Based on theoretical arguments and on empirical insights from lie detection research, it will be argued that the credibility of pain signals cannot be found in features of the signal itself, but in its context. Namely, pain is obviously credible when the context features unforgeable cues, such as an open wound or the enlarged abdomen of a pregnant woman, but also external cues such as the ice water in cold pressor tasks. In absence of such cues, pain can become credible through costly consequences, such as refraining from rewarding behaviors for a significant period. However, these adaptive mechanisms for communicating need may not be shaped for modern circumstances such as experimental settings and therapeutic encounters.

Keywords

pain behavior, malingering, signaling theory, lie detection, social support

Date received: December 19, 2015; Accepted: May 3, 2016

The adaptive value of pain lies in the actions it motivates (Goubert et al., 2005; Wall, 1999; Wiech & Tracey, 2013). On the one hand, there are the actions of the sufferer, such as escaping a painful situation and adopting a relieving posture. On the other hand, there are the actions of observers, namely, assistance, care, and treatment. Observers detect others' needs based on observable cues of pain, so-called pain behavior (also referred to here as pain expression or pain display), such as vocalization, verbal complaint, or posture. Consequently, several theoretical approaches assume that pain behavior serves as a signal with the function of motivating acknowledgment and help from observers (Craig, 2009, 2015; Fabrega, 1997; Finlay & Syal, 2014; T. Hadjistavropoulos & Craig, 2002; T. Hadjistavropoulos et al., 2011; Schiefenhövel, 1995; Steinkopf, 2015; Sullivan, Adams, & Sullivan, 2004; Sullivan et al., 2001; Vigil & Strenth, 2014; Williams, 2002). For example, taking an evolutionary perspective, Finlay and Syal (2014) address the question of why childbirth in humans is so exceptionally painful. They argue that, throughout the course of evolution, the more intensely women expressed pain during childbirth, the better they were able to attract birth assistants and, in this way, raise the probability of their newborns' and their own survival. Based on this advantage, intense labor pain in humans was favored by natural selection.

However, following the assumption that pain behavior can trigger a response of substantial support from others, the status of sufferer is assumed to be attractive to free riders, namely, people who fake pain (Fabrega, 1997; Finlay & Syal, 2014; Steinkopf, 2015; Williams, 2002). Therefore, observers should be suspicious of cheating (Steinkopf, 2015; Williams, 2002), and hence reluctant to help (De Ruddere, Goubert, Vervoort, Kappesser, & Crombez, 2013; Kappesser, Williams, & Prkachin, 2006). However, this suspicion does not seem to lead to accurate cheater detection, as laypeople and even medical

[1] Comparative Developmental Psychology, Department of Education and Psychology, Freie Universität Berlin, Berlin, Germany
[2] Placebo Research Lab, Institute of Medical Psychology, Ludwig-Maximilians-Universität München, München, Germany

Corresponding Author:
Leander Steinkopf, Institut für Medizinische Psychologie, Ludwig-Maximilians-Universität München, Goethestr. 31, 80336 München, Germany.
Email: leander.steinkopf@fu-berlin.de

professionals distinguish poorly between people in pain and people faking pain (Bartlett, Littlewort, Frank, & Lee, 2014; H. D. Hadjistavropoulos, Craig, Hadjistavropoulos, & Poole, 1996; Jung & Reidenberg, 2007; Littlewort, Bartlett, & Lee, 2009). The assumed suspicion toward sufferers and the limited ability to discover faked pain may contribute to the fact that laypeople as well as professionals discount the sufferers' pain when that pain has no apparent medical reason (Chibnall & Tan, 1999; De Ruddere, Goubert, Vervoort, Prkachin, & Crombez, 2012; Gillmore & Hill, 1981; Halfens, Evers, & Abu-Saad, 1990; Tait & Chibnall, 1994, 1997; Twigg & Byrne, 2015). Furthermore, high suspicion and low accuracy may lead to the common problem of misdiagnosing genuine pain for malingering (Robinson, 2011; Shapiro & Teasell, 1998).

The claim that pain behavior can trigger a response of substantial support from others is at odds with the empirical findings that pain is easy to imitate and that, hence, observers should be rather suspicious and reluctant to help. So, the question arises of how this contradiction can be resolved, that is, of how pain behaviors can be made credible and thus convincing to potential helpers. This article suggests that pain behavior itself is not a credible signal, but that it can become credible within a legitimizing context.

Pain Behavior Itself Is Not a Credible Signal

One common solution to the problem of the credibility of a signal is the handicap principle: A signal should be costly, rendering faking expensive and, therefore, unlikely (Spence, 1973; Veblen, 1899; Zahavi & Zahavi, 1996). Referring to this handicap principle, Finlay and Syal (2014) argue that the subjective distress of the sufferer is the cost that makes pain signals credible. This idea seems straightforward, as subjective distress is the most fundamental defining aspect of pain, and, from the perspective of the sufferer, this aspect surely must feel most costly. However, this assumption is problematic in two ways.

