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Pain during nonsuicidal self-injury: An investigation of the sensory and affective components of pain and injury severity in daily life

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Abstract

Background

Physical pain usually serves a protective function by signaling bodily harm and motivating avoidance. In nonsuicidal self-injury (NSSI), individuals deliberately injure their own body tissue without suicidal intent. Previous work suggests that pain during NSSI acts may generally be mild, but minimal daily-life work has distinguished between the sensory and affective components of pain experience during real-life NSSI episodes. Previous work has also not examined how injury severity relates to the sensory and affective components of pain. The present study therefore examined pain intensity, pain pleasantness/unpleasantness, and injury severity during NSSI events in everyday life.

Methods

Participants were 51 cisgender women with DSM-5 NSSI disorder. Across a 15-day ambulatory assessment period, participants reported NSSI events in daily life and completed event-contingent assessments, followed by three follow-up prompts over the subsequent 30 minutes. In multilevel models, we tested whether sensory (pain intensity) and affective (pain pleasantness/unpleasantness) components of pain changed from the NSSI event to the follow-up prompts and whether injury severity predicted pain.

Results

Analyses included 136 NSSI events. Pain during NSSI was mild on average and complete analgesia occurred in approx. 18% of events. Severe pain was rare, and no event was rated as the worst imaginable pain. Pain intensity significantly decreased from the NSSI event to the subsequent follow-up prompts. Pain was appraised as pleasant on average, and this did not significantly change within the follow-up period. Injury severity positively predicted pain intensity, indicating that more severe injuries were rated as more painful. However, absolute pain levels remained low overall.

Conclusions

Pain during real-life NSSI was generally mild, decreased shortly after the event, and was often appraised as pleasant. These findings suggest that pain during NSSI may not merely represent a (low) barrier to self-injury, but may constitute a functionally meaningful component of the behavior. Assessing both sensory and affective components of pain may improve clinical understanding of NSSI maintenance.

Background

Pain is a fundamental human experience that usually serves a protective function. Acute physical pain signals actual or potential tissue damage, captures attention, and motivates behavior that prevents further harm (1, 2). At the same time, pain is not a simple readout of nociceptive input. It is shaped by emotional, cognitive, biological, and social processes, and its meaning can change depending on the context in which it occurs (3, 4). This contextual nature of pain is particularly important for understanding nonsuicidal self-injury (NSSI), defined as the deliberate destruction of one's own body tissue without suicidal intent and not for socially sanctioned reasons (5). Approximately 16% – 18% of adolescents in community samples (6, 7) and 5% of adults in the general population report NSSI (8, 9). NSSI is also highly relevant in borderline personality disorder (BPD), with estimates suggesting that approximately 90% of individuals with BPD have a history of NSSI (10).

Theoretical models of NSSI suggest that pain can be understood as a natural barrier to self-injury, because it is typically unpleasant and signals a threat to bodily integrity (11). However, other work has suggested that pain experience may serve an important function for at least some who self-harm (12). Understanding how pain is experienced and appraised during NSSI is therefore crucial for explaining how individuals may overcome this barrier and engage in NSSI despite bodily harm. In the present study, we focus on two central dimensions of real-life NSSI pain: its intensity and its pleasantness.

Regarding *pain intensity*, several mechanisms have been proposed to explain why individuals may experience mild or absent NSSI-related pain despite potentially significant tissue damage. One possibility is state-dependent analgesia. According to the stress-induced analgesia hypothesis, acute stress and emotional arousal can reduce pain perception through neurobiological systems involving endogenous opioids, cannabinoids, and glutamatergic processes (13). This mechanism is relevant to NSSI because episodes of self-injury are often preceded by intense emotional distress (14, 15). Experimental studies provide some support for this idea, showing that individuals with a history of NSSI reported less pain specifically under distressing conditions (16, 17), although findings are not entirely consistent and may depend on broader individual differences such as trait emotion dysregulation (18).

At the neurobiological level, endogenous opioid involvement has long been proposed, but the evidence remains methodologically limited, particularly because most studies have relied on resting measures or clinical BPD samples and little is known about dynamic opioid fluctuations as a function of affect or NSSI episodes (19). Importantly, our own data showed that salivary β-endorphin was lower immediately before NSSI than after NSSI, and β-endorphin levels were positively associated with injury severity, although not with subjective pain intensity (20). Finally, indirect experimental evidence suggests that perceiving pain as positive may lead to greater recruitment of both opioid and endocannabinoid systems: when pain was framed as beneficial, healthy participants tolerated it longer, and this effect was blocked only when both opioid and cannabinoid antagonists were administered (21). Taken together, these findings suggest that NSSI-related hypoalgesia may not be explained by a single mechanism, but rather by an interplay of acute distress, endogenous pain-inhibitory systems, self-induced sensory attenuation, and cognitive-affective appraisal of pain.

A second possibility for explaining reduced pain intensity is habituation. Whereas stress-induced analgesia refers to a momentary reduction in pain during states of acute distress, the habituation hypothesis proposes that repeated self-injury may lead to reduced pain intensity or reduced pain aversiveness over time (22). Consistent with this idea, meta-analytic evidence indicates that individuals with a history of NSSI show higher pain thresholds on experimental pain induction tasks, and also higher pain tolerance compared with individuals without a history of NSSI or with other forms of psychopathology (22–25). Longitudinal findings further suggest that more frequent or severe NSSI may be associated with increased pain tolerance over time (26). In line with this, a large web-based study found that individuals retrospectively reported less pain during their most recent NSSI episode than during their first episode of NSSI, suggesting that NSSI-related pain may decrease across the course of repeated self-injury (12). It is also important to note, however, that Carpenter et al. (12) found that most participants reported low-to-average NSSI pain and complete analgesia was rare.

