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How should we treat painful sensitivity in the hand? An international e-Delphi study

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ABSTRACT

Background: Evidence synthesis suggests allodynia resulting from neuropathic pain has few interventions with clear effectiveness. As research continues to build this needed evidence base, expert consensus recommendations can address the conflicting approaches within current hand therapy practice.
Purpose: This study aimed to develop consensus recommendations for the clinical management of allodynia from an international panel of hand therapists.
Study Design: This was an international e-Delphi survey study.
Methods: We recruited international hand rehabilitation experts to participate in an e-Delphi survey. Consensus was defined as 75% or more of participants agreeing with a recommendation, and at least 3 rounds of consensus building were anticipated. Experts were identified from 21 countries, and clinical vignettes describing a spectrum of patients with painful sensitivity in the hand were provided to elicit treatment recommendations. Initial recommendations were summarized, and consensus sought for clinical practice recommendations.
Results: Sixty-eight participants were invited, with 44 more added through peer nominations. Fifty-four participants from 19 countries completed the initial survey and were invited to participate in all subsequent rounds. Over 900 treatment suggestions were provided from the initial vignettes across domains, including sensory, physical, and functional interventions, education, and cortical representation techniques: 46 ultimately reached consensus. However, important discrepancies in justification (eg, why allodynia should be covered) and implementation of techniques (eg, desensitization, sensory reeducation) were identified as the consensus exercise progressed.
Conclusions: Experts recommend individually tailored programs to treat allodynia using a variety of physical/movement, sensory-based, and "top-down" approaches; this is highly aligned with contemporary theories, such as the Neuromatrix Model of Pain. However, consensus was not reached on the justification and implementation of some of these approaches, reflecting the lack of a taxonomy and supporting evidence for tactile stimulation approaches in the current literature. Trials directly comparing the effectiveness of these approaches are needed.

The cause of mechanical allodynia is not fully understood. It is a complex composite of peripheral and central nervous system changes.[1] Following tissue/nerve injury, tissues and immune cells release inflammatory mediators,[2] which sensitize nociceptors, causing them to have a lowered threshold for stimulation (peripheral sensitization).[2,3] Sensitized nociceptors induce excitability in nociceptive fibers in the spinal cord (central sensitization).[4] This increase in excitability allows peripheral inputs from mechanosensitive afferents (Aβ fibers), which carry information about touch, to engage with nociceptive pathways in the spinal cord, turning touch sensations into pain.[1] Descending pathways from supraspinal structures to the spinal cord dorsal horn have a direct impact, both facilitatory and inhibitory, on nociceptive neurons.[5] Research also shows changes in areas of activation within the brain in individuals experiencing allodynia.[6–8] In individuals with complex regional pain syndrome (CRPS), the extent of allodynia was found to correlate with the degree of parietal lobe dysfunction.[9] Peripheral nervous system changes are considered a key driver of allodynia, and once brought under control, allodynia should resolve.[4,10] According to Woolf however, the amount of peripheral input needed to maintain central sensitization decreases over time, and in some

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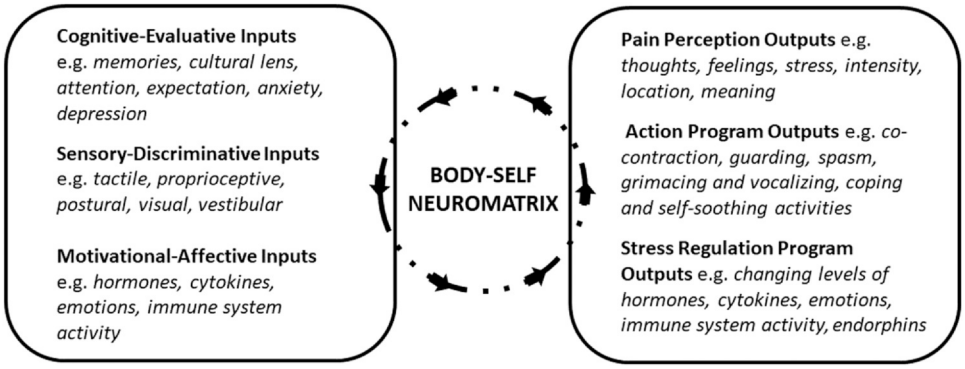

Fig. 1. Neuromatrix Model of Pain.
Adapted from Melzack, 2001[11]. Fig. 1

individuals, the condition can become autonomous and not need peripheral input, but the mechanisms behind this are not well understood.[11]

Pain is not just a physical/sensory experience. The Neuromatrix Model of Pain[12] is a biopsychosocial model that acknowledges the inputs of cognitive/evaluative, sensory/discriminative, and motivational/affective factors in the experience of pain. There is a complex interaction of these inputs from the body, mind, and environment that ultimately influence our thoughts and physical actions, as well as physiological responses. These responses are labeled as outputs in the model and categorized under pain perception, behavioral responses, and stress regulation.[12] The pain experience itself is a stressor and can perpetuate the state, driving the cycle of inputs and outputs.[13] Everyone's distinct neuromatrix determines how pain is interpreted and experienced. The Neuromatrix Model of Pain is useful, as it provides a way of looking at pain that involves not just the contributing factors ("inputs") to pain but also how the individual responds ("outputs"; as presented in Fig. 1) that can be used to inform treatment selection and grading.[13]