The proverbial headache that absolves one from sexual expectations is a cliché based on reality, while many college students prefer to fake abdominal pain rather than fail an important exam. Faking pain is not a costly excuse, since mere imitation does not bring the aversive feeling of real pain. In other words, there is a cheap alternative to the allegedly costly signal. Furthermore, even the subjective distress of real pain is not costly in the sense of the handicap principle. From the evolutionary perspective, the emotional state of an individual, such as the subjective distress of pain, does not count as costs or benefits. Natural selection does not maximize individual happiness (Nesse, 1991), emotional states are only a means to achieve what really counts, namely, survival and especially procreation. Accordingly, costs (i.e., a ''handicap'') should, in order to contribute to credibility, lower the chance of survival (Zahavi, 1975), for example, by wasting energy and resources or by imposing risks. The peacock's tail, for example, qualifies as a costly signal for mate quality, not because it may feel uncomfortable to carry it, but because it costs resources and energy and raises the risk of predation.

Parallels Between Detecting Lies and Detecting Faked Pain

Pain behavior is easy to fake, since the subjective distress of pain cannot be directly seen and, thus, cannot be verified. Similarly, discovering verbal deception is difficult, because the true beliefs of the sender cannot be directly seen and, thus, cannot be verified. There are further parallels between research on verbal deception and lie detection, on the one hand, and research on pain behavior and faking pain on the other hand: the assumed selection pressures, the research paradigms, and the findings.

First, throughout evolutionary history, reliable verbal communication as well as reliable pain communication may have been mutually beneficial for sender and receiver alike. However, in both domains, the sender may have an advantage from manipulating the receiver, and the receiver, in turn, has an advantage from discovering manipulation, what may have resulted in an evolutionary arms race (Bond, Kahler, & Paolicelli, 1985; Bond & Robinson, 1988; Dawkins & Krebs, 1978; Fabrega, 1997; Steinkopf, 2015).

Second, both lines of research were not inspired by problems of credibility in everyday life, but by problems of credibility that may arise in specific professional settings: medical examinations on the one hand and police interrogations and questioning of witnesses on the other hand. Hence, the research paradigms are similar. Both lines of research investigate the respective interview situation or try to model it experimentally (e.g., Fenn, McGuire, Langben, & Blandon-Gitlin, 2015; Jung & Reidenberg, 2007; ten Brinke, Stimson, & Carney, 2014). However, in the currently most common experimental paradigm of lie detection research (e.g., Klein & Epley, 2015; Schindler & Reinhard, 2015; Sowden, Wright, Banissy, Catmur, & Bird, 2015), participants are simply videotaped while telling a truthful or an untruthful story and the videos are consequently used as stimulus material for other participants that should detect deception. A very similar approach is frequently used in research on pain behavior and faking pain, featuring videos of people in pain and people faking pain (e.g., Bartlett et al., 2014; Hill & Craig, 2002, 2004). It is important to note, that in both cases, the receivers have to rely on behavior and expression to judge whether the sender is lying or telling the truth, or faking pain, as the case may be.

Third, both lines of research yield similar results. It is hard to find behavioral markers of verbal deception (DePaulo et al., 2003), as it is difficult to find markers of honest and faked pain (Bartlett et al., 2014). Accordingly, it is hard to distinguish people in pain from people faking pain (Bartlett et al., 2014; H. D. Hadjistavropoulos et al., 1996; Jung & Reidenberg, 2007), as it is hard to distinguish deception from honest communication (Bond & DePaulo, 2006, 2008).

Due to these parallels, the insights from research on deception and lie detection may also be pertinent to pain communication. In particular, doubts about the ecological validity of the results may be a valuable inspiration for pain research. Park, Levine, McCornack, Morrison, and Ferrara (2002) criticized

that the low lie detection rates found in experimental studies are an artifact based on the exclusion of contextual information forcing the participants to exclusively rely on nonverbal cues to judge the veracity of a statement. In fact, in real life, lies are usually discovered by information from the context, not by the nonverbal behavior of the liar (Masip & Herrero, 2015; Park, Levine, McCornack, Morrison, & Ferrara, 2002). Accordingly, introducing a familiar situation and diagnostic contextual information to the experimental paradigm can raise accuracy rates substantially (Blair, Levine, & Shaw, 2010; Bond, Howard, Hutchison, & Masip, 2013; Levine, 2015; Levine, Kim, & Blair, 2010; Reinhard, Sporer, Scharmach, & Marksteiner, 2011).