The sensory component of pain (i.e., pain intensity) is only one piece of how pain is experienced. The affective component, or how pleasant or unpleasant pain is, is also important (27) and the two components are generally considered to be distinct and separable. For example, a painful sensation that is experienced as unpleasant (e.g., muscle soreness after an injury) should have different implications than a painful sensation that is experienced as tolerable, useful, deserved, or even pleasant (e.g., muscle soreness after running a race). Several models of NSSI propose that pain can contribute to the reinforcing effects of self-injury and may be an important aspect of NSSI. For instance, the onset of physical pain may interrupt unwanted thoughts or emotions, while the offset of pain may be experienced as relieving (28–30). Pain may therefore acquire subjective value in the context of NSSI (11), which may lead individuals to experience it as less unpleasant or even pleasant. Selby and colleagues (31) found that some individuals report automatic positive reinforcement from NSSI, including sensations such as stimulation and satisfaction. With regard to pain pleasantness, experimental work in individuals with BPD currently engaging in NSSI has shown that, in the thermal grill illusion, patients with BPD perceived illusory pain as less unpleasant than healthy controls, suggesting altered affective evaluation (32). More recent work further demonstrated that temporal summation of pain unpleasantness, but not pain intensity, was increased in BPD, again indicating that the affective-appraisal component of pain can dissociate from sensory intensity (33). A complete understanding of pain in NSSI may require assessing not only how intense pain is, but also how pleasant or unpleasant it is perceived to be.

In conclusion, much of the existing evidence on NSSI-related pain comes from laboratory studies that use standardized pain tasks, such as cold, pressure or heat pain. These paradigms have been essential for establishing altered pain sensitivity in NSSI, but they necessarily rely on proxies for self-injury-related pain (25). They cannot capture how pain is experienced during actual NSSI episodes in daily life, where the injury is self-inflicted, personally meaningful, and embedded in the individual's current emotional and situational context (34). A small number of studies have begun to address this limitation using ambulatory assessment methods. Selby and colleagues (30) directly examined pain before, during, and after NSSI episodes and found considerable heterogeneity: some episodes were characterized by little or no pain, others by pain onset, and others by pain offset. Daily diary work has reported generally low,

though not absent, pain ratings during NSSI (35), and a large web-based study found that participants retrospectively reported mild to moderate physical pain during and shortly after NSSI (12). Together, these studies suggest that pain during NSSI is variable rather than uniformly absent or uniformly intense.

Despite these advances, important questions remain unresolved. First, the small number of previous daily-life studies has focused primarily on pain intensity, whereas the unpleasantness or pleasantness of pain during NSSI has not been systematically assessed. Second, pain ratings are difficult to interpret without information about the severity of the injury. Low pain during a superficial injury may reflect relatively low nociceptive input, whereas low pain during a moderate or severe injury may indicate altered pain perception or appraisal. Conversely, if more severe injuries are experienced as more intense but not necessarily as more unpleasant, this would suggest that the sensory and evaluative components of pain are partly dissociable in NSSI. Third, little is known about how the sensory and affect components of pain may change in the minutes immediately following NSSI. Because the subjective consequences of self-injury unfold rapidly, repeated assessments shortly after an NSSI episode may be particularly informative for understanding whether pain decreases, persists, or otherwise changes after the injury.

The present study addressed these questions using ambulatory assessment in a sample of individuals with DSM-5 NSSI disorder. Participants reported NSSI events in daily life and completed event-contingent assessments followed by three follow-up prompts during the 30 minutes after the events. This design allowed us to examine NSSI-related pain in the context in which it naturally occurs, while assessing pain intensity, pain pleasantness, and injury severity. First, based on prior findings that NSSI-related pain intensity is often mild to moderate and may decrease after self-injury (30, 35), we hypothesized that pain intensity would decline from the NSSI event to the subsequent follow-up prompts. Second, drawing on models suggesting that pain during NSSI may acquire subjective value, for instance by interrupting aversive internal states or being followed by relief (11, 29, 30), we hypothesized that the affective component of pain would change (towards higher pleasantness due to experiences of relief or relaxation) during the follow-up prompts. Third, because more severe injuries should involve greater nociceptive input, we hypothesized that injury severity would positively predict pain intensity.

Methods

Participants

Three publications have previously reported on this sample, focusing on the release of β-endorphin in the context of NSSI (20), the interpersonal function of NSSI (36), and negative affect reduction following NSSI versus high urge moments (37). In Störkel et al. (20), we reported group-mean level of pain intensity and associations with salivary β-endorphin concentrations, which were non-significant. Participants in the present sample were 51 cis-gender women, with a DSM-5 NSSI disorder (5). Because the larger study included biological markers, we recruited only cisgender women to increase biological homogeneity. We specifically recruited participants who reported repetitive NSSI for the last three months, with at least one NSSI event per week, to maximize the probability that NSSI engagement would be observed during

the NSSI study period. For a complete set of inclusion and exclusion criteria that were applied because of the biological component of the study, see Störkel et al. (20) and the corresponding OSF project (38). Participants were recruited via NSSI-related groups on online platforms, the institution's waitlist and flyers distributed in the department's in- and outpatient units.

Participants were aged 18–45 (*M* = 23.92, *SD* = 6.72) and had been engaging in NSSI for an average of almost ten years (*M* = 9.66, *SD* = 6.48). In addition, participants showed a wide range of psychopathology beyond the required NSSI disorder diagnosis. The most common diagnoses were depression (*n* = 33), borderline personality disorder (*n* = 32) and post-traumatic stress disorder (*n* = 25) (see 20 for more information on comorbid diagnoses). Additionally, 71% (*n* = 36) of participants in the sample reported at least one suicide attempt (*M* = 2.02; range 0–10) and 53% (*n* = 19) of those reported that their suicide attempt reflected a true desire to end their life. The majority of suicide attempts (64%, *n* = 23) occurred within the last two years prior to study participation.

Procedure

The study was approved by the ethics committee of the Medical Faculty Mannheim, Heidelberg University (2014-601N-MA), and was conducted in accordance with the Declaration of Helsinki, Version 2013. All participants provided written informed consent after they received a full description of the study protocol. Participants were compensated 100€ for participation and paid an additional bonus of 50€ if they completed more than 80% of prompts. First, they completed a set of self-report questionnaires and attended an online or in-person orientation session (via the secured platform Patientus, jameda GmBH, Munich, Germany). The session included clinical interviews (see measures) administered by a trained clinical psychology doctoral student, who also provided an introduction to the smartphone app (*movisensXS*, Version 0.7.4682, movisens GmbH, Karlsruhe, Germany) on the study smartphones.

