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Review

A systematic review investigating a tolerance for pain and empathy for other people's pain in psychopathic traits within the general population

Sophie Alshukri [a,*], Victoria Blinkhorn [a], Rachel E. Warsaw [b], Minna Lyons [a]

[a] School of Psychology, Faculty of Health, Liverpool John Moores University, Liverpool, UK
[b] Department of Psychology, Institute of Population Health, University of Liverpool, Liverpool, UK

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ABSTRACT

Psychopathic traits have been related to a higher tolerance for nociceptive pain and a deficit in empathy for others' pain. However, results are varied and inconsistent. As a result, this systematic review was conducted to consolidate findings. Reported in accordance with the PRISMA statement, a comprehensive literature search used 5 databases to identify articles published between 2000 and 2022 examining pain experience and empathy for others' pain in psychopathic traits (PROSPERO: CRD42023426112). From a total of 9522 articles, 8 papers were identified as eligible for inclusion. A total of 573 participants were included across 8 studies. Differences in pain tolerance to pressure and electric shocks were found in those higher in psychopathic traits, but not when using cold temperatures. In addition, higher levels of psychopathic traits related to less brain activity in response to others' pain, thus impacting empathy. This review highlights that within psychopathic traits, pain tolerance findings may be dependent upon the type of nociceptive pain stimulus and data collection method. Additionally, a lack of empathy for others may have a neurological basis. Lastly, boldness and meanness traits may play a specific tole in tolerating more nociceptive pain and lacking empathy for others.

1. Introduction

Psychopathic traits reflect a personality construct comprising of behavioural, affective, and interpersonal features such as shallow affect, impulse control problems, and callousness (Hare, 2003; Patrick et al., 2009). Psychopathy has been associated with a higher tolerance for physical nociceptive pain (e.g. Brislin et al., 2016; Miller et al., 2013) and a lack of empathy for others (van Dongen et al., 2018); however, results are varied and inconsistent. This systematic review aimed to compile research looking at pain experienced by the self and empathy for others' pain in psychopathic traits in the general population and summarise findings.

Many psychopathy measures have been devised over the years for use in adult clinical and community samples, however, only those within the scope of this review (i.e., general/community populations) will be discussed. While these self-report psychopathy tools share a common goal of measuring traits, they vary in their approach. To start, the Triarchic Psychopathy Measure (TriPm; Patrick, 2010) uses a 3-dimensional approach to measure psychopathic traits: boldness (i.e. social dominance, emotional resiliency), meanness (i.e. low empathy, exploitativeness), and disinhibition (i.e. low impulse control; Patrick et al., 2009). The Levenson Self-Report Psychopathy Scale (LSRP; Levenson et al., 1995), on the other hand, is grouped into primary and secondary characteristics. The primary facet encompasses affective and interpersonal traits (i.e., lack of empathy, superficial charm) whereas the secondary facet consists of lifestyle and antisocial traits (i.e., impulsivity, poor behavioural control; Levenson et al., 1995). Next, the Elemental Psychopathy Assessment (EPA; Lynam et al., 2011) is designed to assess psychopathy on 4 higher-order dimensions: antagonism (i.e., aggression, hostility), emotional stability (i.e., anxiety, shallow emotions), disinhibition (i.e., risk-taking, irresponsibility), and narcissism (i.e., grandiosity, superficial charm). Whereas the Self-Report Psychopathy Scale (SRP-4; Paulhus et al., 2016) investigates interpersonal (i.e., superficial charm, manipulation), affective (i.e., shallow emotions, lack of remorse or guilt), lifestyle (i.e., irresponsibility, impulsivity), and antisocial (i.e., behavioural problems, criminality) traits. Lastly, the Minnesota Multiphasic Personality Inventory-2-Restructured Form (MMPI-2-RF; Ben-Porath & Tellegen, 2008) is a 9-scale measure designed to assess a broad range of variables related to psychological functioning. Rather than providing a distinct psychopathy

* Corresponding author.
E-mail address: s.alshukri@2022.ljmu.ac.uk (S. Alshukri).

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score, the measure assesses personality dimensions associated with psychopathic traits. While there is overlap amongst concepts, these psychopathy measures offer rigorous frameworks to help identify psychopathic traits. As a result, research has used these measures to assess how traits affect the experience of nociceptive pain and empathy for other people's pain.