Research on the treatment of allodynia is quite limited, and the primary focus has been on tactile stimulation: that is, the sensory-discriminative aspect of pain. A recent systematic review of 11 tactile stimulation intervention studies for dysesthesia[14] concluded that there is inconclusive evidence and inconsistent implementation, and the studies included were of low to very low quality. One other study looked at the effect of nerve mobilization on allodynia.[15]

The concept of tactile stimulation or "'*desensitization*' is found historically in the treatment of "hypersensitive" hands and originally meant touching/stimulating directly on the "hypersensitive" area.[16–18] More recently, textbooks and research papers offer a variety of recommendations regarding touching in relation to allodynia including (1) avoiding touch to the allodynic area but utilizing touch in a distant anatomically associated cutaneous nerve branch, termed "counterstimulation" in the somatosensory pain rehabilitation (SPR) method,[19] (2) touching outside the painful area and move in toward the allodynia,[20] (3) touching in less painful areas and move toward more painful areas,[21] (4) touch directly on the painful area,[22,23] and (5) avoiding direct touch when CRPS is present.[24] During "desensitization" applied directly to the area, the stimulus may be of various textures or particles (applied to the skin or through immersion of the hand in a tactile medium), vibration, or temperatures, which are often graded from soft/most tolerable to rough/least tolerable.[22] Other aspects that can be included and graded are the amount of attention needed for the task,[21] if it is done by looking at the limb or looking at a reflection of the unaffected limb in a mirror,[25] or with the requirement to determine the location or quality (eg, rough vs soft or large vs small) of the stimulus.[26] Thus, the term "desensitization" does not describe a unified approach, as depicted in Figure 2.

Desensitization may be part of a sensory relearning program for peripheral nerve disorders. In an online survey[27] of 70 European hand therapists, 83.9% reported desensitization (through immersing the hand in different textures) was part of their current sensory relearning programs. Moreover, 79.9% of participants indicated sensory relearning should be used for individuals with hypersensitivity (including hyperesthesia and allodynia), although only 6.8% indicated sensory relearning should be used for patients who experience problems in daily living, phantom pain or sensations, or CRPS. The author suggests "desensitization can be considered as a form of relearning to interpret sensory stimuli as non-noxious" (p. 294).[27]

Given the variety of approaches reported in the literature and lack of supporting research evidence, a consensus based on expert opinion derived from a formal Delphi process[28] could be used to

DESENSITIZATION			COUNTERSTIMULATION
Touch directly on the painful area	Touch in less painful areas and move towards more painful areas	Touch on non-painful areas and move towards painful areas	Touch in non-painful area in an anatomically associated cutaneous nerve branch
Goal – nerve accommodation through touch to the painful area			Goal – reduce aberrant signalling in the spinal cord by 1) avoiding stimulation of sensitized mechanoreceptors and 2) release of neurotransmitters from stimulation to the non-painful area

Fig. 2. Contrasting the various meanings of "desensitization" with those for "counterstimulation" generated by the survey and within the literature.

guide hand therapy practice and identify acceptable interventions in need of robust evaluation. The purpose of this study was therefore to (1) seek consensus on an operational definition of "desensitization" and (2) to generate consensus recommendations for the treatment of allodynia in the hand.

Methods

A full description of the methods is available in a companion paper, "How should we define and assess painful sensitivity in the hand? An international e-Delphi study" in this issue.[29] In brief, we invited international hand therapists with expertise in allodynia and/or sensitization, neuropathic pain, or somatosensory disorders to participate in an e-Delphi survey in early 2021. We sought peer recommendations, including from national hand therapy societies and nominations from colleagues to optimize the geographic diversity of the sample. The first round of the survey elicited ideas using 3 clinical vignettes representing a spectrum of presentations of painful hypersensitivity in the hand. Subsequent rounds sought consensus on a compilation of the treatment strategies and iteratively pursued clarification of guiding definitions and principles underpinning these approaches. Consensus was set a priori at 75% agreement to retain an item. We planned to conduct up to 4 rounds of consensus building to balance sufficient depth of exploration and burden on the respondents, which might reduce participation and retention of the expert pool. Additionally, chi-square analysis of the consensus results was planned to examine 2 priori hypotheses: (1) recommendations might differ by years of experience, reflecting established practice patterns and (2) recommendations might differ by geography, representing differences in philosophical approaches and diffusion of new practices.

Results

Participation details, including the degree of international representation in the e-Delphi process, are described in the companion paper[29]; see Table 1 for a brief summary of participant demographics.

Nine hundred and eighteen treatment items were suggested in round 1. Sensory interventions were the most frequently suggested treatment, representing 22% of all items, with the term "desensitization" representing 39% of these sensory interventions. This was followed by education (14%) and cortical representation (13%). Twenty-eight treatment items were dropped due to being suggested 3 or less times (2 exceptions were promoting bilateral hand activity and neurodynamic exercises). Comments on how or why treatment would be modified for individual patient presentation were explored in subsequent rounds, and recommendations for how to approach treatment were formulated and voted on. Treatments that reached consensus are summarized in Table 2.

