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Psychophysical studies of imagined stimuli: testing the limits of self-knowledge

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There is a coalescing trend in several areas of pain research. Studies endeavoring to measure the extent to which individuals differ in ascribing pain intensity to noxious stimuli are occurring in areas of pain research as diverse as self-assessment questionnaires, genetics, functional neuro-imaging and psychophysics. The article in this issue of *Pain* by Ruscheweyh et al [1] highlights two important points relating to the measurement of individual responses to pain. The first is a point of terminology, the second is a point of critical importance in pain neurobiology: the extent to which responses to imagined stimuli predict clinically-relevant pain outcomes [2].

A variety of terms have been applied to describe inter-individual differences in responsiveness to controlled noxious stimuli and painful experiences: pain sensitivity, pain hypersensitivity, pain responsivity, pain perception, pain reactivity, pain responsiveness and central pain processing are among those commonly used. Of these, 'pain sensitivity' is the term most widely used to describe the tendency of individuals to vary in the extent to which they respond to noxious stimuli. A survey of this term in Pubmed indicates that 'pain sensitivity' was used infrequently prior to 1973 but became the subject in many studies from the late 1970s onwards [3]. A related term, pain hypersensitivity, presumably indicating abnormally increased sensitivity to pain, is much less frequently used. There are many instances however, where 'pain sensitivity' is not chosen by authors to describe the responsiveness of individuals to pain. The potential reasons for this may be several. For example, the broader use of 'sensitivity' in discourse carries the connotation of emotionality. In addition, sensitivity in other technical applications focuses on assessing the capacity to distinguish the presence of especially small stimulus perturbations. The term 'pain perception', also widely used since the 1970s, carries the same implicit meaning of measuring responses to small amounts of pain. The term 'pain reactivity' seems to have had a history in the psychological literature of the mid-twentieth century but found later application to describe both biobehavioral and neurohumoral responses in animal and human studies of pain [4]. The use of the term 'pain responsivity' began in 1981 and became more widespread in the 1990s. Presumably, the word responsivity was chosen to reference the notion that responsivity is measured by assessing *responses* to a particular nociceptive stimulus. One reason that broader use of this term may not be optimal is that in engineering applications, responsivity has a particular meaning: it is the derivative (or slope) of the stimulus-response curve. Given the limitations described here, it is timely to re-consider

the value of 'pain responsiveness' as a term of reference. 'Pain responsiveness' was first used in published pain research in 1977 [5] and has been subject to a steady stream of citations since that time. Pain responsiveness appropriately conveys the quality of being responsive to pain and directly alludes to the process of measuring pain responsiveness by obtaining an estimate of the individual's response to a noxious stimulus. As an added point in favor of wider usage, 'pain responsiveness' is potentially less laden with implied meaning than 'pain sensitivity'.

In the search for new measures of pain responsiveness, the use of a questionnaire that solicits pain ratings in response to imagined pain-provoking experiences [1] challenges traditional 'physical' approaches, where objective stimuli are employed to elicit reproducible responses. In the laboratory setting, diverse psychophysical parameters are sampled for the purposes of understanding both central and peripheral pain processing. Among these, dynamic psychophysical measures have become quite popular; changes in temporal summation and endogenous analgesia capabilities are now considered as representative of the individual's pain responsiveness, especially since abnormalities are observed in both established and idiopathic pain syndromes [6]. Ruscheweyh et al [1] report the development of a 17-item questionnaire seeking to gauge 'pain sensitivity'. The items in the questionnaire invite the respondent to imagine the occurrence of an unexpected pain-provoking experience, e.g., trapping one's finger in a drawer, and rate the degree of pain that would result. Diverse noxious stimuli are represented, including heat, cold, pressure and acid. The items were selected to represent a range of anticipated pain intensities. A primary score was calculated as the mean of the pain-provoking item responses (14 of the total). In mature adult respondents, the instrument showed good internal consistency. The performance of the instrument was compared to a battery of psychophysical measures of pain thresholds and intensities tested in medical students. There was no correlation with psychophysical pain threshold measures, however the correlation with the composite score of experimental pain intensity ratings was strong ($r = 0.56$) and stable when re-tested. Although the practical advantages of using a self-filled questionnaire over device- and technician-dependent psychophysical test are obvious, fundamental questions remain [7]. In which settings does an assessment of responses to imagined stimuli have the potential to substitute for actual psychophysical testing? To what degree does chronic pain distort self-awareness of pain responses and limit the utility of self-assessment measures? Are individuals capable of effectively integrating sensory disturbances, e.g. peripheral nerve injuries, into the pain percept? To what extent is there an overlap between pain-related catastrophizing and the parameters of an instrument like the PSQ [1]? And perhaps most controversially, to what extent is there a unitary quality of pain responsiveness that influences pain responses across various nociceptive modalities?

The results of Ruscheweyh et al [1] indicate that prompting patients to imagine pain scenarios may be more effective in eliciting correlates of psychophysically-determined pain responsiveness than are more global self-assessments, however the full value of this conceptualization will only be revealed when it is tested against clinical pain.

Pain responsiveness is clearly going to be a major study field in the near future. Studies that evaluate pain responsiveness by use of diverse approaches as well as actual psychophysical paradigms, understood within the contexts of pain symptomatology, clinical prognostication, diagnosis and therapeutic outcomes will give the answers.

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