PAIN® 152 (2011) 1083–1089

PAIN®

www.elsevier.com/locate/pain

Perceiving pain in others: Validation of a dual processing model

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Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

ARTICLE INFO

Article history:
Received 24 September 2010
Received in revised form 17 December 2010
Accepted 14 January 2011

Keywords:
Assessment
Pain behaviour
Automatic
Controlled
Communication
Empathy

ABSTRACT

Accurate perception of another person's painful distress would appear to be accomplished through sensitivity to both automatic (unintentional, reflexive) and controlled (intentional, purposive) behavioural expression. We examined whether observers would construe diverse behavioural cues as falling within these domains, consistent with cognitive neuroscience findings describing activation of both automatic and controlled neuroregulatory processes. Using online survey methodology, 308 research participants rated behavioural cues as "goal directed vs. non–goal directed," "conscious vs. unconscious," "uncontrolled vs. controlled," "fast vs. slow," "intentional (deliberate) vs. unintentional," "stimulus driven (obligatory) vs. self driven," and "requiring contemplation vs. not requiring contemplation." The behavioural cues were the 39 items provided by the PROMIS pain behaviour bank [27], constructed to be representative of the diverse possibilities for pain expression. Inter-item correlations among rating scales provided evidence of sufficient internal consistency justifying a single score on an automatic/controlled dimension (excluding the inconsistent fast vs. slow scale). An initial exploratory factor analysis on 151 participant data sets yielded factors consistent with "controlled" and "automatic" actions, as well as behaviours characterized as "ambiguous." A confirmatory factor analysis using the remaining 151 data sets replicated EFA findings, supporting theoretical predictions that observers would distinguish immediate, reflexive, and spontaneous reactions (primarily facial expression and paralinguistic features of speech) from purposeful and controlled expression (verbal behaviour, instrumental behaviour requiring ongoing, integrated responses). There are implicit dispositions to organize cues signaling pain in others into the well-defined categories predicted by dual process theory.

1. Introduction

The ability to recognize and understand pain in others benefits both the sender, by permitting delivery of help, and the receiver, by permitting avoidance of danger [7,21]. Efforts to disentangle the complexity of the processes engaged when witnessing others in pain have addressed biological [11,31], psychological [18,34] and social [26,28] processes. The distress of a person in pain may be signaled by a variety of sources, including self-report, nonverbal behaviour, or visible tissue damage [10]. The reaction of the observer in turn depends on these "bottom up" sources of information, as well as "top down" decision-making processes [14]. Although many sources of information may be available to the observer, verbal and nonverbal actions provide the most direct evidence for inferring subjective states. This article examines the processes engaged when observers use behavioural evidence to evaluate another person's painful distress.

Hadjistavropoulos and Craig [16] proposed that expression of pain is modulated by two fundamentally different but complementary biological systems that can be construed as automatic and controlled in character. This reflects dual process theory research in cognitive neuroscience, which describes simultaneous activation of both automatic and controlled neuroregulatory processes during virtually any task [25,29]. When applied to pain behaviour, the former represents the sender's immediate reflexive and spontaneous behavioural reaction (e.g., nociceptive withdrawal reflexes, facial expression, and paralinguistic responses, such as gasping and crying), whereas the latter involves use of purposeful, instrumental actions to exercise control, including efforts to minimize distress and harm and engaging the reactions of others (e.g., organized, instrumental activity such as medication use and verbal reports of pain).

In turn, the process whereby observers respond to pain in others similarly can be categorized as automatic, (i.e., the immediate, visceral reaction to the sender's pain), or controlled, (i.e., engaging deliberate higher level judgmental processes to evaluate the pain expression) [10]. These distinct observer reactions would be expected to be differentially responsive to pain expressions perceived

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doi:10.1016/j.pain.2011.01.025

as automatic or controlled. Perceived automatic reactions to pain appear more likely to evoke the immediate gut level reactions and emotional engagement that lead the receiver to hurt in sympathy, whereas perceived controlled expression seems more likely to instigate active decision making and cognitive efforts to understand the meaning of the person's distress.