Tables summarizing the treatment approach recommendations, round 1 treatment categories, and round 1 sensory treatment items suggested and items that were dropped in each round, including the number of participants who provided an opinion and percent agreement, are available as supplemental online material (see Supplemental Files). Table 3 is a summary of the results on whether covering an area of allodynia is recommended.

What participants meant by certain words/terms used in round 1 was explored over rounds 2-4. In round 2, participants were asked for their preferred approach to "*desensitization*." Low endorsements were given to the statements "*I don't use desensitization*," 4% (2/52); and "*touch directly on the painful area with no restrictions*," 2% (1/52). More support was given for the descriptions "*touch directly on the painful area, grade textures*," 19% (10/52); "*touch in an associated cutaneous nerve branch (somatosensory rehabilitation method)*," 29% (15/52); and "*touch next to / around but not on the painful area, grade textures, move towards allodynia*," 46% (24/52). It became clear that the term "*desensitization*" was not being used in a consistent way. In round 3, based on the literature and previous responses within the survey, a term and a description of it were presented for voting with the following results: *"I agree that touching directly on an area of allodynia is appropriately described by the term 'desensitization,'"* 55% (26/47) agreed; and *"I agree that touching in a distant anatomically associated cutaneous nerve branch is appropriately described by the term 'counterstimulation*," 65% (30/46) agreed. It is not clear in the literature or in previous rounds which term is best used to describe touching next to/around but not directly on an area of allodynia. Thus, we asked the participants if they agreed that the term "desensitization" best describes this, 47% (22/47) agreed, or if the term "sensory relearning" best describes this, 42% (19/45) agreed. None met consensus. In round 4, a different approach was taken. Participants were presented with multiple possible meanings to choose from to define each word. The percentage support was based on all options given, including the option of "*I don't have an opinion on the definition of this approach*," as it was deemed relevant to capture this information. There was a preference for "*desensitization*" to describe touching directly on an area of allodynia by 69% (29/42). Of note, 9 of the 10 comments in response to this terminology question expressed opposition to using the approach with clients. The term "*counterstimulation*" was preferred for touching in a distant anatomically associated cutaneous nerve branch 51% (21/41). Touching next to/around but not on the area was described as "*desensitization*" by 40% (16/40) and as "*sensory relearning*" by 28% (11/40). If those with no opinion were excluded from the analysis, these numbers would be changed as follows: desensitization 81% (29/36), counterstimulation 70% (21/30) touching next to/around but not on, as desensitization 52% (16/31) and as sensory relearning 36% (11/31). No approach had a term used to describe it that reached consensus. Figure 3 summarizes the terms used to describe each of the 3 tactile stimulation approaches.

Participants indicated that they would approach desensitization differently depending on underlying mechanisms, including whether the allodynia was felt to be more due to peripheral or cortical changes. Thus, we evaluated agreement with the statement, "*If the allodynia is felt to be more due to peripheral drivers direct desensitization on the area is appropriate,*" and 61% (28/46) agreed. As this was borderline in reaching consensus, it was asked again in round 4 with slightly altered wording to increase clarity, that is, *"If the allodynia is*

Table 1
Participant demographics for rounds 1 and 4

Demographics	Round 1 ($n = 54$)	Round 4 ($n = 43$)
% OT, % PT	74%, 26%	79%, 21%
Average years practicing hand therapy	17 (range 1-35)	18 (range 3-35)
Certified hand therapist (through a certifying organization)	43%	47%
Pursuing certification or previously certified	13%	12%
Highest level of education		
Other	4%	5%
Bachelor's	26%	28%
Master's	37%	30%
OTD/DPT	9%	9%
PhD (academic)	24%	28%
Practice location		
Urban	72%	74%
Suburban	11%	12%
Rural	4%	2%
Mixed	13%	12%

DPT = Doctorate in Physical Therapy; OT = occupational therapist; OTD = Occupational Therapy Doctorate; PT = physical therapist.