The sampling schedule comprised various different types of prompts, which are described in detail in the supplemental material on OSF (38). Figure 1 shows the prompt types that were included in the current analyses. The study period was 15 days, with an additional baseline day without self-harm, that was included for the biological markers reported in Störkel et al. (20). Participants answered five semi-randomized daily prompts (prompt interval min. 2 hrs.) during their normal wake hours. In case of an NSSI event, participants were asked to self-initiate a report on the app as soon as possible after the event and answer NSSI specific questions (see measures). After completing the NSSI assessment, participants responded to three follow-up prompts (after 10, 20, and 30 minutes), which assessed the trajectory of pain (intensity and pleasantness), affect, tension, and dissociation following NSSI. Random prompts included questions about affect, interpersonal events, dissociation, tension, the current urge for NSSI and also asked whether any NSSI event occurred since the last assessment that hadn't been reported yet. If participants indicated an NSSI event during a random prompt survey, they also answered all NSSI specific questions and received follow-up prompts.

Measures

An overview of all measures (e.g. affect, β-endorphin), including those not relevant to the current investigation, is provided in the supplemental material on OSF (38).

Questionnaires and interviews

Psychopathology. The required NSSI diagnosis, as well as frequency, motives and methods of NSSI, were assessed using the *Self-injurious Thoughts and Behavior Interview: German* (SITBI-G; 39). We assessed participants' psychopathology using the *Structured Clinical Interview for the Diagnostic and Statistical Manual of Mental Disorders fourth edition* (SCID-I; 40), because the DSM-5 interview was not available in German at the time of data collection (April 2017 – November 2018). In addition to this, we administered the BPD section of the *International Personality Disorder Examination* (IPDE; 41).

NSSI frequency. Participants were asked about NSSI frequency regarding four time-periods: lifetime, during the last three months, the last month, and during the last week. Additionally, participants reported their age at the first time they self-harmed and their age at the last time of NSSI engagement. Thus, we were able to infer for how long participants had already been engaging in NSSI.

NSSI appraisal. Three items assessed how participants appraise their NSSI: "Self-injury is a problem for me.", "I want to stop self-injuring or reduce my self-injury.", "I have more thoughts about wanting to die or wanting to kill myself when I don't self-injure."

Pain intensity. Five items assessed pain surrounding NSSI: "When you self-harm, how much physical pain do you experience…" "in general," "the last time you self-harmed," "the first time you self-harmed," "while you are self-harming (e.g., when you first cut your skin)," and "several minutes after you self-harmed." Participants rated their pain from 0 ("no pain") to 10 ("worst imaginable pain"). These items were adopted from a large web study (n = 1630) assessing physical and emotional pain surrounding NSSI (12).

Change in pain intensity. Participants rated how long it takes, on average, for their sense of pain to return to a "normal" level with the options: "10 minutes or less", "10–30 minutes", "30 minutes – 1 hour", "1 hour – 1 day", "more than one day", "my sense of pain during NSSI is the same as on any other time". Furthermore, participants reported whether their feeling of physical pain has changed from their first engagement to the last recent with the options: "now, I feel much less pain than during my first NSSI", "now, I feel a little less pain than during my first NSSI", "I feel the same amount of pain during NSSI than during my first NSSI", "now, I feel a little more pain than during my first NSSI", "now, I feel much more pain than during my first NSSI". These items were taken from Carpenter et al. (12).

NSSI severity. Participants reported whether they received *or* should have received medical care for NSSI wounds in the last three months. Additionally, participants were asked to describe the most severe NSSI event of the last three months using the three categories "mild" (superficial cuts, bruises,

scratching), “moderate” (not only skin, but also underlying tissue was damaged, strongly bleeding cuts, 2nd/3rd degree burns), and “severe” (cuts to fat tissue, damaged sinews, bone fractures, inner bleeding).

EMA items

Time. Participants were asked to estimate, in minutes, how much time had passed since they engaged in NSSI.

Method. Participants were asked to select which methods they used to self-harm from the following list (multiple choice): cutting, wound manipulation, scratching, burning/ ice burning, head banging/punching self, other.

Motives. Participants reported their motive for NSSI engagement by choosing one *or* more of the following options: “wanted to reduce aversive tension or overwhelming emotions”, “wanted to express my self-hatred/ self-contempt”, “wanted to feel something (other than nothing)”, “wanted help/ attention of others”, “had another reason”, “don’t know why I self-harmed”.

Severity. NSSI severity was assessed using the categories: “mild” (superficial cuts, bruises, scratching), “moderate” (not only skin, but also underlying tissue is damaged, strongly bleeding cuts, 2nd/3rd degree burns), and “severe” (cuts to fat tissue, damaged sinews, bone fractures, inner bleeding).

Effectiveness. Participants were asked to indicate how effective the NSSI event was, by answering the item: “Did the NSSI event have the desired effect?” (“yes”, “no”, “I don’t know”).

Pain. We assessed pain intensity with two questions. First, we asked participants to rate the intensity of their pain *right now* (as they were entering the data, i.e. after having completed the NSSI engagement). Additionally, we asked participants to retrospectively rate the intensity of pain *during* NSSI engagement from 0 = “no pain” to 10 = “worst imaginable pain” on an eleven-point Likert scale. To assess the affective component of pain, we asked participants to rate the pleasantness of their *current* pain as well as the pain *during* NSSI from 0 = “pleasant” to 10 = “unpleasant” (German anchors: ‘angenehm’ and ‘unangenehm’, respectively). The items for sensory and affective pain ratings were also asked during the follow-up prompts.

Data analysis

We used multi-level models (MLM) with person-level random intercepts to account for the nested structure of the EMA data with prompts nested within participants. We used the function *lmer* from the R package *lme4* and the package *lmerTest* to obtain p-values (42, 43). In models which describe a time-trajectory, we included a linear time predictor to represent the time-trajectory from the retrospectively reported NSSI event (t0), the moment participants reported their current rating for the sensory and affective pain component in the app (t1) until the last follow-up (t4, 30 minutes after t1). Finally, to examine the associations between pain intensity and pain pleasantness/unpleasantness with severity of

the injury, we created a three-level ordinal variable for severity ratings (mild = -1, moderate = 0 and severe = 1).