Although theoretical arguments and sources of evidence can be marshaled to support this dual processing perspective [10], a systematic evaluation of whether receivers readily differentiate between automatic and controlled cues of pain has not been undertaken. We hypothesized that observers of others in pain would construe diverse features of pain behaviour in accordance with this theoretically derived automatic/controlled distinction. The study was undertaken to identify (1) whether different actions associated with pain would be perceived as voluntarily controlled or enabled by unconscious processes, and (2) whether these categorizations were reliable across a large group of observers, indicating broad implicit propensities to classify pain behaviours consistent with this distinction.

2. Method

2.1. Procedures

Using online survey methodology, we examined reactions to a broad sample of the diverse pain behaviours available to infer pain. Ratings on dimensions conceptually associated with perceived automaticity and control were subjected to exploratory and confirmatory factor analyses. The study was approved by the University of British Columbia Behavioural Research Ethics Board.

2.2. Participants

The primary sample of research participants was comprised of 308 individuals (159 female, 147 male; 2 did not identify gender) surveyed using the online hosting service Mechanical Turk (http://www.mechanicalturk.com). This Web site interface is managed by Amazon.com and facilitates the completion of simple tasks posted by researchers through a pool of more than 100,000 registered users from more than 100 countries. Users receive a small monetary reward for each task performed. Studies testing the validity of this medium for scientific research have yielded highly reliable results that are shown to be superior to university samples for generalizing to the population at large [4].

Participants' mean age was 29 years, with a range from 18 to 57 years. The majority of participants were native English speakers (76.20%), whereas 25 participants spoke primarily South Asian languages (Hindi, Tamil), and 16 named their first language as an Asian language (Indonesian, Cantonese, Tagalog). The remainder of the participants spoke a total of 31 other languages in addition to English, with no single group exceeding 2% of the total sample. Of the participants, 224 were born in the United States or Canada, whereas 42 (13.90%) were originally from India. Natives of 29 other countries in Europe, South America, and Asia comprised the rest of the sample.

2.3. Measures

2.3.1. Pain behaviour items

A Pain Behaviours Survey was created to evaluate the extent to which participants perceived common pain behaviours as automatic or controlled actions. A comprehensive database of the necessary and sufficient pain behaviours signaling pain to others is not available; however, the recently published Patient Reported Outcome Measurement Information System (PROMIS) pain behaviour item bank provided an extensive sample of rigorously evaluated items [27]. In constructing this data bank, developers consulted clinical reviews and qualitative research studies, including empirically established pain behaviour scales based on both observation and self report, to generate a preliminary set of 52 pain behaviours. These items were reviewed by six pain experts before being distributed to 15,328 participants from the general public, to eliminate unclear (e.g., "gave a detailed description of the pain to others," "massaged the part of the body that hurt") and repetitive items. Thirteen items were discarded because of unsatisfactory ($P > .001$) scores on item response theory (IRT) FIT analysis, an indicator of content validity. The 39 pain behaviours had an internal consistency of 0.99 and were describe as representing a comprehensive description of behavioural manifestations of the pain experience, including movement, social interaction, and facial/verbal and affective components (Table 1).

In the present study, participants were asked to rate each of the 39 pain behaviours provided by the PROMIS pain behaviour item bank (e.g., called for someone to help him/her, grimaced, isolated him/herself from others) on subscales representing variations on the distinction between automatic and controlled behaviour, described below. Three additional safety items were added to ensure that participants were reading each question and responding in a logical manner. These questions were designed to be very obviously automatic or controlled ("turned on the television," "blinked his/her eyes," "told a joke") and allowed researchers to apply guidelines that would eliminate randomly generated response sets and maintain the integrity of the results.

2.3.2. Automaticity subscales

Seven subscales were constructed to represent facets of the perceived automatic and controlled distinction as derived from Moors and De Houwer's theoretical and conceptual analysis [25]. They concluded that the distinction is best defined using three features: goal-related features (intentional/unintentional, goal-directed/goal independent, stimulus-driven/self-driven, controlled/uncontrolled); awareness features (conscious/unconscious); and efficiency features (fast/slow, efficient/inefficient). The (in)efficient scale referred to the amount of processing resources required, and was revised to (not) requiring contemplation' because of ambiguity in the initial wording. The seven constructs representing the above named features were presented to participants as 10-point Likert scales counterbalancing the order of automatic/controlled anchors to limit potential bias. Participants were instructed to indicate where on the scales they perceived each action to belong, thinking of "an average adult without any distinguishing features other than the fact that they are in pain," when considering the characteristics of each pain behaviour. To encourage full use of the scale research, participants were advised to use as much variability in their ratings as possible.