Table 2
Recommended treatments to consider

Allodynia of the hand treatment recommendations	Therapists who provided an opinion, *n* (% agreement)
Therapists should determine which treatment components may be most helpful based on the unique concerns of each client. The following treatments are recommended for you to consider. Not all will be appropriate for every client.	43 (95)
Sensory intervention	
If the allodynia is felt to be more due to central drivers, direct desensitization on the area is not appropriate and treatments that focus on altering cortical representation of the limb are more appropriate.	45 (78)
Sensory reeducation (stereognosis, localization, discrimination) outside the area of allodynia	44 (75)
Tactile stimulation (various approaches, see text)	50
Other physical interventions	
Approaches to improving movement (with allodynia in the presence of reduced movement)	
Bilateral hand activities	50 (90)
Light grasping, pinching	51 (80)
Active range of motion of joints outside the area of allodynia	45 (84)
Active range of motion of joints within the area of allodynia	46 (76)
Nerve gliding (in the presence of neural tension)	46 (80)
Active use of the hand in fine motor tasks	42 (83)
Edema management (with allodynia in the presence of edema)	
Positioning/elevation	49 (88)
Encouraging movement to promote circulation	47 (73)
Light aerobic exercise	46 (78)
Compression*	46 (78)
Manual edema techniques*	39 (77)
Modalities	
Transcutaneous electrical nerve stimulation	29 (79)
Manual techniques	
Soft tissue work/mobilization/scar massage*	42 (76)
"Top-down" interventions	
Functional intervention	
Modify activities/use of devices	52 (92)
Promote use of hand in meaningful tasks	52 (92)
Promote use of hand in activities of daily living	52 (88)
Graded exposure to activity	51 (86)
Gloves for temperature control*	48 (85)
Gloves to reduce vibration*	36 (78)
Splinting for neurological deficit*	47 (87)
Splinting to promote functional use*	45 (78)
Techniques to alter cortical representation	
Promote bilateral activities	45 (91)
Imagined movements	42 (81)
Imagined sensations	35 (77)
Graded motor imagery	33 (76)
Laterality training via an app	31 (77)
Laterality training via pictures	46 (80)
Mirror therapy—motor focus	46 (85)
Mirror therapy—sensory focus	38 (82)
Education	
Managing consequences of nerve injury	52 (98)
Assessment results and treatment plan	52 (98)
Activity/exercise schedule	51 (90)
Sleep hygiene	52 (90)
Pain education	52 (88)
Medical aspects of the condition	52 (83)
Importance of supports	
Providing a home program	52 (100)
Involving counseling recoping as needed	52 (98)
Involving physician remedication for pain control as needed	52 (98)
Techniques delivered in the hand therapy setting	
Goal setting	51 (98)
Reassurance/covey security	44 (95)
Cognitive or dialectical behavior therapy	31 (90)
Breathing exercises for relaxation	46 (83)
Mindfulness meditation	42 (79)

* See text below for discussion retouching or not during treatment.

felt to be more due to peripheral drivers, i.e. *peripheral sensitization, touching directly on the area of allodynia may be helpful."* This received slightly more support at 66% (27/41) but did not reach consensus. We also asked, *"If the allodynia is felt to be more due to central drivers, direct desensitization on the area is not appropriate and treatments that focus on altering cortical representation of the limb are more appropriate,"* and 78% (35/45) agreed.

Manual edema techniques reached consensus in round 2. However, when we asked in round 3 if it should be performed in a way that avoids touching the area, it became borderline in reaching consensus of 74% (34/46). In round 4, we asked if the allodynic area should be touched during manual edema techniques, 2% agreed (1/43), 40% (17/43) indicated it should not be touched, and 58% (25/43) chose the response "It depends on the client, sometimes touching the area of allodynia is appropriate, sometimes it should be avoided during manual edema techniques." The same questioning was used to explore if touching the area of allodynia should be included during soft tissue work/mobilization/scar massage; 12% (5/41) agreed, 37% (15/41) recommended to avoid, and 51% (21/41) chose the "it depends" option as described above. This option of "it depends" was newly added to several questions in round 4 based on participant feedback.

In round 2, support for transcutaneous electrical nerve stimulation (TENS) placement included "sympathetic ganglion/nerve trunk/neck shoulder area (assuming no allodynia in area)," 58% (11/19); "other," 53% (8/15); "not on allodynic area," 50% (15/30); and "contralateral," 28% (5/18). No specific approach to TENS reached borderline consensus. However, in round 3, to determine if there was support for the modality in general, we asked if participants "recommend TENS as a treatment modality that may help reduce allodynia and its impact"; 79% (23/29) agreed.

Two themes related to assessment and treatment of allodynia were observed across the rounds. These were (1) assessment and treatment decisions depend on the client and (2) to touch or not to touch. For theme 1, deeper exploration over the rounds sought to determine what factors were considered most important in clinical decision-making, that is, what do decisions depend on? Three subthemes were observed, where assessment and treatment decisions appeared to depend on (1) the mechanisms contributing to the allodynia, (2) psychosocial factors, and (3) functional status. These subthemes were influential and are reflected in many of the individual assessment and treatment items and the approach recommendations.

Chi-square analysis was performed to examine the association between geographic location or years of experience and whether participants recommended touching an area of allodynia when peripheral sensitization was suspected. No statistically significant association was found (p value set at .05) for geographic location

Table 3
Responses to 'Should an area of allodynia be covered?'

Reasons and rationale for covering or exposing an area of allodynic skin	Therapists who provided an opinion, *n* (% agreement)
It was agreed that an area of allodynia is best left uncovered ($n = 47$, 79%). However, the reasons to not cover were diverse (none met consensus).	
It is better to leave the area of allodynia exposed as a cover will contact the area and may contribute to the pain	29 (48), round 3
It is better to leave the area of allodynia exposed to desensitize the area	29 (41), round 3
It is better to leave an area of allodynia exposed as covering it may contribute to undesirable altered cortical processing	43 (74), round 4
It was agreed that in some circumstances, a cover may be appropriate.	
Reasons a cover may be considered (all met consensus).	
If a cover is necessary, it should be applied in a way that does not cause pain to increase (as much as is possible)	46 (93)
Consider using a cover for other medical concerns such as edema management or contracture treatment	42 (81)
Consider using a cover for specific tasks only as needed	46 (80)
Consider using a cover if it helps the client use their hand more functionally. Wean the cover gradually	42 (76)