Credibility Through Contextual Information

Applying these insights from lie detection research to the domain of pain communication implies to change the focus from the credibility of the pain expressions themselves to contextual information. Taking another look at the example of labor pain, we see that the rather cheap (in evolutionary terms) display of pain by a pregnant woman just before giving birth is accompanied by an obvious contextual cue: the enlarged abdomen. The obvious distress of pain might effectively trigger attention from others, but the presence of the enlarged abdomen legitimates the distress to potential helpers and even places pain into a meaningful context that indicates which kind of help is adequate. Similarly, an open wound is a contextual cue that lends credibility to the accompanying pain signals. Contextual cues form a meaningful context for pain, provide hints at a causal explanation and, in this way, lend credibility to the pain signal. Similarly, the common paradigms of experimental pain research not only inflict pain on the participant but also offer a meaningful context. The stimuli, such as keeping a hand in ice cold water (e.g., Vigil, Strenth, et al., 2015), receiving electric shocks (e.g., Colagiuri, Quinn, & Colloca, 2015), or undergoing heat applications (e.g., Fehse, Maikowski, Simmank, Gutyrchik, & Meissner, 2015), are generally acknowledged as painful experiences and, in this way, offer legitimation for the participant's pain.

However, in many cases, the cause of pain is not directly discernible as opposed to the pain from an open wound or from ensuing childbirth. For example, in case of pain resulting from infectious disease, pathogens cannot serve as obvious contextual cues because they are not visible by usual means. So, how does the expression of pain become credible when pain behavior is not accompanied by visible cues such as in the case of infectious disease? Usually, infection leads to an immune response associated with symptoms, such as fever, and a set of sickness behaviors, such as loss of sexual, culinary, and social appetite (Dantzer & Kelley, 2007; Hart, 1988). Fever can be considered an honest signal (Steinkopf, 2015), because it imposes direct costs, such as energy expenditure and the risk of damaging host tissue (LeGrand & Alcock, 2012). Sickness behaviors are based on a motivational shift away from immediately rewarding activities, such as sexuality, feeding, and building friendships, which allows maximization of immune activity (Aubert, 1999; Lopes, 2014). Refraining from these fitness-enhancing activities imposes opportunity costs on the sufferer which could contribute to the credibility of pain expressions.

Other painful conditions which do not have a directly discernible cause, such as musculoskeletal or neuropathic pain, can also change the behavior of the sufferer. Pain can be seen as a motivational state that demands escape from the painful situation, seeking safety, and adopting a relieving posture (Wall, 1999). This motivational state, in this sense very similar to the aforementioned sickness behaviors, undermines normal behavior such as sexuality, feeding, and building friendships. Again, refraining from these fitness-enhancing behaviors imposes opportunity costs that could contribute to the credibility of pain expression. In contrast, a person who is allegedly in pain but still enjoys life and does not miss out on joyful and fitness-enhancing opportunities probably does not signal pain convincingly. In fact, refraining from enjoyable activities due to alleged pain leads to stronger ratings of pain by others (Kappesser & Williams, 2008).

Behavior changes in the sufferer due to pain can impose opportunity costs and, in this way, raise the credibility of pain. But also the behavior of others may change due to the pain of the sufferer and impose further opportunity costs which in turn raise the credibility of pain. Displaying pain might bring about support from others, but, at the same time, be costly in terms of loss of attractiveness, for example, as a mate (Ackerman & Kenrick, 2008; Vigil & Strenth, 2014). In fact, people in pain are judged to be less warm, less likable, less competent, less dependable, and less physically fit (Ashton-James, Richardson, Williams, Bianchi-Berthouze, & Dekker, 2014; Martel, Wideman, & Sullivan, 2012), reflecting their current unattractiveness. In turn, the trade-off between signaling a need for help and demonstrating attractiveness to the opposite sex should also influence the regulation of pain. Accordingly, when in mild pain, male patients report lower pain intensity when examined by female practitioners as compared to male practitioners (Vigil & Alcock, 2014). Women in the high-fertility phase of the menstrual cycle show higher pain tolerance in the cold pressor task when experimenters were male as compared to female, while this difference was not found for women in the low-fertility phase (Vigil, DiDomenico, et al., 2015). These studies suggest that pain is reduced when the opportunity costs of missing out on chances for mating is high. Conversely, incurring these opportunity costs could make pain behavior a costly and, therefore, credible signal.

Finally, it is important to note that opportunity costs can only contribute to credibility significantly when they are sufficiently high, that is, when the underlying behavior change lasts long enough. Depressive symptoms exhibited for 10 min are cheap, but if exhibited for 10 months they may be very costly. Therefore, opportunity costs may be more convincing under conditions of long-term contact, as seen within a closely related social group, while they may be less convincing under

the condition of short-term contact in a medical or scientific setting.

Summary

Some expressions of pain are loud, attention grabbing, and aversive for observers. These expressions may be optimized for the purpose of catching other people's attention, but at the same time, they are rather easy to fake. This may raise the question of how the pain signal is made credible. However, pain does not usually occur in a vacuum but within a meaningful context. Obvious cues, such as an open wound or the enlarged abdomen of a pregnant woman, often accompany pain and, in this way, make pain credible, even though the pain itself is not costly. Even without obvious cues, pain may become costly through its behavioral and social consequences. People in pain refrain from rewarding behaviors and, in this way, incur opportunity costs that contribute to the credibility of their pain. In addition, pain signals vulnerability and, thus, a loss of attractiveness to others, which further contributes to opportunity costs. Probably, the combination of attention-grabbing displays of pain with a costly behavior change and obvious cues that form a meaningful context constitutes the communication strategy that most reliably elicits aid in cases of need.