3. Results

3.1. Data screening

The data were screened for duplicate internet protocol addresses, indicating that a participant responded twice or more, and for nonsensical responses (all values of 10 and/or 1 on the Likert scale for all 42 questions). This eliminated six sets of scores from the original 308, leaving 302 completed data sets. The three safety questions were also evaluated for answers in opposition to the expected pattern of response. An individual's survey responses were to be eliminated if all three questions were responded to as values of 5, or if two or more of the questions were rated as the extreme opposite (e.g., as 1 if 10 was expected) of the anticipated

Table 1
Exploratory factor analysis for initial pain behavior items.

Item	Factor 1 (Controlled)	Factor 2 (Automatic)	Factor 3	Factor 4
(1) Became angry	−0.02	−0.14	0.08	−0.13
(2) Became irritable	−0.08	0.26	0.21	0.21
(3) Called for someone to help him/her	0.54*	−0.04	−0.19	0.07
(4) Moved stiffly	−0.25	0.31	0.02	0.59
(5) Asked people to leave him/her alone	0.49*	0.01	−0.16	−0.04
(6) Cried	−0.25	0.46*	0.11	0.14
(7) Moaned, whined or whimpered	0	0.53*	0.06	0.28
(8) Moved extremely slowly	0.16	−0.04	0.01	0.56
(9) Limped	−0.14	0.13	0.03	0.54
(10) Isolated her/himself from others	0.53*	−0.12	−0.14	−0.07
(11) Lay down	0.59*	−0.15	0.01	0.07
(12) Squirmed	−0.08	0.67*	0.05	0.04
(13) Curled up in a ball	0.31	0.51*	−0.03	−0.07
(14) Groaned	0.06	0.55*	0.16	0.25
(15) Asked for help doing things needing to be done	0.77*	−0.25	−0.22	−0.12
(16) Bent over while walking	0.19	0.25	0.05	0.38
(17) Facial activity (squinching eyes, opening eyes wide, frowned)	−0.10	0.57*	0.37	0.15
(18) Tried to stay very still	0.75*	−0.14	−0.12	−0.10
(19) Thrashed	−0.13	0.60*	0.31	0.04
(20) Appeared upset or sad	−0.02	0.56*	0.25	0.03
(21) Flung his/her arms around	0.04	0.37	0.37	−0.05
(22) Asked for help walking/changing position	0.77*	−0.28	−0.16	−0.09
(23) Walked carefully	0.78*	0.56	0.17	0.06
(24) Clenched his/her teeth	−0.29	0.47	0.36	0.05
(25) Grimaced	−0.33	0.52*	0.3	0.11
(26) Screamed	−0.14	0.64*	0.12	0.02
(27) Gasped	−0.42	0.64*	0.17	0.15
(28) Moved limbs protectively	0.4	0.01	0.16	0.3
(29) Frowned	−0.09	0.60*	0.14	0.14
(30) Became quiet and withdrawn	0.32	0.19	−0.06	0.02
(31) Drew knees up	0.38	0.1	0.28	0.31
(32) Used a cane or something else for support	0.43	0.1	0.29	0.32
(33) Protected the part of the body that hurt	0.66*	−0.10	−0.29	0.08
(34) Upper body tensed up	0.65*	−0.13	−0.28	−0.08
(35) Avoided physical contact with others	−0.18	0.18	0.68	0.21
(36) Clenched jaw or gritted teeth	0.60*	−0.16	−0.09	0.15
(37) Winced	−0.17	0.27	0.7	0.07
(38) Bit or pursed lips	−0.34	0.24	0.68	0.04
(39) Body became stiff	−0.10	0.26	0.72	−0.11

* Items loaded adequately for retention (⩾.0.32).

answer; however, no additional participants were eliminated based on these criteria, and only three participants rated one of the items at its opposed extreme.

It was concluded there were adequate data to justify randomly halving the sample to perform both exploratory and confirmatory analyses on the survey data, with sample sizes of 151 for each factor analysis and a satisfactory ratio of 3.98 cases per variable [1,19]; this strategy was more rigorous than an exploratory analysis using the full sample, an approach that would have precluded use of confirmatory analyses.