Use of generative AI

We used ChatGPT (OpenAI) to assist with copy editing and minor R code refactoring for figure generation. The tool did not contribute to study design, data collection, data analysis, or interpretation of the results. All outputs were verified by the authors, who take full responsibility for the content.

Results

Descriptive results: questionnaire data

Participants reported that they engaged in an average of 10.36 (*SD* = 6.44; range = 3–32) NSSI events in the last month and 124.41 (*SD* = 104.08; range = 5.5–624) NSSI events during the last year (see 20 for more information on NSSI history). The severity of the most severe injuries in the last three months was, in the majority of the cases, rated as “moderate” *n* = 37 (73%) or “severe” *n* = 12 (23%). Only two individuals reported mild injuries as the most severe ones. Furthermore, 37% (*n* = 19) of the injuries required professional, medical interventions (in *n* = 7 cases not performed but needed) and 47% (*n* = 24) of the injuries were treated by the participants on their own. Taken together, participants reported frequent and severe NSSI within the last three months.

When describing pain during NSSI, participants reported mild to moderate NSSI pain “in general” (*M* = 4.43, *SD* = 2.05), “last time you self-harmed” (*M* = 3.88, *SD* = 1.95), “while you are self-harming” (*M* = 3.69, *SD* = 2.20), and “several minutes after NSSI” (*M* = 4.49, *SD* = 2.39). For the item “first time you self-harmed” (*M* = 5.8, *SD* = 3.03) we observed higher pain-ratings. A paired-samples t-test was conducted to compare perceived intensity during the “first time of NSSI” and the most recent NSSI experience. The results indicated that intensity of pain was significantly higher during the first experience than during the most recent one ($t(50) = 4.31$, $p < 0.001$, $d = .60$, CI[0.30–0.90]). This aligns with results for the item assessing whether “physical pain levels have changed since the first NSSI”, for which 84% of participants reported that they now feel “much less pain” (*n* = 27) or “a little less pain” (*n* = 16) compared to their first NSSI engagement. With regard to the pain trajectory after an NSSI event, most participants (35%, *n* = 18) reported that it took 10–30 minutes for their pain perception to return to a normal level, whereas 20% (*n* = 10) estimated 30 minutes to 1 hour, and 25% (*n* = 13) reported 1 hour to one day (see supplemental material for the full distribution).

The majority of the sample reported that NSSI is a problem for them (*n* = 30), while *n* = 19 rated NSSI as somewhat problematic. In line with this, n = 34 reported wanting to stop or reduce NSSI, while n = 12 reported partly wanting to do so. At the same time, 82% (*n* = 42) of the sample reported having (somewhat) more suicidal thoughts when they reduced or ceased NSSI engagement.

Descriptive results: EMA data

During the EMA period, participants responded to 4,619 prompts and reported a total of 155 NSSI events (*M* = 3.04 per participant; *SD* = 2.45; range = 0–15), resulting in a high compliance rate of 92.04% across all prompts. In the current analyses, only the self-initiated NSSI-prompts, random prompts with contemporaneously reported NSSI, and their follow-ups were included (for more information about the other prompt-types, see 38). We excluded incomplete trials as well as all NSSI events that were reported more than 30 minutes after the injury to minimize participants' memory bias (*n* = 19). After data cleaning, *n* = 521 data points were part of the current analyses (*n* = 136 NSSI events and *n* = 385 follow-ups). As we included only participants who reported tissue damaging NSSI, the most common method for NSSI was cutting (*n* = 107; see Störkel et al. (20) for a complete overview). In more than half of the cases (55.88%), participants reported more than one motive for the current NSSI act. The motives *"reduce aversive tension or overwhelming emotions"* (*n* = 99) and *"self-hatred/ self-contempt"* (*n* = 59) were most frequently endorsed.

Overall, the reported pain intensity for pain *during* NSSI (reported retrospectively after the event) was low, with an average pain intensity of *M* = 2.63 (*SD* = 2.08; range = 0–9) across events. Participants rated the majority of their injuries as mildly painful, with the majority reporting a score of 1–3 (*n* = 73, 54%), and a subsample of *n* = 13 participants reported complete analgesia (i.e. a score of 0) for at least one of their NSSI events (*n* = 24 events, 18%). Only *n* = 6 (4%) of all NSSI events were rated as severe pain, i.e. a score of 7–9 on the Likert scale, and no injury was rated 10, i.e. worst imaginable pain. Additionally, participants rated the pain they were experiencing *at that moment* (= while answering the prompt, after the NSSI event) as slightly lower, on average, than the pain they experienced *during* the NSSI event (*M* = 2.49, *SD* = 2.06, range = 0–9). Across the three follow-up prompts, pain intensity ratings showed a descriptive decrease (follow-up 1: *M* = 2.48, *SD* = 2.16, range = 0–8; follow-up 2: *M* = 2.01, *SD* = 1.99, range = 0–7; follow-up 3: *M* = 2.01, *SD* = 2.03, range = 0–7) .

Regarding the affective component of pain, participants described the NSSI events overall as pleasant *M* = 2.11 (*SD* = 2.02, range = 0–9; Likert scale: 0 = "pleasant" to 10 = "unpleasant") and only *n* = 12 (9%) of the NSSI events were rated on the unpleasant side (i.e. > 5) of the valence scale. *Directly after* the NSSI event (= while answering the prompt after the NSSI event) and across the follow-up prompts, affective ratings of pain shifted slightly in the direction of unpleasantness. However, this change was very small, and the ratings remained on the pleasant side of the valence scale (directly after the event: *M* = 2.22, *SD* = 2.06, range = 0–8; follow-up 1: *M* = 2.27, *SD* = 2.25, range = 0–8; follow-up 2: *M* = 2.19, *SD* = 2.35, range = 0–9; follow-up 3: *M* = 2.67, *SD* = 2.56, range = 0–9).

For severity, participants rated the majority (*n* = 79) of their injuries as *"moderate", n* = 46 were rated as *"mild"*, and *n* = 11 as *"severe"*. Figure 2 shows the ratings for pain intensity, unpleasantness of pain and severity of the injury for every NSSI event per participant.