To date, research investigating how psychopathy affects experiencing nociceptive pain and empathising with others' pain is varied. Firstly, studies looking at experiencing nociceptive pain in psychopathy tend to assess pain tolerance, that being the amount of subjective pain one can withstand (Kanner, 2009). Studies have looked at a variety of pain stimuli to measure tolerance, including electric shocks, pressure and cold temperatures (Brislin et al., 2016; Miller et al., 2013). Results have found associations between the meanness facet of psychopathy and pressure tolerance (Brislin et al., 2016) as well as correlations between pressure and electric shocks, but not cold temperatures (Miller et al., 2013). From the little amount of evidence that exists, it is important to look for trends between nociceptive pain experience as research shows this may link to a lack of empathy for others (Fallon et al., 2020).

There is growing research proposing that a deficit in pain perception in the self is associated with a lack of empathy for others (e.g. Berluti et al., 2020; Branchadell et al., 2024). Evidence has suggested that the heightened tolerance to nociceptive pain found in those with psychopathic traits may underpin the underestimation of others' experience of pain (see Branchadell et al., 2024). As a result, individuals with psychopathy are less sensitive to the distress of others (Kaseweter et al., 2022; Waller et al., 2020). Moreover, brain imaging research has highlighted that the same neural networks may be activated when experiencing pain and when observing others in pain (see Fallon et al., 2020 for meta-analysis). Specifically, findings have showed that activation in the anterior insula (AI) and anterior mid-cingulate cortex (aMCC) overlap during empathy and pain experiences (Corradi-Dell'Acqua et al., 2016; Fallon et al., 2020). Since lower levels of neural activity have been found in response to nociceptive pain stimuli in individuals with psychopathic traits (Brislin et al., 2022), this may influence the lower levels of brain activation observed for other people's pain and distress (e.g., Berluti et al., 2020; Branchadell et al., 2024; Brislin et al., 2022; Seara-Cardoso et al., 2015). Due to the implication of this body of work, such as potentially distinct or shared emotional networks, it is important to explore responses to nociceptive pain stimuli in psychopathy as they may underlie the experience of empathy for others.

Research looking at empathy for pain is more abundant than that of experiencing physical nociceptive pain in those with psychopathic traits (e.g. Penagos-Corzo et al., 2002; Burghart & Mier, 2022). Empathy is one of the factors that aid daily functioning and social interactions with others (Singer & Lamm, 2009). However, a lack of empathy is a hallmark of psychopathic personality (Hare, 2003; Patrick et al., 2009). Empathy for the pain of others is important to look at as the distress cues of other people are typically not recognised by individuals with psychopathy (e.g. Dawel et al., 2019; Kaseweter et al., 2022), and pain is an extension of distress (Rogers et al., 2018). Numerous methods have been used to collect data on empathic responses to others' pain such as skin conductance responses (SCR), functional magnetic resonance imaging (fMRI) and self-report responses amongst others (e.g. Berluti et al., 2020; Decety et al., 2015; Pfabigan et al., 2015). However, this information lacks consolidation, and findings should be brought together to look at similarities and differences between data modalities.

Previous reviews have explored some aspects of psychopathy and empathy. For example, a previous meta-analysis explored how psychopathy is associated with alexithymia (i.e., difficulty describing and identifying feelings; Bagby et al., 1994) and empathy (Burghart & Mier, 2022). By looking at research from the past 30 years in a variety of populations (e.g. clinical, community, correctional), reviewers found the most pronounced empathy deficit was the lack of ability to feel empathic concern for others. This could be explained by a sole focus on goal-relevant information and disregarding irrelevant information such as a victim's pain. The meta-analysis also unearthed a positive association between psychopathy and alexithymia, which has been further linked to aggressive behaviour in people with psychopathy (Velotti et al., 2016). Another meta-analysis looked at the association between psychopathy, antisocial behaviour (e.g., acts of aggression and rule breaking; Burt, 2012) and empathy (Campos et al., 2022). People with psychopathy have long been associated with antisocial acts, with debates as to whether it is a core component or an outcome of the personality trait (see Campos et al., 2022). The meta-analysis revealed interpersonal-affective traits within psychopathy were strongly linked to deficits in affective empathy, while those with antisocial traits (ranging in offenders, conduct disorders, antisocial personality disorders) had greater cognitive empathy impairments. Building on these insights into the complex relationships between psychopathic traits and empathy, further reviews have explored other areas affected by psychopathic traits, such as the processing of affective stimuli.