3.2. Subscale validity

To determine the internal consistency of the seven subscales representing automaticity, inter-item correlations were used. This method was preferred to Cronbach's α because of the high number of items on the scale [5]. Subscales that averaged a correlation of at least 0.2 over the 42 behaviour items were regarded as having adequate reliability [5]. The lone subscale that did not correlate adequately was the fast vs. slow dimension ($r = 0.12$). This was likely the result of inadequate definition; confusion was expressed during debriefing by a number of participants concerning whether the distinction referred to the onset or the duration of the behaviour. It was discarded from further analyses. The six reliable subscales averaged an inter-item correlation of 0.31. These moderate correlations were expected, as the subscales represented the three distinct features of automaticity described by Moors and De Houwer (goal-directed, conscious awareness, and efficiency) [25]. We chose to group all seven in the survey as together they formed the most comprehensive measurement of automaticity; however, it was noted that correlations within the goal-directed feature averaged 0.42, higher than the correlation for the complete set. The inter-item correlations among the subscales, particularly within each feature, provided sufficient internal consistency to justify the use of a combined index.

3.3. Factor analysis

Scores for each behaviour item were collapsed across the six validated subscales to yield a single score on the automatic/controlled dimension, with selected scales reverse scored so that a rating of 1 equated to highly automatic behaviours and 10 indicated highly controlled behaviours. This yielded 42 mean automaticity scores for each participant.

An exploratory factor analysis (EFA) was conducted on the initial sample of 151 participants to establish the underlying structure of the variables. The most commonly used EFA tool, principal component analysis (PCA), was used to identify the implicit structure governing participants‘ scores on the 42 pain behaviours [33]. (We also asked about three domains independent of pain behaviour, two which were indisputably controlled (telling a joke, turning on the TV) and one that was automatic (eye blinking). These items loaded appropriately on the controlled and automatic factors, increasing our confidence in the present samples.)

Table 2
Confirmatory factor analysis for final pain behavior items.

	Factor 1 loadings	Factor 2 loadings
Factor 1: controlled		
(3) Called for someone to help him/her	0.56	0
(5) Asked people to leave him/her alone	0.67	0
(10) Isolated her/himself from others	0.61	0
(15) Asked for help doing things needing to be done	0.88	0
(18) Tried to stay very still	0.81	0
(22) Asked for help walking/changing position	0.86	0
(34) Upper body tensed up	0.78	0
(36) Clenched jaw or gritted teeth	0.6	0
Factor 2: Automatic		
(6) Cried	0	0.67
(7) Moaned, whined or whimpered	0	0.35
(12) Squirmed	0	0.6
(14) Groaned	0	0.53
(17) Facial activity (squinching eyes, opening eyes wide, frowned)	0	0.7
(19) Thrashed	0	0.51
(20) Appeared upset or sad	0	0.67
(25) Grimaced	0	0.83
(26) Screamed	0	0.6
(27) Gasped	0	0.83
(29) Frowned	0	0.46

The PCA yielded ten factors with an Eigenvalue greater than 1.0. As many of these factors were likely due to random error, we conducted a parallel analysis using Monte Carlo bootstrapping procedures. A parallel analysis indicates how many factors would be expected by mere chance. According to the parallel analysis, the first four factors should be retained.

To determine the structure of these factors, we then conducted a factor analysis using unweighted least squares (ULS) extraction with a Varimax rotation. A Varimax rotation was selected because the factors were hypothesized to be orthogonal. Items were considered adequately loaded if they attained a loading of 0.32 or higher and, in cases in which a variable loaded on both factors, a difference of at least 0.15 was required to assign the item to the higher loaded factor [38]. Using these criteria, it was found that 11 behaviours loaded on Factor 1, with seven highly loaded items (>0.60). Twelve different behaviours loaded on Factor 2, with five loading above 0.60. The first factor, "perceived controlled," included verbal items such as "called for someone to help him/her," "asked people to leave him/her alone," a finding consistent with theory regarding controlled pain behaviours. The second factor, "perceived automatic," included items such as "cried" and "moaned, whined, or whimpered," and was consistent with the predictions regarding automatic pain behaviours. The third and fourth factors each represented less than 5% of the total variance of the model, and only four items between the two loaded significantly (Table 1). These items were not interpretable using a priori theory, although they seemed to include ambiguous pain behaviors. A scree plot further indicated the minimal contribution of these factors to the model, and thus, confirmatory analyses focused on the first two factors.