Hypothesis testing

To test our first hypothesis that pain intensity would decline from the NSSI event to the subsequent follow-up prompts, we used a multilevel model with a linear time predictor. Overall, participants reported only mild pain across reports (*Est.* = 2.77, *SE* = 0.22, $p < .001$). In line with our hypothesis, There was a significant linear decrease in pain intensity across assessments from the retrospectively rated NSSI event (t0) to the last follow-up prompt (t4) 30 minutes later (*Est.* = -0.18, *SE* = 0.05, $p < .001$).

To test our second hypothesis that pain pleasantness would change across the post-event period, we conducted a second multilevel model with a linear time predictor. Participants rated pain across reports as pleasant on average (*Est.* = 2.17, *SE* = 0.24, $p < .001$). Descriptively, pain became slightly less pleasant over the following 30 minutes, but the linear time effect did not reach statistical significance (*Est.* = 0.09, *SE* = 0.05, $p = .081$). Thus, pain pleasantness did not significantly change from the NSSI event to the subsequent follow-up prompts.

Finally, we tested whether injury severity predicted pain intensity. As expected, more severe injuries were rated as more painful (*Est.* = 1.15, *SE* = 0.16, $p < .001$), see Fig. 3. However, pain ratings remained within the mild to moderate range overall, suggesting that even more severe injuries were not necessarily experienced as highly painful.

Exploratively, we also tested whether injury severity predicted the affective component of pain. Exploratorily, we also tested whether injury severity predicted the affective component of pain. Greater injury severity was associated with higher unpleasantness ratings (*Est.* = 0.71, *SE* = 0.17, $p < .001$), although ratings remained on the pleasant side of the scale on average.

Discussion

The present study investigated how pain is experienced during real-life episodes of NSSI in individuals with DSM-5 NSSI disorder (5). Specifically, we focused on pain intensity, pain pleasantness/unpleasantness, and injury severity. Based on prior evidence suggesting that NSSI-related pain is often mild to moderate and may decrease after the injury (12, 30), we expected pain intensity to decline from the NSSI event to the subsequent follow-up prompts. Drawing on models suggesting that pain may acquire subjective value during NSSI, we further examined whether pain pleasantness changed during the same post-event period. Finally, because more severe injuries should involve greater nociceptive input, we expected injury severity to positively predict pain intensity.

Overall, findings suggest that pain during NSSI was present, but generally mild and positively appraised. In retrospective questionnaire ratings, participants reported mild to moderate pain across different indicators of NSSI-related pain. Participants retrospectively rated their pain highest for the first lifetime episode of NSSI, whereas pain during more recent NSSI episodes was rated lower. This pattern is consistent with habituation accounts, according to which repeated self-injury may reduce the intensity or aversiveness of pain over time (22), and with findings from Carpenter et al. (12). The present sample was characterized by frequent and chronic NSSI, with participants reporting an average history of almost ten

years of self-injury. Thus, the relatively low pain ratings observed for the captured daily-life NSSI events may partly reflect habituation processes among individuals with longstanding NSSI.

The ambulatory assessment data supported and extended this picture. Across the analyzed 136 NSSI events, pain intensity during NSSI was low on average, with most events rated as mild pain intensity. Complete analgesia occurred in 24 events (17.65%) clustered within 13 participants. Severe pain was rare, and no event was rated as the worst imaginable pain. This aligns with Selby and colleagues (30), who also found substantial heterogeneity in real-life NSSI pain, with episodes characterized by analgesia, pain onset, or pain offset. Thus, NSSI-related pain was not uniformly absent in the present study; pain onset occurred in most episodes, and pain intensity was typically mild. Together with Selby and colleagues (30), the results highlight the need to consider both person-level and event-level variation in NSSI-related pain intensity.

In addition to these descriptive findings, MLM results found that pain intensity significantly decreased from the NSSI event to 30 minutes later. This finding is consistent with pain-offset processes, according to which pain reduces after the self-injury, which may have a relieving effect (11, 29, 30), though we did not directly test this here. In combination with the descriptive findings, this suggests a pattern in which pain is often present during self-injury, but is generally low in intensity and short-lived. In the language of the pain onset model, the onset of pain may still be important because it provides a salient bodily sensation that can interrupt or redirect aversive internal states (28, 30). In terms of pain offset, the reduction of pain may generate more general relief (12, 30).

Interestingly, the questionnaire data and ambulatory assessment data did not converge with respect to the post-event pain intensity trajectory. In the questionnaire ratings, participants retrospectively reported somewhat higher pain intensity several minutes after NSSI as compared to the retrospective rating during NSSI in daily life. This pattern is consistent with Carpenter et al. (12) who used the same items and also found that participants retrospectively reported slightly higher pain intensity after NSSI than during NSSI, with more participants reporting an increase than a decrease in pain intensity after NSSI. In contrast, our ambulatory assessment data showed a significant decline in pain intensity from the NSSI-event rating to the last follow-up. Several explanations for this are possible. Retrospective questionnaire ratings may capture participants' generalized beliefs or memories about NSSI pain, whereas ambulatory ratings capture pain close to the moment it occurs. It is also possible that participants interpret "several minutes after NSSI" differently in a global questionnaire than in an event-contingent assessment with fixed follow-up intervals. For example, retrospective reports may be influenced by later wound-related sensations, whereas the ambulatory assessment focused on the immediate post-event period. This discrepancy highlights the value of ambulatory assessment for studying NSSI pain intensity, as real-time or near-real-time assessments may reveal short-term dynamics that are difficult to reconstruct retrospectively.

Additionally, we tested whether more severe injuries would be experienced as more painful and more unpleasant and found evidence for this. This finding indicates that pain perception was not fully

decoupled from the extent of tissue damage. Injuries rated as severe were defined as cuts to fat tissue, damaged sinews, bone fractures, or inner bleeding, which are clinically substantial injuries for which high pain intensity and high unpleasantness might be expected. However, among the 11 events rated as severe, only two were rated as highly painful, one was rated as involving no pain, five as mild pain, and three as moderate pain. It is important to note, of course, that the relationship of pain experience and tissue damage is never linear and there are factors, such as greater endogenous opioid response, that might lead to less pain from a severe injury, especially in the immediate aftermath, than might otherwise be expected. Figure 3 further illustrates that high-severity events were not consistently accompanied by high pain unpleasantness. Instead, several severe events were rated on the pleasant side of the scale, and only isolated severe events were appraised as clearly unpleasant. Thus, greater injury severity was associated with both higher pain intensity and higher unpleasantness, although absolute ratings remained relatively low and on the pleasant side of the affective scale on average. This suggests that nociceptive input matters, but that both the intensity and appraisal of pain may be altered in the context of NSSI. Future studies with larger numbers of high-severity NSSI events should examine whether the strength of these associations differs across sensory and affective pain components.