Limitations

Throughout this article, pain behavior has been regarded as a signal of need that may elicit care. However, displaying pain can have very different effects, depending on the environment. Not every observer will eagerly help a sufferer. In a more hostile environment, the obvious weakness of the sufferer might be taken advantage of by predators or exploited by conspecifics. In such case, it is important not to signal need convincingly, but to effectively suppress pain. Further, as mentioned above, pain may be suppressed in front of less hostile others to ensure mate value and social status. In fact, just like humans are good at faking pain, they are also good at suppressing pain expression (Hill & Craig, 2004; Larochette, Chambers, & Craig, 2006). Further, pain behavior does not only communicate a need for care but may serve as a warning to others. An individual expressing a stomach ache may prevent others from ingesting spoiled food, an individual displaying pain from a bee sting may alert others to the presence of bees. When hypothetically regarding the warning function of pain expression exclusively, neither a sufferer has an immediate individual payoff from signaling pain nor does a not-sufferer benefit from faking pain, though exceptions are imaginable. This means that sufferers should not invest heavily in signaling pain, but this also means that observers should be more alert and less suspicious toward these warning signals.

Throughout this article, pain behavior has not been parsed in different types. However, pain behaviors are commonly categorized as either protective or communicative (T. Hadjistavropoulos & Craig, 2002). For instance, limping can be regarded as protective, as it serves to favor an injured body part, whereas facial expression is considered to be communicative, as it does not serve a protective function and, at the same time, is easily discernible for observers. Further, communicative pain behavior is regarded as being more under conscious control than protective pain behavior (Martel, Trost, & Sullivan, 2012) and is more pronounced when the sufferer is intending to communicate pain (Sullivan et al., 2006). Both types can signal pain to others, however, observer judgments of pain-related limitations are rather influenced by protective pain behaviors (Martel, Wideman, et al., 2012). From the perspective of the present article, both types of pain behavior would be regarded as fulfilling, among others, communicative functions. Communicative pain behaviors, such as vocalizations, are useful to alert the attention of observers, whereas protective pain behaviors, such as limping, act as costly restrictions that make pain more credible the longer they are maintained. Thereby, it is important to note that fake limping can be seen as equally costly as limping forced by pain. However, limping forced by pain also serves the function of protection, while it does not have this benefit to those that only fake limping.

The present article treated contextual information that might contribute to the credibility of pain expressions. However, certain contextual cues, such as gender, race, or age, can also bias pain estimation (Wandner, Scipio, Hirsh, Torres, & Robinson, 2012). Being not only a lab phenomenon, the racial bias, for instance, may cause racial discrimination in pain treatment (Drwecki, Moore, Ward, & Prkachin, 2011; Green et al., 2003). Not being the focus of the present article, such biases will be subject to evolutionary analysis in a follow-up article.

Implications

The present article implies that research conceptualizing pain as a signal or as an act of communication should not regard pain in isolation but take into account its meaningful context and its behavioral and social consequences. The context cannot be ignored, as an exclusion of context amounts to the absence of legitimizing cues. Furthermore, when a legitimizing context or its absence influences the judgments and behavior of observers, the sufferer probably adapt their pain communication to these circumstances.

This simple idea may have implications worth considering for current research paradigms. Research on pain takes place in humans and nonhuman animals, especially rats, but nonhuman animals do not receive extensive support from their conspecifics when they are in pain. Hence, from the perspective of the present article, the situational structure of pain communication is completely different between the species. Rats were not shaped by a selection pressure for credible pain signals that might have shaped humans. Similarly, pain experiments in humans may lack ecological validity when it comes to the credibility problem of pain communication. The typical setting constitutes a very comfortable situation for communicating pain, because the pain stimuli provide immediate legitimation for pain expression, and researchers even expect subjects to express their pain. This experimental situation is structurally

different from real-life situations when convincing pain communication might be difficult, but most crucial. Making pain credible can take time in real life. People with chronic pain are in a completely different communicative situation when they complain about their pain toward their peers or towards a physician. Peers can observe costly behavior changes over a long period and can therefore acknowledge the credibility of pain, while the doctor–patient interaction is too brief for sending credible signals in the idiom of behavior change. In such a situation, merely getting a diagnosis may alleviate suffering, because the pain is recognized as legitimate and the effort for making pain credible can be reduced (Steinkopf, 2015). All in all, research on affect, behavior, and cognition of pain observers (Bastian, Jetten, Hornsey, & Leknes, 2014; Goubert et al., 2005); research on the social modulation of pain (Decety & Fotopoulou, 2015; Krahé, Springer, Weinman, & Fotopoulou, 2013; Mogil, 2015); and research on pain malingering (Butcher, Arbisi, Atlis, & Mcnulty, 2003; Kucyi, Scheinman, & Defrin, 2015; Mendelson & Mendelson, 2004) could benefit from taking into account contextual factors that can enable or undermine pain's communicative function.

Declaration of Conflicting Interests

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

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: I acknowledge support by the German Research Foundation and the OpenAccess Publication Funds of Freie Universität Berlin.

References

Ackerman, J. M., & Kenrick, D. T. (2008). The costs of benefits: Help-refusals highlight key trade-offs of social life. *Personality and Social Psychology Review*, *12*, 118–140. Retrieved from http://doi.org/10.1177/1088868308315700

Ashton-James, C. E., Richardson, D. C., Williams, A. C. de. C., Bianchi-Berthouze, N., & Dekker, P. H. (2014). Impact of pain behaviors on evaluations of warmth and competence. *Pain*, *155*, 2656–2661. Retrieved from http://doi.org/10.1016/j.pain.2014.09.031

Aubert, A. (1999). Sickness and behaviour in animals: A motivational perspective. *Neuroscience and Biobehavioral Reviews*, *23*, 1029–1036. Retrieved from http://doi.org/10.1016/S0149-7634(99)00034-2

Bartlett, M. S., Littlewort, G. C., Frank, M. G., & Lee, K. (2014). Automatic decoding of facial movements reveals deceptive pain expressions. *Current Biology*, *24*, 738–743. Retrieved from http://doi.org/10.1016/j.cub.2014.02.009

Bastian, B., Jetten, J., Hornsey, M. J., & Leknes, S. (2014). The positive consequences of pain: A biopsychosocial approach. *Personality and Social Psychology Review*, *18*, 256–279. Retrieved from http://doi.org/10.1177/1088868314527831

Blair, J. P., Levine, T. R., & Shaw, A. S. (2010). Content in context improves deception detection accuracy. *Human Communication Research*, *36*, 423–442. Retrieved from http://doi.org/10.1111/j.1468-2958.2010.01382.x

Bond, C. F., & DePaulo, B. M. (2006). Accuracy of deception judgments. *Personality and Social Psychology Review*, *10*, 214–234. Retrieved from http://doi.org/10.1207/s15327957pspr1003_2

Bond, C. F., & DePaulo, B. M. (2008). Individual differences in judging deception: Accuracy and bias. *Psychological Bulletin*, *134*, 477–492. Retrieved from http://doi.org/10.1037/0033-2909.134.4.477

Bond, C. F., Howard, A. R., Hutchison, J. L., & Masip, J. (2013). Overlooking the obvious: Incentives to lie. *Basic and Applied Social Psychology*, *35*, 212–221. Retrieved from http://doi.org/10.1080/01973533.2013.764302

Bond, C. F., Kahler, K., & Paolicelli, L. (1985). The miscommunication of deception: An adaptive perspective. *Journal of Experimental Social Psychology*, *21*, 331–345.

Bond, C. F., & Robinson, M. (1988). The evolution of deception. *Journal of Nonverbal Behavior*, *12*, 295–307. Retrieved from http://doi.org/10.1007/BF00987597

Butcher, J., Arbisi, P., Atlis, M., & Mcnulty, J. (2003). The construct validity of the Lees-Haley fake bad scale does this scale measure somatic malingering and feigned emotional distress? *Archives of Clinical Neuropsychology*, *18*, 473–485. Retrieved from http://doi.org/10.1016/S0887-6177(02)00142-7

Chibnall, J. T., & Tan, R. C. (1999). Social and medical influences on attributions and evaluations of chronic pain. *Psychology & Health*, *14*, 719–729. Retrieved from http://doi.org/10.1080/08870449908410760

Colagiuri, B., Quinn, V. F., & Colloca, L. (2015). Nocebo hyperalgesia, partial reinforcement, and extinction. *Journal of Pain*, *16*, 995–1004. Retrieved from http://doi.org/10.1016/j.jpain.2015.06.012

Craig, K. D. (2009). The social communication model of pain. *Canadian Psychology [Psychologie Canadienne]*, *50*, 22–32. Retrieved from http://doi.org/10.1037/a0014772

Craig, K. D. (2015). Social communication model of pain. *Pain*, *156*, 1198–1199. Retrieved from http://doi.org/10.1097/j.pain.0000000000000185

Dantzer, R., & Kelley, K. W. (2007). Twenty years of research on cytokine-induced sickness behavior. *Brain, Behavior, and Immunity*, *21*, 153–160. Retrieved from http://doi.org/10.1016/j.bbi.2006.09.006

Dawkins, R., & Krebs, J. R. (1978). Animal signals: Information or manipulation. In J. R. Krebs & N. B. Davies (Eds.), *Behavioural ecology: An evolutionary approach* (pp. S282–S309). Sunderland, MA: Sinauer Associates.