In addition to exploring the relationships between psychopathic traits and empathy, further reviews have synthesised findings on affective processing within psychopathic traits. To start, individuals with comorbid anti-social personality disorder and psychopathy showed atypical patterns of affective reactivity and difficulty processing negative and aversive stimuli (Marsden et al., 2019). However, this review was conducted in prison populations and may not be generalisable to other groups. Next, a recent systematic review looking at facial affect processing found incarcerated males with medium to high levels of psychopathy had impairments in recognising disgust and fearful facial expressions (Chapman et al., 2018). Collectively, the above literature suggests an issue in the processing of affective information, such as negative stimuli and facial expressions in those with psychopathic traits, which leads to a lack of empathy. While the above reviews are useful, there lacks a consolidation of evidence looking at how psychopathy effects empathy for others' pain and directly experienced nociceptive pain within community samples alone.

Given the abundance of research in the area, there is a lack of consistency in findings relating to experiencing nociceptive pain in oneself and empathy for others' pain within the general population or community samples. As a result, this review aimed to consolidate studies looking at physical nociceptive pain experience and empathy for the pain of others. This was done by reviewing peer-reviewed literature on physical nociceptive pain and pain empathy in healthy individuals with no physical or mental health afflictions within the general population with psychopathic traits assessed by a valid measure.

2. Methodology

The present systematic review is reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (see Page et al., 2021). A priori protocol was published on the PROSPERO international register of systematic reviews (CRD42023426112; https://www.crd.york.ac.uk/prospero/).

2.1. Eligibility criteria

To qualify as eligible for inclusion, studies were required to examine responses to receiving physical nociceptive pain stimuli and/or observing others receiving physical nociceptive pain stimuli between 2000 and 2022. The studies had to include within participant comparisons (e.g. recordings taken at multiple time points) or between participant comparisons (e.g. high and low psychopathy scores). Participants had to be healthy adults with no physical or mental health afflictions, aged over 18 years of age and recruited from the general population. Participants also had to be screened for psychopathic personality traits using a validated psychopathy measure suitable for non-clinical use. Therefore, studies could not include participants from clinical, incarcerated or forensic settings or use psychopathy measurement tools designed solely for clinical use.

2.2. Information sources and searches

The main literature search took place between May to June 2023 using five data databases: MedLine, PsychInfo, PubMed, Scopus, and Web of Science. Search terms were devised via scoping searches and included key words for physical pain and pain empathy. Key words were: ("psychopathy" OR "psychopathic" OR "psychopath" OR "psychopath*" AND "empathy for pain" OR "pain empathy" OR "pain empath*" OR "pain empathy" OR "directly experienced pain" OR "experienced pain" OR "pain" OR "pain perception" AND "human").

2.3. Study selection

Two authors were responsible for the evaluation of articles suitable for inclusion. SA screened titles and abstracts, with a random sample of 20 % of titles crossed-screened by RW; no disagreements arose. SA screened full texts of articles to identify those eligible for inclusion.

2.4. Data collection

Data was extracted by SA and cross-checked by RW. In cases where data was unclear, or multiple versions of a paper were located, corresponding authors were contacted for clarification. Data extracted included participants, pain and empathy exposure, comparison groups, outcomes, and outcome collection method (see Table 2).

2.5. Quality assessment

The quality of the papers included in the present systematic review were assessed using the Newcastle-Ottawa Scale (NOS; Wells et al., 2000) modified for cross-sectional studies. NOS was created to assess the quality of non-randomised studies for inclusion in meta-analyses and systematic reviews using a star-based system. Studies were evaluated using three criteria: sample selection, group comparability, and the outcome being investigated. A total score was calculated, and a rating was assigned to each study (see Table 2).