After the initial exploratory analysis, a confirmatory factor analysis (CFA) was conducted on the remaining 151 participant data sets, in the interest of achieving the superior power and utility attributable to a replicable structure [35]. Both EFA guidelines and theory were used to select items to retain for confirmatory analysis, and 11 automatic behaviours, along with 8 controlled actions were selected. We used robust maximum likelihood [5] as the extraction method, because the data had high levels of kurtosis (e.g., normalized estimate of kurtosis, 17.71). According to Bentler [2], robust methods should be used for any normalized estimate of kurtosis exceeding 2.0.

Although the mean and variance-adjusted χ^2 test did not fit ($\chi^2 = 36.44$, $P = .02$), the χ^2 test has been shown to be too sensitive and overpowered [5]. However, the CFA had adequate fit according to most other fit indexes (RMSEA = 0.07, CFI = 0.91, Bentler–Bonett non-normed fit index, 0.90). In addition, the 90% confidence interval of the RMSEA ranged from 0.055 to 0.083, indicating a good fit [3]. Thus, the 19-item structure was replicated in a CFA.

We predicted the factors to be uncorrelated, but both the EFA and the CFA indicated that they were significantly negatively correlated ($r = -0.19$, $P < .05$; $r = -0.71$, $P < .001$, respectively). The final CFA replicated the findings of the EFA, with only 1 of 8 controlled behaviours and 4 of 11 automatic behaviours loading below 0.60 (see Table 2). This demonstrates the strength of the initial analyses, and provides support for the hypothesized distinction.

3.4. Demographic analysis

Gender and first language were analyzed across all 42 variables for mean differences in subcategories, using independent-sample *t*-tests. In the case of gender, no differences were found in 38 of the 39 target variables [$t(297) < 1.20$, $P < .12$]. The lone significant difference was for the item "frowned," with female participants rating the item as more controlled [$t(297) = 2.09$, $P = .04$, $d = 0.24$]. First language had similarly small differences between English native speakers and all others [$t(297) < 1.43$, $P < .08$]. The three exceptions were "became angry," "moved stiffly," and "told a joke." Native English speakers judged "became angry" and "told a joke" to be significantly less controlled [$t(297) = -1.98$, $P = .05$, $d = 0.23$; $t(297) = -2.42$, $P = .02$, $d = 0.28$], and "moved stiffly" to be more controlled than did non-English speakers [$t(297) = 3.00$, $P = .003$, $d = 0.34$)]. Because of the small effect sizes of these differences and the relatively small sample of non-English speakers, it was determined that these disparities were not substantial enough to warrant the exclusion of their data from analyses. Thus, although there were some differences across gender and language, these differences were small relative to the high degree of agreement when considering ratings of items across the combined groups.

4. Discussion

The study findings provided strong evidence of implicit dispositions to organize perceived cues signaling pain in others into two well-defined categories. These categories are consistent with the theoretical and evidence-based distinction between automatic, reflexive behaviours, and those modulated by executive functions [10].

4.1. Automatic/reflexive pain expression

Facial expression and paralinguistic features of speech emerged as the most heavily loaded cues on the perceived automatic factor. A smaller number of items resembling withdrawal reflexes signaled uncontrolled motor effort to protect injuries. It is notable that 11 of 12 items that loaded significantly in the EFA were retained in the CFA. The item that shifted to the ambiguous category, "curled up in a ball" would seem inconsistent with theoretical expectations of automatic pain behaviour.

4.1.1. Facial expression

Participants rated facial expressions of pain as highly automatic, consistent with both the facial expression literature [12] and pain research [9,21,37]. Although voluntary control of facial expression is not unusual, most people do not self-monitor facial displays on a continuing basis. There also is evidence that posed facial expressions of pain differ in subtle details from the spontaneous expression [17]. Because research participants were not provided with pictures or context, it would appear that the perceived automatic/controlled distinction is based on intrinsic knowledge rather than immediate cues associated with visual discrimination or contextual factors.