Decety, J., & Fotopoulou, A. (2015). Why empathy has a beneficial impact on others in medicine: Unifying theories. *Frontiers in Behavioral Neuroscience*, *8*, 457. Retrieved from http://doi.org/10.3389/fobeh.2014.00457

DePaulo, B. M., Lindsay, J. J., Malone, B. E., Muhlenbruck, L., Charlton, K., & Cooper, H. (2003). Cues to deception. *Psychological Bulletin*, *129*, 74–118. Retrieved from http://doi.org/10.1037/0033-2909.129.1.74

De Ruddere, L., Goubert, L., Vervoort, T., Kappesser, J., & Crombez, G. (2013). Impact of being primed with social deception upon observer responses to others' pain. *Pain*, *154*, 221–226. Retrieved from http://doi.org/10.1016/j.pain.2012.10.002

De Ruddere, L., Goubert, L., Vervoort, T., Prkachin, K. M., & Crombez, G. (2012). We discount the pain of others when pain has no medical explanation. *Journal of Pain*, *13*, 1198–1205. Retrieved from http://doi.org/10.1016/j.jpain.2012.09.002

Drwecki, B. B., Moore, C. F., Ward, S. E., & Prkachin, K. M. (2011). Reducing racial disparities in pain treatment: The role of empathy and perspective-taking. *Pain*, *152*, 1001–1006. Retrieved from http://doi.org/10.1016/j.pain.2010.12.005

Fabrega, H. (1997). *Evolution of sickness and healing*. Berkeley, CA: University of California Press.

Fehse, K., Maikowski, L., Simmank, F., Gutyrchik, E., & Meissner, K. (2015). Placebo responses to original vs generic ASA brands during exposure to noxious heat: A pilot fMRI study of neurofunctional correlates. *Pain Medicine*, *16*, 1967–1974. Retrieved from http://doi.org/10.1111/pme.12783

Fenn, E., McGuire, M., Langben, S., & Blandon-Gitlin, I. (2015). A reverse order interview does not aid deception detection regarding intentions. *Frontiers in Psychology*, *6*, 1298. Retrieved from http://doi.org/10.3389/fpsyg.2015.01298

Finlay, B. L., & Syal, S. (2014). The pain of altruism. *Trends in Cognitive Sciences*, *18*, 615–617. Retrieved from http://doi.org/10.1016/j.tics.2014.08.002

Gillmore, M. R., & Hill, C. T. (1981). Reactions to patients who complain of pain: Effects of ambiguous diagnosis1. *Journal of Applied Social Psychology*, *11*, 14–22. Retrieved from http://doi.org/10.1111/j.1559-1816.1981.tb00819.x

Goubert, L., Craig, K. D., Vervoort, T., Morley, S., Sullivan, M. J. L., de C Williams, A. C., . . . Crombez, G. (2005). Facing others in pain: The effects of empathy. *Pain*, *118*, 285–288. Retrieved from http://doi.org/10.1016/j.pain.2005.10.025

Green, C. R., Anderson, K. O., Baker, T. A., Campbell, L. C., Decker, S., Fillingim, R. B., . . . Vallerand, A. H. (2003). The unequal burden of pain: Confronting racial and ethnic disparities in pain. *Pain Medicine*, *4*, 277–294. Retrieved from http://doi.org/10.1046/j.1526-4637.2003.03034.x

Hadjistavropoulos, H. D., Craig, K. D., Hadjistavropoulos, T., & Poole, G. D. (1996). Subjective judgments of deception in pain expression: Accuracy and errors. *Pain*, *65*, 251–258. Retrieved from http://doi.org/10.1016/0304-3959(95)00218-9

Hadjistavropoulos, T., & Craig, K. D. (2002). A theoretical framework for understanding self-report and observational measures of pain: A communications model. *Behaviour Research and Therapy*, *40*, 551–570.

Hadjistavropoulos, T., Craig, K. D., Duck, S., Cano, A., Goubert, L., Jackson, P. L., . . . Fitzgerald, T. D. (2011). A biopsychosocial formulation of pain communication. *Psychological Bulletin*, *137*, 910–939. Retrieved from http://doi.org/10.1037/a0023876

Halfens, R., Evers, G., & Abu-Saad, H. (1990). Determinants of pain assessment by nurses. *International Journal of Nursing Studies*, *27*, 43–49.

Hart, B. L. (1988). Biological basis of the behavior of sick animals. *Neuroscience & Biobehavioral Reviews*, *12*, 123–137. Retrieved from http://doi.org/10.1016/S0149-7634(88)80004-6

Hill, M. L., & Craig, K. D. (2002). Detecting deception in pain expressions: The structure of genuine and deceptive facial displays. *Pain*, *98*, 135–144.

Hill, M. L., & Craig, K. D. (2004). Detecting deception in facial expressions of pain: Accuracy and training. *Clinical Journal of Pain*, *20*, 415–422. Retrieved from http://doi.org/10.1097/00002508-200411000-00006

Jung, B., & Reidenberg, M. M. (2007). Physicians being deceived. *Pain Medicine*, *8*, 433–437. Retrieved from http://doi.org/10.1111/j.1526-4637.2007.00315.x

Kappesser, J., & Williams, A. C. de C. (2008). Pain judgements of patients' relatives: Examining the use of social contract theory as theoretical framework. *Journal of Behavioral Medicine*, *31*, 309–317. Retrieved from http://doi.org/10.1007/s10865-008-9157-4