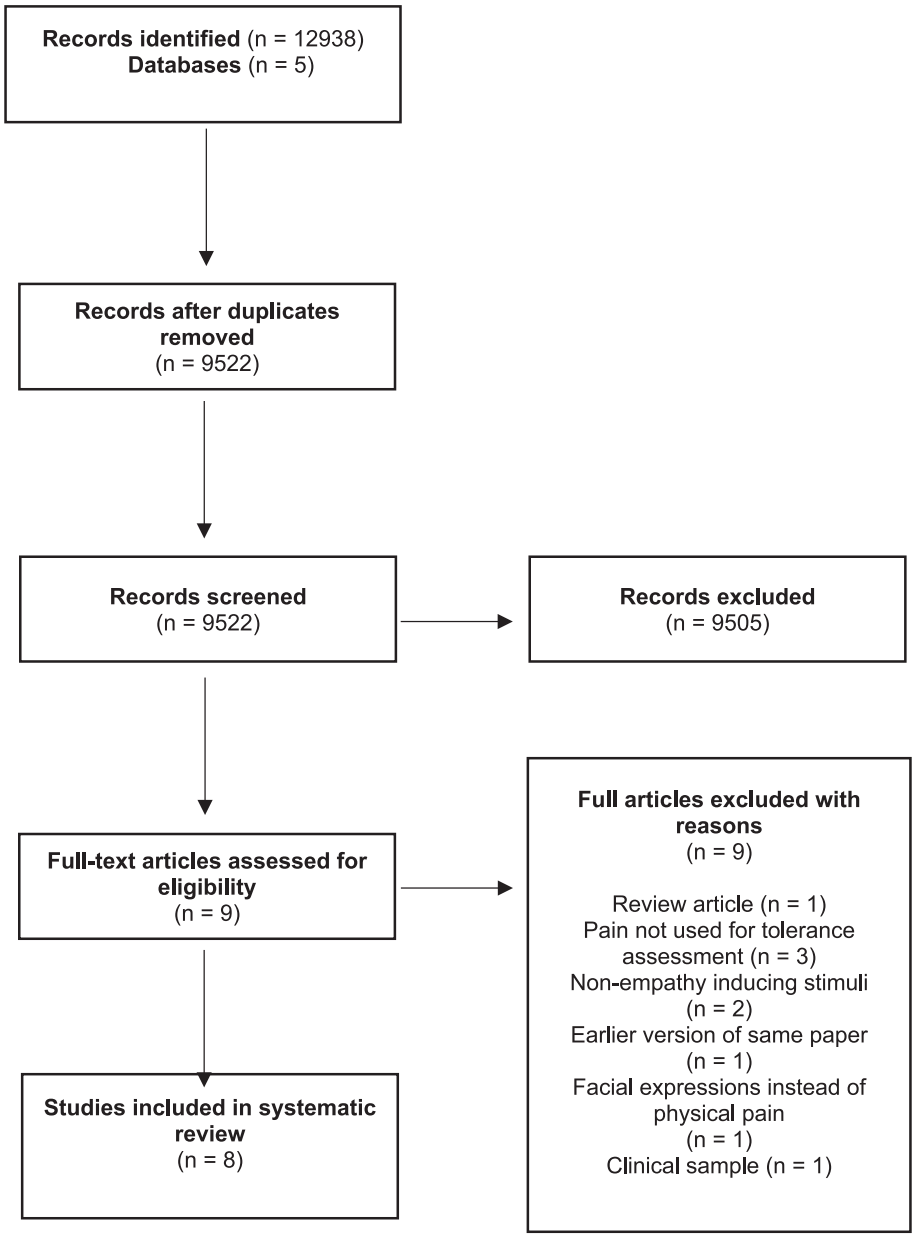

Fig. 1. PRISMA flowchart of the selection of studies.

3. Results

3.1. Study selection

Once duplicates were removed, a total of 9522 articles were identified from literature searches. After screening, 9 articles were identified as meeting eligibility criteria. However, one author was contacted to confirm that an earlier version of their paper existed as the full text could not be located. Therefore, 8 articles met the criteria. The process of study selection is shown in Fig. 1.

3.2. Study characteristics

The number of participants in each study ranged from 21 (Berluti et al., 2020) to 115 (Anestis et al., 2022), with a total of 573 participants and an average of 72. Participants were largely sampled from student and community populations, with ages ranging between 17 and 56. Four studies used a pressure algometer or pneumatic stimulator to apply pressure to stimulate pain, and one study used cold temperatures, electrical stimulation and a pressure algometer to stimulate pain. Stimuli were either applied to hands, fingers or fingernails, or arms.

Four studies used images of other people's hands and feet in painful and matching non-painful situations to measure empathy responses, whereas one study used a confederate receiving pressure stimulations. Seven out of the 8 studies collected self-report responses to either pain intensity or empathy for others, while three studies used electroencephalography (EEG), and two studies used functional magnetic resonance imaging (fMRI) (see Table 1 for full study characteristics).

3.3. Quality assessment in included studies

The cross-sectional adaptation of the NOS was used to screen included studies for risk of methodological bias (Wells et al., 2000). Of the eight studies included, two were rated as “good” and six were rated as “satisfactory” based upon three assessment criteria (see Table 2 for details).

3.4. Experiencing nociceptive pain

3.4.1. Pressure stimuli

Pressure pain, involving algometer and pneumatic stimulations, were examined in 5 studies (Anestis et al., 2022; Berluti et al., 2020; Brislin et al., 2016; Brislin et al., 2022; Miller et al., 2013). All studies collected self-report data relating to pain experience or tolerance, one study collected EEG data, and one study collected fMRI data (see Table 1). Anestis et al. (2022), Brislin et al. (2016), