trative incident. Of course, such anecdotal accounts carry no weight in hypothesis testing, but they sometimes point to possible studies.

Through a high window, I was able to unobtrusively observe my 6-year-old and 2-year-old daughters drawing lines on the driveway with chalk and running along the lines. They bumped into each other in what seemed to be a very minor collision, with neither one falling down. The 2-year-old continued playing, but the 6-year-old, in a bad mood perhaps due to hunger or fatigue, ran to the front door, a distance of about 20 meters, with an angry expression. She came in the door, and once she saw me, she started to cry ("release of suppression"), complaining that her little sister had hurt her shoulder. Her facial expression at this point seemed to show more pain than anger, though my own actions were predicated on my speculative interpretation that her intent was to get her sister in trouble ("exaggerated pain expression reinforced by its previous consequences").

If the reinforcement hypothesis is correct, then positive or solicitous attention paid to children's pain behaviour should increase it. On the other hand, if the evolutionary explanation is correct, then repeated elicitation of caregiving in situations of pain (or threat of pain) should lead eventually to greater security and independent coping in the child. Thus, the two accounts may lead to opposite predictions for children's later coping with pain where their parents provide positive consequences for pain behaviour early in life. A prospective study could examine later coping (e.g., with immunization injections at four to five years of age) in children whose parents are observed to reinforce, versus ignore, earlier pain behaviour. One might expect an interaction with age: Cuddling and reassurance for a hurt toddler would presumably have a different effect on later coping, than the same parental caregiving offered to an older child or adolescent whose current developmental task is separation from the parent and mastery of independent skills.

Williams suggests more study of "everyday painful events in humans and onlookers' responses to them, preferably covertly observed" (sect. 8). My research group had an opportunity to carry out such a study a few years ago (von Baeyer et al. 1998). We stationed observers in six day-care centers, during periods of active play among the 3- to 5-year-old children. An event-sampling instrument adapted from the Dalhousie Everyday Pain Scale (Fearon et al. 1996) was used to record observations of minor painful incidents such as collisions with other children, falls, and scrapes. We accumulated 112 hours of observation of 50 children, capturing a total of 51 minor painful events (and incidentally replicating the finding of Fearon et al. [1996], that children in this situation have minor "owies" or "booboos" at the rate of about 0.3 incidents per child per hour, though some children have a higher rate and others none).

Based on written descriptions of the events, we were able to score their apparent severity independently from judgments of the children's expressions of pain. The response of day care staff was also scored, from ignoring through verbal reassurance to picking up, cuddling, and first aid. The significant observation in the present context is that the intensity of the caretaking response by day care staff was unrelated to the severity of the incidents, but was strongly associated with the intensity of the child's expression of pain. In other words, a child who had a "severe" incident, but failed to express distress, got less attention than a child who had a minor event but expressed it with high intensity. We did not, however, adequately separate facial expression of pain from other pain behaviours, such as crying.

Ear piercing offers another opportunity for observation of pain in children without the complications of illness and fear of medical procedures (von Baeyer et al. 1997; Spafford et al. 2002). Children having their ears pierced, for the most part, have voluntarily sought it rather than having it imposed on them. Moreover, because the studs are shot into the earlobes by a spring-loaded gun, the physical stimulus is fairly standard, with minimal intersubject differences attributable to variations in operator skill or speed.

In the first study cited above, we videotaped children before, during, and after the ear piercing. Interestingly, in several children (perhaps a third of the sample), the classic differentiation of pain into first (sharp, rapid, epicritic) and second (dull, slow, protopathic) seemed to be observable in some children's facial expressions. The first pain response, a rapid wince and eye closing occurring within 0.2 seconds after the insertion of the stud, was probably mingled with a startle response to the loud click made by the ear-piercing gun. Commonly the child's face then relaxed into a smile or a neutral face for about 2 seconds (as if they were thinking, "That wasn't so bad"), and then a different, higher-intensity facial expression was displayed. This second pain expression had more in common with sadness: a frown, furrowed brow, and lateral mouth stretch, perhaps expressing the onset of a duller pain in the earlobe, a pain which in most children was more severe than expected (von Baeyer et al. 1997). Unfortunately, the prototypic pattern of facial expressions described above did not emerge as a group finding when formal facial action coding was carried out (Hale et al. 1998): It could be seen only in some participants, and then only with variations in time course and intensity.