The most novel finding of the study concerns the affective component of pain. Participants rated pain during NSSI as pleasant on average, and most NSSI events fell on the pleasant side of the scale. Pain pleasantness did not significantly change across the follow-up period. This finding suggests that pain during NSSI is not merely reduced in intensity, but may also be appraised in a qualitatively different way. This distinction is important and has so far been largely overlooked in daily-life research on NSSI pain, which has primarily focused on pain intensity. Pain that is mild and pleasant is unlikely to function as a strong deterrent or barrier. Instead, it may be experienced as tolerable, meaningful, deserved, regulating, or subjectively useful. This is consistent with theoretical models proposing that pain can contribute to the reinforcing effects of NSSI, for example by interrupting aversive internal states, producing relief, or providing a concrete sensory experience that is valued in the moment (28–30). It is important to note that the item used to assess the affective component of pain was bipolar, with ratings below five indicating the pain was pleasant and ratings above 5 indicating that it was unpleasant. This is different than how pain intensity was assessed and it is possible that some participants may have meant to indicate that the pain was “not unpleasant” as opposed to pleasant or desirable. However, even if this is the case, participants rated their pain as very minimally aversive, if at all. Importantly, the item was administered in German, using the anchor “angenehm” (“pleasant”). In this context, “angenehm” may refer not only to enjoyment or desirability, but also to experiences such as relief, relaxation, or soothing. Thus, ratings on the pleasant side of the scale should not necessarily be interpreted as indicating that participants enjoyed the pain itself. Rather, they may reflect that pain was experienced as positively valenced or relieving in the context of NSSI. This interpretation is consistent with the proposed reinforcing function of NSSI pain, particularly when pain contributes to relief from aversive affective states.

Taken together, the findings emphasize the importance of considering both sensory and affective processes. This distinction helps move the discussion beyond the question of whether individuals can

self-injure despite feeling pain. For many individuals or episodes, pain may not merely be a barrier that has to be overcome. Instead, pain may be part of the function of NSSI. It may be a necessary or functionally important ingredient of NSSI because it creates a salient bodily sensation, marks the self-injury as effective, or contributes to relief, grounding, self-punishment, or emotion regulation. Clinically, it may be insufficient to assess whether self-injury “is painful.” Individuals may report pain, but the pain may be mild, tolerable, pleasant, or experienced as serving a function. Assessment should therefore include questions about both pain intensity and pain pleasantness/unpleasantness. For example, clinicians might ask whether pain during NSSI feels unpleasant, relieving, deserved, calming, or pleasant. Such information could be relevant for case formulation and intervention planning as it would likely help better understand what is rewarding and reinforcing about the behavior. If pain is experienced as pleasant or regulating, treatment may need to address not only NSSI urges and antecedents, but also the learned meaning and perceived benefits of pain. Psychoeducation may also be useful, particularly because pain sensitivity can change over time and may not reliably signal the severity or long-term consequences of tissue damage.

Limitations

The present study may be subject to several limitations. First, the sample consisted of cis-gender women with DSM-5 NSSI disorder (5). This restriction was due to the biological component of the larger study project, which involved assessment of salivary beta-endorphin and is reported in detail elsewhere (20). Although this sampling strategy increased biological homogeneity and also maximized the likelihood of observing NSSI events during the ambulatory assessment period, it limits generalizability to men, gender-diverse individuals, individuals with less frequent NSSI, and community samples. The high psychopathological load of the sample is further underlined by the fact that 65% of the sample had a depressive disorder, and 63% met criteria for BPD.

Second, although the study was highly informative about real-life NSSI episodes, injury severity was assessed through self-report using three broad categories. These categories provided clinically meaningful information about tissue damage, but they may not capture more fine-grained differences in wound characteristics. Future work would benefit from more fine-grained or even objective indicators of injury severity. For example, participants could be asked to provide standardized wound photographs, where ethically and clinically appropriate, which could then be rated by trained clinicians or analyzed using machine-learning-based approaches to classify wound severity. Such approaches would allow researchers to examine more precisely whether pain intensity and pain pleasantness are proportionate to actual tissue damage.

Third, pain intensity and pain pleasantness were assessed via self-report. This is appropriate given that pain is inherently subjective, but ratings may nevertheless be influenced by interpretation of scale anchors or the time elapsed between the injury and the event-contingent assessment. We minimized this concern by excluding events reported more than 30 minutes after the injury, but some variability in reporting delay remained. Relatedly, we assessed pain intensity and pain appraisal only after NSSI had

occurred. We did not assess pain expectancies before self-injury, including expectations about how intense, pleasant, relieving, or useful the pain would be. Such expectancies may be highly relevant for understanding why individuals initiate NSSI in the first place (44). Future ambulatory studies should therefore assess anticipatory beliefs about pain and its expected effects before NSSI, for example during high-urge moments.

Fourth, the study focused on short-term pain dynamics during the 30 minutes after NSSI. This design captured the immediate post-event period, but cannot address longer-term changes in pain, wound-related discomfort, or subsequent NSSI risk and therefore cannot test which aspects of NSSI pain may be involved in maintaining NSSI. Longitudinal studies with burst-designs are necessary to address these questions.

Conclusions

Taken together, the present findings suggest that pain during real-life NSSI is not simply absent, but often mild, short-lived, and appraised as pleasant. Although injury severity predicted higher pain intensity, pain ratings remained low overall, even for some clinically severe injuries. These results indicate that pain during NSSI may only partly follow the protective logic of acute physical pain. Instead, pain may constitute a functionally meaningful component of NSSI, providing a salient bodily sensation that can be experienced as tolerable, useful, or pleasant. Distinguishing pain intensity from pain appraisal may therefore be crucial for understanding why NSSI is maintained despite bodily harm. Clinically, the findings suggest that assessment should not only ask whether NSSI hurts, but also how pain is experienced, whether it is expected to be useful, and whether it is appraised as pleasant or relieving.