4.1.2. Paralinguistic display

Consistent with characterization of paralinguistic vocalizations as reflexive actions related to features of stress and intonation in breathing and speech, participants judged items such as gasped and groaned as highly automatic. Similarly, crying was identified by participants as an automatic reaction despite the cognitive/affective basis of crying in adulthood and the perception by many clinicians that crying is primarily a manipulative response [13,36]. This counter-intuitive finding may be due to the lack of auditory input in judgments using the present survey methodology, as features of sound quality (tone, pitch, amplitude) are heavily involved in differentiating faked and credible paralinguistic behaviours [36].

4.2. Controlled/purposive pain expression

The collection of controlled pain behaviours comprised two major categories: verbal behaviour and ongoing protective actions. All seven of the highly loaded EFA items were retained, and remained highly loaded in the CFA analysis, suggesting that certain controlled behaviours are very apparent.

4.2.1. Verbal behaviour

Consistent with linguistic research, which indicates that substantial coordination is required for speech communication, verbal responses were viewed as highly controlled [30]. The capacity to use language to communicate painful distress emerges in the course of early child development [32], and requires some minimal level of intellectual facility as well as socialization to enlist care from others [15]. The necessity of synchronizing verbal requests with the availability, attention, and potential for responding of others makes verbal behaviour one of the most controlled responses to pain. In consequence, it becomes vulnerable to observers imposing personal beliefs and biases. It is consistent with the proposition that pain verbalizations confound pain perception and the person's competence in commanding the attention of those who may provide care [28].

4.2.2. Ongoing protective behaviour

Complex instrumental behaviours requiring ongoing, integrated responses, such as lying down or isolating oneself from others, also were viewed as highly controlled. These were differentiated from the automatic withdrawal reflexes noted above by their organized and extended duration, a distinction similar to that posited for the broad range of pain measures used to study animal models of pain, specifically, that of nociceptive withdrawal reflexes, such as a startle response, and operant behavioural measures such as analgesic consumption [24]. Maintaining organized sequences of behaviour requires ongoing monitoring and conscious attention to both subjective experiential cues and the immediate physical and social environment.

4.3. Ambiguous behaviours

A number of pain behaviours were not consistently characterized as representing automatic or controlled expression. These are noted in Fig. 1, along with the items loading on the automatic and controlled clusters. Research participants appeared uncertain as to how to categorize these ambiguous items. This was likely indicative of the ambiguity of behaviours such as "walked carefully," and "became angry," given their potential for both reflexive and controlled expression.

4.4. Observer perceptions of pain

Empirical support for the proposition that two major specific modalities of pain expression are perceived by observers implies the parallel evolution of implicit capacities to react to pain with emotional resonance and to understand the meaning of the sender's behaviour. The complementary propensities to react to painful events and respond to the expressive behaviours of others would have emerged progressively in the course of evolution and human development. Automatic reactions in the form of nonverbal expression were available to observers long before verbal expression became available as a complementary but different form of expression. Facial activity expressive of pain can be identified in nonhuman animals [21] and is present in human infants from birth [8]. Later in the course of evolution, humans came to perform deliberate, goal directed displays of pain, such as using language