Kappesser, J., Williams, A. C. de C., & Prkachin, K. M. (2006). Testing two accounts of pain underestimation. *Pain*, *124*, 109–116. Retrieved from http://doi.org/10.1016/j.pain.2006.04.003

Klein, N., & Epley, N. (2015). Group discussion improves lie detection. *Proceedings of the National Academy of Sciences of the United States of America*, *112*, 7460–7465. Retrieved from http://doi.org/10.1073/pnas.1504048112

Krahé, C., Springer, A., Weinman, J. A., & Fotopoulou, A. (2013). The social modulation of pain: Others as predictive signals of salience—A systematic review. *Frontiers in Human Neuroscience*, *7*, 386. Retrieved from http://doi.org/10.3389/fnhum.2013.00386

Kucyi, A., Scheinman, A., & Defrin, R. (2015). Distinguishing feigned from sincere performance in psychophysical pain testing. *The Journal of Pain*, *16*, 1044–1053. Retrieved from http://doi.org/10.1016/j.jpain.2015.07.004

Larochette, A.-C., Chambers, C. T., & Craig, K. D. (2006). Genuine, suppressed and faked facial expressions of pain in children. *Pain*, *126*, 64–71. Retrieved from http://doi.org/10.1016/j.pain.2006.06.013

LeGrand, E. K., & Alcock, J. (2012). Turning up the heat: Immune brinksmanship in the acute-phase response. *Quarterly Review of Biology*, *87*, 3–18.

Levine, T. R. (2015). New and improved accuracy findings in deception detection research. *Current Opinion in Psychology*, *6*, 1–5. Retrieved from http://doi.org/10.1016/j.copsyc.2015.03.003

Levine, T. R., Kim, R. K., & Blair, J. P. (2010). (In)accuracy at detecting true and false confessions and denials: An initial test of a projected motive model of veracity judgments. *Human Communication Research*, *36*, 82–102. Retrieved from http://doi.org/10.1111/j.1468-2958.2009.01369.x

Littlewort, G. C., Bartlett, M. S., & Lee, K. (2009). Automatic coding of facial expressions displayed during posed and genuine pain. *Image and Vision Computing*, *27*, 1797–1803. Retrieved from http://doi.org/10.1016/j.imavis.2008.12.010

Lopes, P. C. (2014). When is it socially acceptable to feel sick? *Proceedings of the Royal Society: Biological Sciences*, *281*, 20140218. Retrieved from http://doi.org/10.1098/rspb.2014.0218

Martel, M.-O., Trost, Z., & Sullivan, M. J. (2012). The expression of pain behaviors in high catastrophizers: The influence of automatic and controlled processes. *Journal of Pain*, *13*, 808–815. Retrieved from http://doi.org/10.1016/j.jpain.2012.05.015

Martel, M. O., Wideman, T. H., & Sullivan, M. J. L. (2012). Patients who display protective pain behaviors are viewed as less likable,

less dependable, and less likely to return to work. *Pain*, *153*, 843–849. Retrieved from http://doi.org/10.1016/j.pain.2012.01.007

Masip, J., & Herrero, C. (2015). Police detection of deception: Beliefs about behavioral cues to deception are strong even though contextual evidence is more useful. *Journal of Communication*, *65*, 125–145. Retrieved from http://doi.org/10.1111/jcom.12135

Mendelson, G., & Mendelson, D. (2004). Malingering pain in the medicolegal context. *The Clinical Journal of Pain*, *20*, 423–432. Retrieved from http://doi.org/10.1097/00002508-200411000-00007

Mogil, J. S. (2015). Social modulation of and by pain in humans and rodents. *Pain*, *156*, S35–S41. Retrieved from http://doi.org/10.1097/01.j.pain.0000460341.62094.77

Nesse, R. M. (1991). What good is feeling bad? *The Sciences*, *31*, 30–37. Retrieved from http://doi.org/10.1002/j.2326-1951.1991.tb02346.x

Park, H. S., Levine, T., McCornack, S., Morrison, K., & Ferrara, M. (2002). How people really detect lies. *Communication Monographs*, *69*, 144–157. Retrieved from http://doi.org/10.1080/714041710

Reinhard, M.-A., Sporer, S. L., Scharmach, M., & Marksteiner, T. (2011). Listening, not watching: Situational familiarity and the ability to detect deception. *Journal of Personality and Social Psychology*, *101*, 467–484. Retrieved from http://doi.org/10.1037/a0023726

Robinson, K. M. (2011). Malingering? No evidence in a predominantly Hispanic worker's compensation population with chronic pain. *Pain Management Nursing: Official Journal of the American Society of Pain Management Nurses*, *12*, 33–40. Retrieved from http://doi.org/10.1016/j.pmn.2009.08.002

Schiefenhövel, W. (1995). Perception, expression, and social function of pain – A human ethological view. *Science in Context*, *8*, 31–46.