Abbreviations

BPD
Borderline personality disorder
DSM
5–Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition
EMA
Ecological momentary assessment
IPDE
International Personality Disorder Examination
MLM
Multilevel model
NSSI
Nonsuicidal self–injury
OSF
Open Science Framework
SCID

Structured Clinical Interview for DSM
SITBI
G–German version of the Self–Injurious Thoughts and Behaviors Interview

Declarations

Declarations

Ethics approval and consent to participate:

This study was approved by the Medical Ethics Committee II of the Medical Faculty Mannheim, Heidelberg University (protocol no. 2014-601N-MA). All participants provided written informed consent prior to participation.

Consent for publication:

Not applicable.

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Author Contribution

Conceptualization: IN, JH, LS, RC; Methodology: IN, JH, LS; Software: JH, LS; Data Curation: LS, JH; Formal Analysis: LS, JH; Investigation: LS; Resources: IN; Writing – Original Draft: LS, JH; Writing – Review & Editing: All authors; Visualization: LS, JH; Supervision: IN; Project Administration: LS, IN; Funding Acquisition: IN. All authors read and approved the final manuscript.

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Data Availability

The datasets generated during the current study and the analysis code are available at OSF (https://osf.io/uqmky).

Footnotes

1. These are not reported herein, but a list of all assessed questionnaires is included in the supplemental material (38).

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Figures

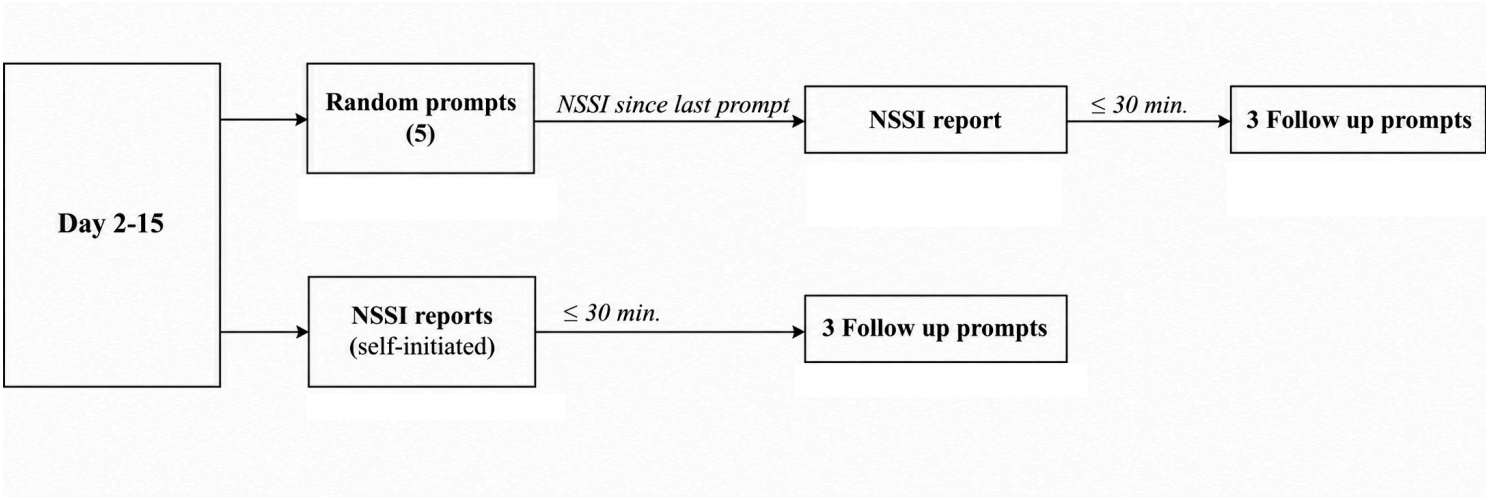


Figure 1

Assessment design for NSSI events. At the NSSI report, participants retrospectively rated pain during the NSSI event (t0) and rated their current pain at the time of reporting (t1), followed by three follow-up assessments at 10, 20, and 30 minutes after t1 (t2–t4).

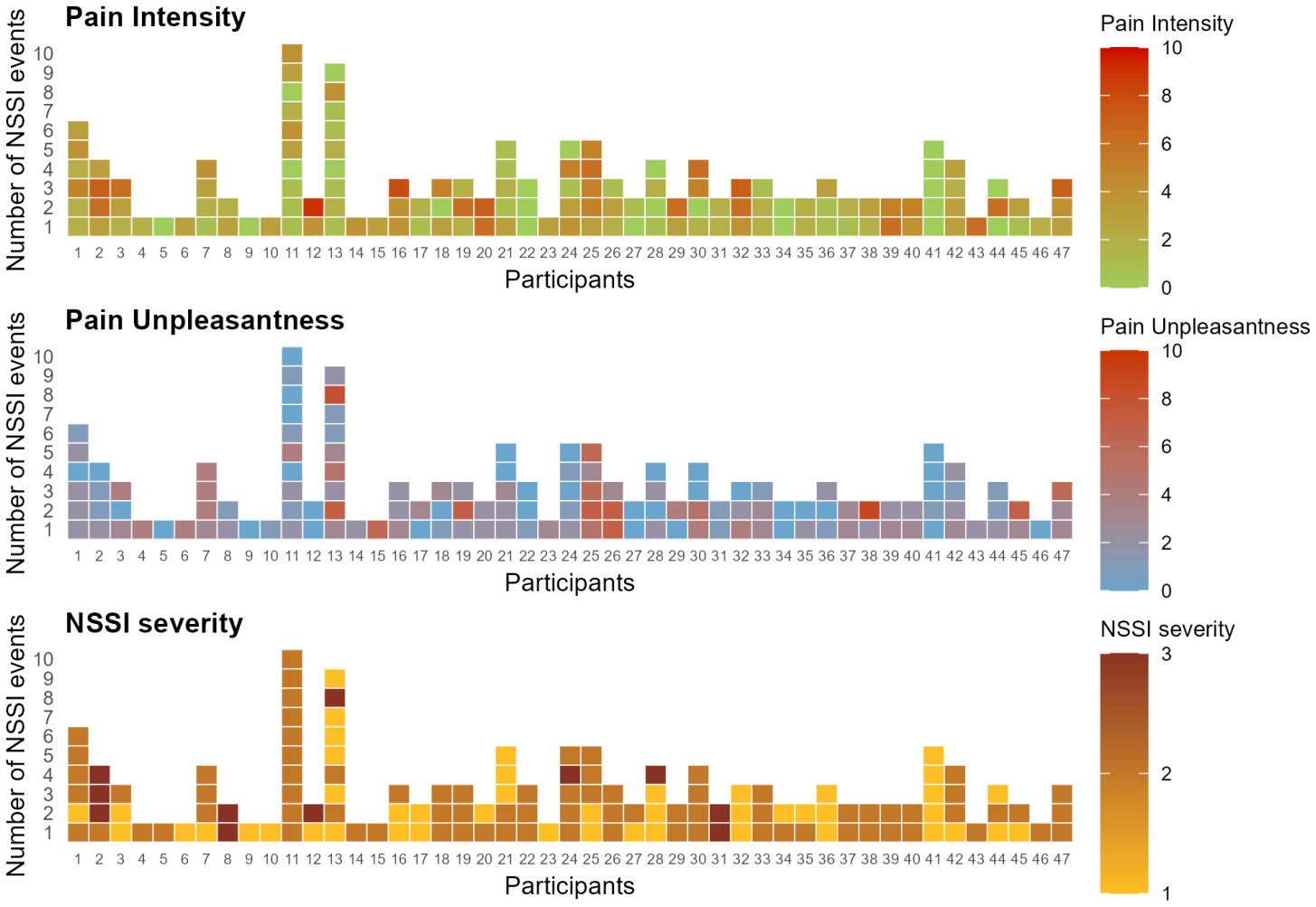


Figure 2

Pain intensity, pain unpleasantness, and injury severity across NSSI events and participants. **Pain intensity:**0 = no pain - 10 = worst pain; **Pain unpleasantness**: 0 = pleasant – 10 = very unpleasant; **Severity**: 1 = mild, 2 = moderate, 3 = severe.

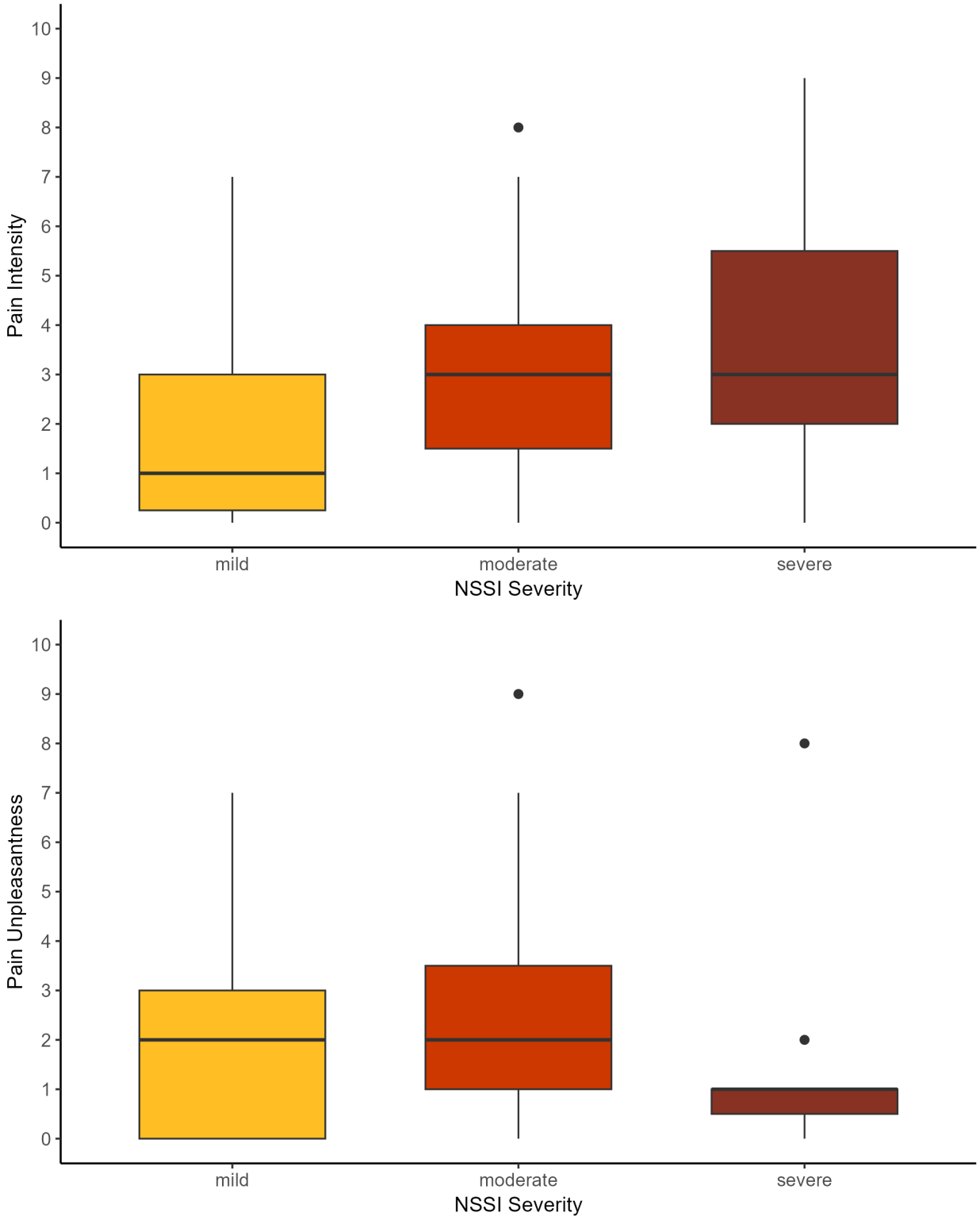


Figure 3

Descriptive event-level distributions of pain intensity (top) and pain pleasantness/unpleasantness (bottom) across NSSI severity categories.