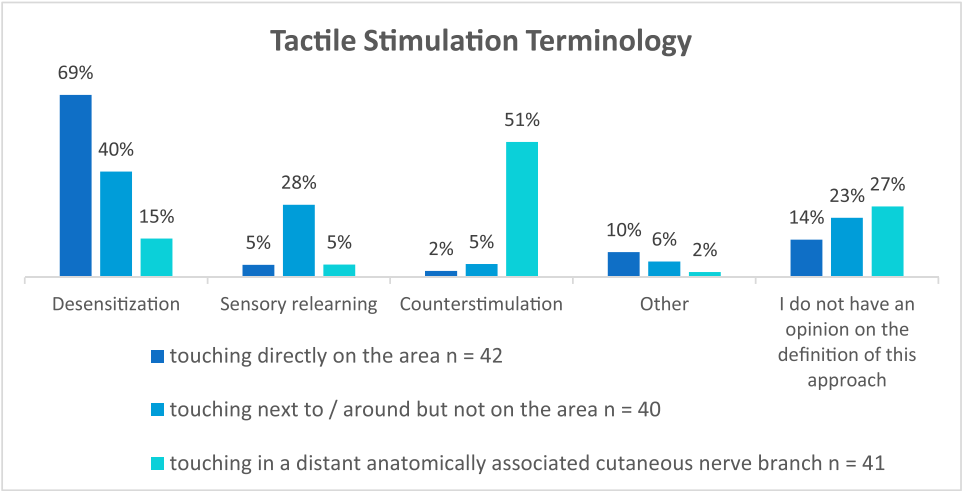

Fig. 3. Terms used by participants to describe tactile stimulation approaches.

(North America vs Europe vs other regions), X^2 (2, $n = 41$) = 4.47, p = .11 or for years of experience, X^2 (2, $n = 41$) = 0.73, p = .69. The results were also not statistically significant for an association for the terms "desensitization," "sensory relearning," or "other" to mean touching near an area of allodynia and geographic location, X^2 (4, $n = 31$) = 5.65, p = .23 or for years of experience X^2 (4, $n = 31$) = 1.08, p = .9. However, given the small sample, this analysis was likely underpowered to find a difference if one existed.

Discussion

Recommendations for treatment were generated by the participants with the overarching caveat that the selection of individual items would depend on the unique presentation of each client. Factors considered important in the selection of these options were the presumed underlying mechanisms contributing to the allodynia and the psychosocial and functional status of the individual. Whether an area of allodynia should be touched was a consistent theme throughout the study, and consensus was not reached around this issue. The recommendations generated from this study can be used to provide guidance to clinicians until more robust research is undertaken. Research to date has been limited, of low quality, and has focused primarily on various approaches to tactile stimulation.[14] Broadly grouped, recommended interventions from this survey were sensory (including tactile stimulation), other physical, and "top-down" interventions, which included functional interventions, techniques to alter cortical representation, education, support, and psychosocial interventions. Interestingly, it was treating the impact and psychosocial aspects that were the most quickly and strongly agreed upon in the study. Research within the specialty of hand therapy often focuses on the impairment level of function[30,31]; however, our results suggest a broad focus on participation and are congruent with a client-centered and biopsychosocial approach.

When the skin on the hand is touched gently and an individual subsequently experiences pain, the nervous system from the hand to the cortex is involved. Allodynia requires a peripheral stimulus, receptors to pick it up, nerves to carry the messages, the spinal cord to sort and relay, descending control from the brain, and the brain itself to perceive the pain.[1] The question is, "At what level(s) have things gone wrong, and what can we do to help normalize the system?" The Neuromatrix Model of Pain[12] suggests multiple inputs simultaneously contribute to a painful experience. When allodynia pain is evoked, either by the individual through touch or use or by a therapist's touch, there are sensory-discriminative inputs (cutaneous and visual), cognitive-evaluative inputs (attention, expectation, mood, past experiences), and motivational-affective inputs (hormonal, immune, and limbic system activity). These inputs all influence the perception of pain, as well as the behavioral and physiological responses. Ultimately, pain is processed in the brain.[2]

A point of disagreement during our study was whether it is helpful to touch an area of allodynia. This lack of agreement in approach reflects not only the broader literature, which includes conflicting viewpoints, but even a lack of clarity in published treatment guidelines. For example, the most recent guidelines for CRPS from

the United Kingdom[32] include recommendations for desensitization in an appendix. The instructions give several examples of direct stimulation on the affected limb using the wording "applying to the affected area" (p. 47) but then also direct the individual to apply various textures by starting in an area where touch is tolerated and moving toward the area where it is not tolerated.[32] This lack of agreement on the ideal approach to cutaneous sensitization is similar to the ongoing debates about whether activity relieves pain or provokes pain in persons with evidence of central sensitization (eg, in chronic primary pain syndromes).[33] More research is needed to identify who is most likely to benefit from which approach.

The term "*desensitization*" does not mean the same thing to everyone. Desensitization was described in a seminal article[16] as *"decreasing the sensitivity of the hand to an external stimulus"* (p. 178). Direct stimulation using textures, immersion, and vibration was described. Recently, an updated definition of desensitization[34] was put forward: *"desensitization is a strategy to control or change sensory and/or nociceptive inputs to modulate sensory processing and thus the perceptual experience* via *direct stimulation to an area of unpleasant cutaneous dysesthesia. These inputs can be tactile, thermal or proprioceptive, and the intended target of modulation is both at the spinal level (dorsal horn) and memory and emotional centres in the brain"* (p. 67). We explored the meaning of the term "*desensitization*" over the survey rounds. Of those with an opinion, 81% agreed that touching directly on an area of allodynia is best described by the term "desensitization." However, in a separate question, 52% also indicated that touching near but not on the area is best described by the term "desensitization." Most of the comments in response to the terminology questions expressed opposition to touching an area of allodynia, as it is painful. This lack of agreement on terms may have an impact on the interpretation of past research or on future research and reviews, as the term is not applied consistently. More work is needed to reach an agreement on the meaning of "*desensitization*." Historically, desensitization has meant touching directly on the area of allodynia,[16–18] and this was more endorsed by survey participants; perhaps only touching directly on the area should be retained as the meaning of desensitization. Consensus could be sought on a different term to describe nonpainful touching near an area of allodynia so that these different approaches can be contrasted and compared to better understand if, how, when, and for whom they may provide benefit.

An important issue is whether touching on an area of allodynia is appropriate when allodynia is associated with CRPS. In a recent practice survey of 132 professionals who treat CRPS,[35] "desensitization" was reported to be used "always/frequently" by 67%. However, a definition of desensitization was not given, and some may have interpreted "desensitization" to mean touching around (not painful), and others may have interpreted it to mean touching directly on the area (painful). The UK CRPS practice guidelines are unclear about where to touch.[32] However, recent textbooks recommend against direct touch[24] or recommended touch start outside the area and that pain should not be allowed to increase.[20] Survey participants indicated direct desensitization on an area of allodynia is not appropriate when the allodynia is centrally driven, and cortical changes are felt to be contributing to the client's pain. Participants endorsed the statements "*consider more central treatments if allodynia is part of the diagnosis of CRPS*" and "*consider being more cautious to avoid pain increase if allodynia is part of the diagnosis of CRPS,*" and "*If the allodynia is felt to be more due to central drivers, direct desensitization on the area is not appropriate and treatments that focus on altering cortical representation of the limb are more appropriate.*" Based on these statements, touching an area of allodynia that is associated with CRPS is not advised. This recommendation can be used to clarify the lack of clear guidance in the current clinical practice recommendations for CRPS.[32,36]

Basic science research suggests peripheral sensitization is driven by hyperactivity in nociceptors in the skin and peripheral neurons.[4] The idea that touching on an area of allodynia may be more helpful when the allodynia is due to peripheral sensitization was explored. Although there are theoretical grounds for this hypothesis, this concept did not meet consensus. However, in round 4, two-thirds of participants agreed that touching directly on the area may be helpful when peripheral sensitization is suspected. A study of 39 individuals with pain/discomfort at or around a scar from an injury or surgery[37] found a significant decrease in the visual analogue scale (VAS) (from 73 to 51) for touch-evoked pain after 6 weeks of a home program of desensitizing with a texture that was "barely tolerated" on the painful area. A decrease in pain on stroking the area with the other hand was one of the inclusion criteria for the study, which likely biased the outcome, as only those who responded on screening were included and individuals with CRPS were excluded. The authors suggested that hyperaesthesia from nociceptive pain may be more responsive to treatment.[37]

In contrast, the SPR method recommends avoiding contact with the allodynic area plus comfortable stimulation in a distant anatomically associated cutaneous nerve distribution.[19] SPR methods are thought to be effective by (1) allowing neurotransmitters, generated from comfortable stimulation in an anatomically related nerve branch to reduce the aberrant signaling in the spinal cord; and (2) by avoiding tactile stimuli to the area of allodynia in therapy and daily activities so there is less input to maintain the maladaptive neuroplasticity contributing to the allodynia.[19] Integral to this approach is avoidance of touch to the area of allodynia in therapy and in daily activities, which is a significant departure from the historical use of "desensitization." It is worth considering whether it is the careful avoidance of touch/stimulation, the "counterstimulation," or the combination of both, which is the active ingredient in this approach. The SPR concepts of avoiding touching an area of allodynia and comfortable counterstimulation in an associated cutaneous nerve branch were voted on but did not reach consensus agreement. There is limited yet promising research on the SPR methods. A retrospective cohort study[38] of 48 individuals with CRPS who had been treated with SRM at the Somatosensory Rehabilitation Centre in Switzerland showed a reduction in allodynia and improvements in scores on the Questionnaire Douleur St. Antoine (French version of the McGill Pain Questionnaire). Upon completion of treatment, the average Questionnaire Douleur St. Antoine score was 20, down from a baseline of 48 (effect size Cohen's $d = 1.64$). The average length of treatment was 81 days. Allodynia was completely resolved in 27 individuals (56% of the total sample where only 58% completed treatment). Spicher, who developed the SPR method, reported on 43 individuals from the same treatment center[39] with resolved static mechanical allodynia (SMA). Excluded from the results were 39 individuals who did not meet the inclusion criteria of having resolved SMA (22 stopped treatment, and 17 continued to have SMA at the time of analysis). The author describes an underlying hypoesthesia in all cases and presents the length of time taken for the SMA to decrease through the stages of the Rainbow Pain Scale (a measure of allodynia severity). On average, a period of 70 days ± SD 66 days (range: 8-206 days) of treatment was necessary for SMA to resolve. In a case series of individuals post burns,[40] the majority of patients (13/17 or 76%) showed substantial improvements after SPR. Further research comparing the SPR method to other forms of tactile stimulation treatment for allodynia would be helpful, and the research agenda needed to close the knowledge gap has been well described.[41]

Participants recommended psychosocial factors, such as fear, anxiety, and ability to cope with pain, be considered when treating allodynia, and treatment be modified accordingly, congruent with a biopsychosocial approach to pain. To aid in the discussion of whether it may be helpful to touch an area of allodynia, Table 4 presents

Table 4
Neuromatrix Model of Pain applied to touching an area of allodynia

Neuromatrix Component	Touching may be helpful	Touching may be unhelpful	Clinician to consider
Input			
Cognitive-evaluative Past experience and personality inputs. Level of anxiety, attention, and expectation of pain with touch	Client may have a "no pain no gain" perspective and touching the area may be considered a "good pain"	Client may have had negative past experiences with pain/therapy. Anticipating touching may reinforce anxiety and stress	What are the client's cognitive and affective states? - Perspective on touching the area? -Past history with pain?
Sensory-discriminative Sensory input activates Aβ fibers Visual input of hand getting touched	Activating Aβ fibers may allow them to "accommodate" Visual input may bring positive attention to the hand	May reinforce already overactive connections from Aβ to nociceptors in the spinal cord. Visual input may increase anxiety	What is the client's physiological state? -Severity of allodynia? -Is the allodynia territory expansive?
Motivational- affective Cytokines, stress hormones, and/or limbic system activity	Low levels of stress systems activity have a positive influence during a painful experience	High levels of stress systems activity have a negative influence during a painful experience	What is the client's affective state? -Are stress hormones/cytokines likely low or high?
Output			
Pain perception Cognitive-evaluative Sensory-discriminative Motivational-affective	Positive evaluation of touching may contribute to descending inhibition and reduce pain	May increase attention, stress, and anxiety around touching hand. May "wind up" pain pathways	What is the pain response to touching? (cognitive, sensory, and affective)
Action programs Involuntary action Voluntary action Coping strategies	May increase spontaneous and intentional use	May pull hand away, reduce use of hand, reduce attendance in therapy or adherence to home exercises	What behaviors are observed? -Engaged or fearful? -Effect on hand use?
Stress regulation Stress hormones, immune activity, endorphin levels	May reduce fear of touch and reduce stress systems activity	May increase fear of touch and activate stress systems activity	Does touching appear to stress or motivate the client?

our application of the Neuromatrix Model of Pain[12] to touching an area of allodynia. In the absence of consensus or robust evidence, we hope this synthesis of our discussions with a relevant theory can inform individual-level clinical decision-making.

Participants recommended approaches to reduce edema and improve movement in the presence of allodynia, nerve gliding in the presence of neural tension and allodynia, soft tissue work/mobilization/scar massage, and TENS. Of these recommended options, only nerve mobilization[15] was evaluated 26 years ago with positive results. Our survey supported nerve gliding as a possible treatment for allodynia in the presence of neural tension. Mobilization of tissues and scar massage were also recommended; however, research is limited in this area.[42] A case study[43] describes a reduction in CRPS signs and symptoms, including allodynia, following manipulation of the thoracic spine. An interesting avenue of research worth pursuing is evaluating if an improvement to the environment in which nerves function can contribute to the reduction of allodynia (through edema reduction, increased range of motion, mobilization of tissues, and mobilization of the nervous system itself).

TENS was recommended as a treatment option, but electrode placement was not agreed upon. A 2017 Cochrane review[44] of TENS for neuropathic pain in adults (excluding individuals with CRPS or fibromyalgia) concluded it is impossible to confidently state whether TENS is effective in relieving pain when compared to sham TENS for neuropathic pain. The quality of the 15 studies reviewed was considered very low, and further research was recommended. Future work should consider electrode placement as a variable when evaluating the effectiveness of TENS in neuropathic pain with allodynia.

Hands are integral to daily function, work, and leisure. When pain limits the ability to touch, hold, and manipulate, functional use is impacted. Hands are used to get washed and dressed, cook and eat, touch, gesture, or communicate, allowing participation in life roles. Limitations of the hand can affect a person's life in profound ways.[45] In this way, allodynia of the hand is particularly important and different from allodynia on other body areas, such as the trunk or upper arm, which could have a lesser impact on daily activities and participation in life roles. In addressing the importance of function, participants recommended (1) modifying activities (use of assistive devices), (2) promoting hand use in meaningful activities and ADLs, (3) graded exposure to activity, and (4) the use of gloves or splints for specific reasons (including for temperature control, protection from vibration or for neurological deficits). Covering the area with a glove/splint/gel etc. was also recommended if it improved functional use of the hand although in general, covering an area of allodynia was not recommended. Whether a therapist should promote the use of the hand, including touch of the allodynic area or should be advising the client to avoid touch is an important question. Research comparing touch vs avoidance of touch and considering psychological variables is needed to clarify which approach is more likely to benefit individual clients.

An interesting difference in approach to treatment between the 3 vignettes in round 1 was the suggestion to cover the area of allodynia. Covering was suggested 19 times in the fingertip amputation case. Covering in the cases of CRPS and peripheral nerve injury was infrequent (2 and 4 times, respectively). Following fingertip injuries covering to "protect" the finger, for scar management, and edema control is suggested in the text Rehabilitation of the Hand and Upper Extremity.[46] Covering specifically to protect from pain/allodynia is not mentioned. In a previous version of this text, covering an area to allow for function for individuals with CRPS was suggested if desensitization was unsuccessful.[23] The reasons behind this seeming preference in our survey and the literature to cover for a fingertip amputation with allodynia but not for allodynia from other causes are unclear.

Participants recommended treatments targeting cortical representation (including promoting bilateral activities, imagined movement and sensation, mirror therapy, laterality recognition training, and graded motor imagery or GMI). While the exact mechanisms are not clear at the cortical level, central sensitization is thought to be an amplifier of peripheral input.[4] Research on methods

to alter cortical representation of a limb by Moseley[47,48] and others[49,50] report decreased pain in individuals with CRPS and phantom limb pain, conditions that often present with allodynia. However, the assessment of pain in these studies was via numeric rating scale (NRS) or VAS, capturing resting/spontaneous pain—not evoked pain/allodynia. Thus, while GMI and its components appear helpful in the treatment of CRPS, the research in this area should be applied cautiously to allodynia on its own as studies have not assessed for changes in allodynia in response to GMI and its components. Applying touch to the unaffected limb during mirror therapy has been suggested,[25] and mirror therapy with a sensory focus was recommended in the survey. The high support for cortical representation treatments for allodynia shown in the survey suggests these approaches may be common in practice. To date, there have been no studies that have specifically assessed the effect of cortical representation treatments on allodynia in individuals with and without CRPS.

Limitations and recommendations for future research.

We sought to develop international consensus recommendations for the treatment of allodynia but want to note key limitations of this work related to sampling. Although we sought to identify international experts from sources other than peer-reviewed publications (in recognition of potential publication bias), we recognize there may be sampling bias in who was able to respond to English surveys. We made efforts to reach out to national hand therapy societies to request recommendations but were not successful in contacting all member chapters of the International Federation of Societies for Hand Therapy; therefore, our results may lack generalizability.

This work raises several key recommendations for future research in hand therapy and other rehabilitation settings. First, there is a need to include screening for allodynia and measures of allodynia severity in studies addressing neuropathic pain conditions and CRPS, particularly those using cortical representation treatments. Such classification of study participants will support subgroup analysis of persons with and without allodynia to evaluate the potential for different responses and levels of effectiveness. Second, we strongly advocate for studies comparing direct and indirect stimulation approaches for the management of allodynia. Within this work, it will be important to identify predictors of positive responses to approaches that provoke pain vs those that protect against evoked pain when allodynia is present. Finally, the strong support for interventions supporting return to meaningful activities demands that participation outcomes be included in studies of treatments targeting painful sensitivity in the hand therapy context.

Conclusions

Most of the hand therapy research on allodynia has evaluated various approaches to tactile stimulation, but the quality of studies has been low, and the risk of bias is high.[14] Early work[16–18] recommended direct touch to an area of “hypersensitivity.” More recent opinions[19,20,24] suggest direct touching of allodynia may not always be appropriate, an opinion reflected in our survey results. Many factors such as the underlying mechanisms and the functional and psychosocial status of the individual when making decisions around assessment and treatment, including whether the area should be touched or not, may be considered. More research is needed to help understand how best to assess for and treat allodynia.

Declaration of Competing Interest

The authors declare no conflict of interest.

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Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.jht.2023.08.003.

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Quiz: # A55

Record your answers on the Return Answer Form found on the tear-out coupon at the back of this issue. There is only one best answer for each question.

#1. The study design is
- a. RCTs
- b. e-Delphi survey
- c. case series
- d. qualitative

#2. Tactile stimulation has been used synonymously with
- a. stroke and scratch therapy
- b. Semmes-Weinstein deep pressure therapy
- c. physical agent modalities
- d. desensitization

#3. The Neuromatrix Model of Pain is a
- a. traditional tool for evaluating pain
- b. modified VAS
- c. biopsychosocial model
- d. best practices model advocated by the AMA

#4. Consensus among experts was set at
- a. 70%
- b. 75%
- c. 80%
- d. 90%

#5. The authors perceive the need for more evidence to support the use of tactile therapies in treating hand allodynia
- a. true
- b. false