The complex influences of social context on pain expression can also sometimes be seen in the ear-piercing situation. I have previously described the following interesting situation:

Identical twin girls, aged nine, are getting their ears pierced. Each watches the other's piercing, and the whole sequence is captured on the researcher's videotape. The first child conveys much distress in her pain ratings and her facial expressions, which, however, somehow appear posed; we see another hint of her having "hammed it up" or exaggerated her pain expression when she makes eye contact with her waiting sister and briefly grins. The second child, perhaps acting out an unspoken game with her twin, then displays a nonchalant air, indicating in her self-ratings and her face that the pain of ear piercing is inconsequential.

These twins, each given a pair of presumably nearly identical painful stimuli, behaved (nonverbally and in their pain ratings) very differently from each other. We have no direct evidence about the reasons for the differences, but we may surmise that social psychological characteristics of the measurement situation are much more important and influential than are nociceptive variables. (Champion et al. 1998, p. 148).

It appears that the evolutionary hypothesis might receive its strongest support from studies of early infancy and of strong pain, while the reinforcement hypothesis may best explain behaviour at later ages and with milder pain.

Williams' review will, I think, lead to much further discussion, theoretical elaboration, and empirical investigation concerning facial expressions of pain.

An evolutionary theory of pain must consider sex differences

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Abstract: According to Williams, human facially expressed pain, and its perception by conspecifics, is generated by evolved mechanisms. We argue that a key variable – sex (male, female) – needs to be considered for a complete theory of pain expression and perception. To illustrate, we cite findings on sex differences in pain and pain perception, and in crying and crying responsiveness.

Williams proposes that "human expression of pain in the presence or absence of caregivers, and the detection of pain by observers, arise from evolved propensities" (target article, Abstract). Her account is timely and important, linking a large body of evidence from the medical and psychological literatures on pain to modern evolutionary theory. This link has hitherto been neglected on both sides. However, the otherwise laudable target article is mute on sex (male, female) as a key explanatory variable in this context. Because sexual selection is a prime evolutionary force, and because human sex differences are pervasive, an evolutionary account seems incomplete when sex is not considered (Shackelford & Weekes-Shackelford 2000).

Sex differences in pain and pain perception. Sex differences in pain expression and pain detection are expected on the basis of sex-differentiated processes such as intrasexual competition, and, relatedly, status-striving and attempts at resource accumulation, among males on the one side, and heavier parental care and affiliativeness with children, kin, and family among females, on the other (Mealey 2000). Consequences of these sex-differentiated phenomena may include male attempts to hide facial expressions of pain, and poorer detection of pain in others; and female superiority of pain detection and more reliable expression of own pain.

Indeed, the literature on human pain and pain behavior is brimming with evidence of sex differences, which have been summarized in both narrative research syntheses (Fillingim 2000) and meta-analyses (Riley et al. 1998). There is also a recent *Behavioral and Brain Sciences* target article (Berkley 1997), documenting a vast array of sex differences in the pain domain. According to Berkley's deductive analysis, the three prime factors for sex differences in pain are sex differences in reproductive organs, in compositional features of sex hormones, and in temporal features of hormonal action. In females, for example, numerous pain-related conditions fluctuate with the menstrual cycle and, relative to males, enlarged variability in pain behaviors is to be expected in females.

The Williams article does not address either sex-differentiated evidence about pain-related expression and behavior, or Berkley's (1997) *BBS* target article. Sex as an explanatory variable is absent in the theorizing of the current target article. This constitutes an important omission. This is not to claim that there are noticeable sex differences in the *gestalt* or form of the facial expression of pain. We argue instead that it is also important to consider the perceiver's response to facially expressed pain, that is, to consider male versus female pain signaling in relation to male versus female responsiveness to signaled pain. Hadjistavropoulos et al. (1996), for example, demonstrated sex-differentiated pain perception by having observers judge videos and photographs of patients with back pain. The judgments covaried with patients' sex, as well as with their physical attractiveness: Male patients, relative to females, were judged to be functioning better, psychologically; likewise for physically attractive patients, relative to unattractive ones. These sex-linked and attractiveness-linked perceptual differences must be regarded as observer-biased, because they were not associated with actual patient functioning.

Sex differences in crying and crying responsiveness. Important sex differences also pertain to crying, weeping, and tearfulness. Crying can be regarded as a form of emotional coping behavior in response to psychological pain. It not only relieves tension, but also reliably elicits emotional support and therefore holds manipulative potential (Vingerhoets & Scheirs 2000). This behavioral category, not discussed in the target article, clearly is a form of both facial and acoustical expression of pain and is important in clinical contexts.

Sex differences in crying frequency and crying proneness have been demonstrated, the latter ones still evident when controlling for personality differences (Peter et al. 2001). Sex differences also extend to crying intensity, self-report of postcrying affect, and crying elicitors across interpersonal and stimulus situations (Lombardo et al. 1983; Williams & Morris 1996). There is also a sex difference in the median age of decline in childhood weeping (11 versus 16 years for males versus females, respectively [Williams 1982]).

There are not only sex differences in crying, but also in responsiveness to it. Examples include males showing a larger increase in skin conductance than females and further showing an increase in heart rate (unlike females) while viewing and listening to videotapes of a crying infant, whereas no sex differences in physiological reactivity emerge when a smiling infant is observed (Brewster et al. 1998). In another experiment (Condry et al. 1983), participants occupied with an unrelated task heard a nearby infant (girl versus boy) starting to cry. Females responded more quickly to the girl than to the boy, whereas males responded slower and without difference in regard to the crying infant's sex. A final example pertains to the mean fundamental frequency found for infant crying (Murry et al. 1977). Although mothers do reliably recognize their own crying infant from other crying infants, the sex of an unknown crying infant cannot be identified with reliability. There is a tendency for male infants to have a higher fundamental frequency in crying than female infants. This may confuse the listener and makes sense in the light of findings suggestive of sex-differentiated responsiveness according to sex-of-crier.

In all, there are important sex differences in the expression and perception of pain that add to the explanatory power, as well as to the clinical practice implications, of an evolutionary account of the facial expression of pain.

Author's Response

Facial expression of pain, empathy, evolution, and social learning

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Abstract: The experience of pain appears to be associated, from early infancy and across pain stimuli, with a consistent facial expression in humans. A social function is proposed for this: the communication of pain and the need for help to observers, to whom information about danger is of value, and who may provide help within a kin or cooperative relationship. Some commentators have asserted that the evidence is insufficient to account for the consistency of the face, as judged by technical means or in the perceptions of observers, or that facial expression is epiphenomenal to a gross behavioural defensive response to pain. The major criticism is that it is unnecessary to invoke evolutionary mechanisms beyond the emergence of an unconditioned facial response to pain in neonates, subsequently shaped and maintained by instrumental and social reinforcement throughout life. These criticisms are addressed, acknowledging the need for further data to address some, and elaborating the areas in which evolutionary and operant mechanisms would predict different behavioural interactions, rather than acting synergistically. Several supportive commentaries propose extending evolutionarily-based hypotheses to sex differences, the complexities of others' responses within the social relationship, and the role of empathy. A number of commentators provided valuable suggestions for experimental paradigms or methodological issues. Overall, addressing these issues indicates the need for further conceptual development and for collection of data specifically in relation to these hypotheses.

I aimed to raise issues concerning the role of evolution in the facial expression of pain and to invite reexamination of available data in the light of these issues: I am encouraged by the debate represented in these commentaries and par-