Schindler, S., & Reinhard, M.-A. (2015). Increasing skepticism toward potential liars: Effects of existential threat on veracity judgments and the moderating role of honesty norm activation. *Frontiers in Psychology*, *6*. Retrieved from http://doi.org/10.3389/fpsyg.2015.01312

Shapiro, A. P., & Teasell, R. W. (1998). Misdiagnosis of chronic pain as hysteria and malingering. *Current Review of Pain*, *2*, 19–28. Retrieved from http://doi.org/10.1007/s11916-998-0059-5

Sowden, S., Wright, G. R. T., Banissy, M. J., Catmur, C., & Bird, G. (2015). Transcranial current stimulation of the temporoparietal junction improves lie detection. *Current Biology*, *25*, 2447–2451. Retrieved from http://doi.org/10.1016/j.cub.2015.08.014

Spence, M. (1973). Job market signaling. *The Quarterly Journal of Economics*, *87*, 355–374. Retrieved from http://doi.org/10.2307/1882010

Steinkopf, L. (2015). The signaling theory of symptoms: An evolutionary explanation of the placebo effect. *Evolutionary Psychology*, *13*, 1474704915600559. Retrieved from http://doi.org/10.1177/1474704915600559

Sullivan, M. J. L., Adams, H., & Sullivan, M. E. (2004). Communicative dimensions of pain catastrophizing: Social cueing effects on pain behaviour and coping. *Pain*, *107*, 220–226. Retrieved from http://doi.org/10.1016/j.pain.2003.11.003

Sullivan, M. J. L., Thibault, P., Savard, A., Catchlove, R., Kozey, J., & Stanish, W. D. (2006). The influence of communication goals and physical demands on different dimensions of pain behavior. *Pain*, *125*, 270–277. Retrieved from http://doi.org/10.1016/j.pain.2006.06.019

Sullivan, M. J. L., Thorn, B., Haythornthwaite, J. A., Keefe, F., Martin, M., Bradley, L. A., & Lefebvre, J. C. (2001). Theoretical perspectives on the relation between catastrophizing and pain. *Clinical Journal of Pain*, *17*, 52–64. Retrieved from http://doi.org/10.1097/00002508-200103000-00008

Tait, R. C., & Chibnall, J. T. (1994). Observer perceptions of chronic low-back-pain. *Journal of Applied Social Psychology*, *24*, 415–431. Retrieved from http://doi.org/10.1111/j.1559-1816.1994.tb00590.x

Tait, R. C., & Chibnall, J. T. (1997). Physician judgments of chronic pain patients. *Social Science & Medicine (1982)*, *45*, 1199–1205.

ten Brinke, L., Stimson, D., & Carney, D. R. (2014). Some evidence for unconscious lie detection. *Psychological Science*, *25*, 1098–1105. Retrieved from http://doi.org/10.1177/0956797614524421

Twigg, O. C., & Byrne, D. G. (2015). The influence of contextual variables on judgments about patients and their pain. *Pain Medicine*, *16*, 88–98. Retrieved from http://doi.org/10.1111/pme.12587

Veblen, T. (1899). *The theory of the leisure class: An economic study of institutions*. New York, NY: Macmillan.

Vigil, J. M., & Strenth, C. (2014). No pain, no social gains: A social-signaling perspective of human pain behaviors. *World Journal of Anesthesiology*, *3*, 18. Retrieved from http://doi.org/10.5313/wja.v3.i1.18

Vigil, J. M., & Alcock, J. (2014). Tough guys or sensitive guys? Disentangling the role of examiner sex on patient pain reports. *Pain Research & Management*, *19*, E9–E12.

Vigil, J. M., DiDomenico, J., Strenth, C., Coulombe, P., Kruger, E., Mueller, A. A., . . . Adams, I. (2015). Experimenter effects on pain reporting in women vary across the menstrual cycle. *International Journal of Endocrinology*, 520719. Retrieved from http://doi.org/10.1155/2015/520719

Vigil, J. M., Strenth, C. R., Mueller, A. A., DiDomenico, J., Beltran, D. G., Coulombe, P., & Smith, J. E. (2015). The curse of curves. *Human Nature*, *26*, 235–254. Retrieved from http://doi.org/10.1007/s12110-015-9232-9

Wall, P. (1999). *Pain: The science of suffering*. London, England: Weidenfeld & Nicolson.

Wandner, L. D., Scipio, C. D., Hirsh, A. T., Torres, C. A., & Robinson, M. E. (2012). The perception of pain in others: How gender, race, and age influence pain expectations. *The Journal of Pain*, *13*, 220–227. Retrieved from http://doi.org/10.1016/j.jpain.2011.10.014

Wiech, K., & Tracey, I. (2013). Pain, decisions, and actions: A motivational perspective. *Frontiers in Neuroscience*, *7*, 46.

Williams, A. C. de C. (2002). Facial expression of pain: An evolutionary account. *Behavioral and Brain Sciences*, *25*, 439–488.

Zahavi, A. (1975). Mate selection—A selection for a handicap. *Journal of Theoretical Biology*, *53*, 205–214.

Zahavi, A., & Zahavi, A. (1996). *The handicap principle: A missing piece of Darwin's puzzle*. New York, NY: Oxford University Press.