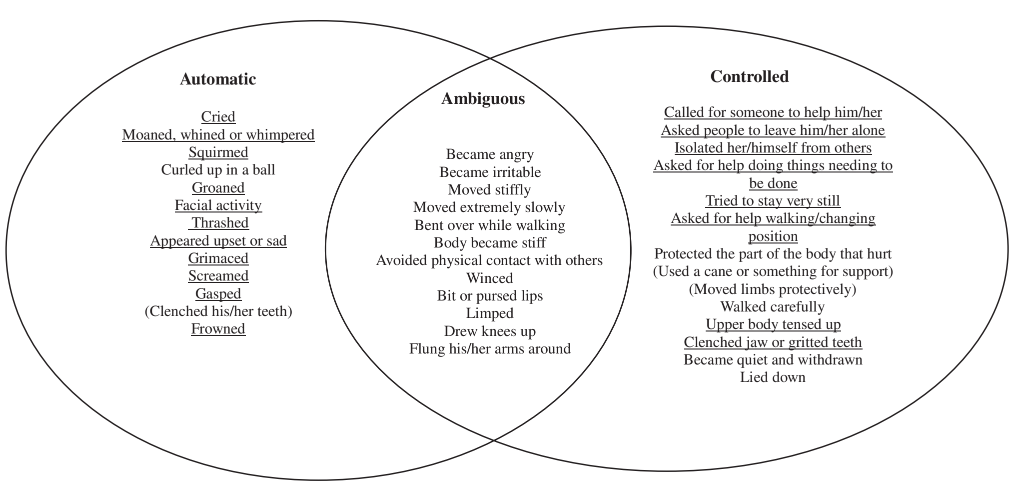

Fig. 1. Automatic, ambiguous, and controlled pain behaviors, as determined by the exploratory factor analysis. Three items almost missed significance in the analysis because of slight double loading effects with one of the uninterpretable factors (difference between loadings of 0.1 < 0.11). These items are indicated in brackets, and are included in the automatic and controlled categories. Note: Underlined items represent those that were also confirmed as automatic or controlled by the CFA.

or completing rating scales, as well as to detect and critically evaluate these more subtle cues in others using executive functions.

Some pain behaviours would appear to transform from automatic to controlled expression in the course of development. Crying has been shown to be a reliable, nonspecific sign of distress in infants and is widely viewed as automatic at that age [6]. Over the course of development, it comes to be construed as a form of controlled expression and is often discounted by clinicians as a manipulative action in school-aged children [13]. In infants and children, crying is most likely to have origins in aversive states, including pain, hunger and fatigue. In adults, crying is more often the result of socially instigated emotions such as anguish or frustration [20]. Two distinct cry responses become identifiable as age increases: an involuntary cry, accompanied by sobbing or hyperventilating, and a more controlled cry, characterized by a more neutral facial expression that is more likely to be viewed as calculated by observers [36]. Given this distinction, it is probable that participants in the current study presupposed the former type of cry, as "cried" was characterized as an automatic expression. Additional research is necessary to study observer reactions to the audible and visual characteristics of different types of crying, as well as other paralinguistic and verbal reactions.

Perception of controlled reactions as goal-directed, conscious, intentional, deliberate, self-driven, and requiring contemplation would lead to efforts to differentiate the origins of pain behaviour in either painful experience or as the product of other motives, for example, efforts to convince others of the severity of the pain [23]. In consequence, controlled or ambiguous pain behaviours appear more likely to evoke questions about the credibility of the behaviour than would automatic expressions [10]. It is noteworthy that controlled and ambiguous pain behaviors may be employed by patients with both acute and chronic pain in efforts to manage their pain. In chronic pain patients, automatic behaviors are likely to be primarily associated with spontaneous (e.g., paroxysmal neuropathic pain) or elicited (e.g., movement) exacerbation of pain [22].

The PROMIS database was developed to be broadly representative of the domain of behaviours expressive of pain. Finding clusters corresponding to automatic and controlled domains was perhaps all the more surprising because the specific behaviours were not selected to represent the two categories. The PROMIS data bank would appear to require further validation through direct observation of pain behaviour. Some of the PROMIS items do not correspond to empirical descriptions of how people react when in pain. For example, facial activity was described as including "opening eyes wide" and "clenched jaw or gritted teeth," features that are rarely observed in empirical accounts [9]. It is encouraging to note that empirically supported features of facial expression, such as grimacing, loaded more highly on both the exploratory and confirmatory analysis than did the incongruent items.

The findings support further investigation of the processes engaged when perceiving pain in others. The written format without context or audiovisual input may have been important. It allowed research participants to remain uninfluenced by factors such as physical features of the parties in pain (e.g., attractiveness, age, gender, or cultural background) and the context in which pain was being expressed. Study of the structure using visual and aural cues is warranted, and it is possible that varying contexts would influence perception of pain behaviours as automatic and controlled. The influence of personal experience and biases on judgments would also be valuable to study.

5. Conclusion

In conclusion, the confirmatory factor analyses supported the dual processing model of pain expression by demonstrating reliable, implicit predispositions to organize cues signaling pain in others into well-defined clusters of pain behaviour defined by the automatic (unintentional, reflexive) and controlled (intentional, reflective) distinction.

Conflict of interest statement

The authors confirm that there is no conflict of interest in connection with this work.

Acknowledgments

This research was supported by grants from the Social Sciences and Humanities Research Council of Canada and the Canadian Institutes of Health Research.

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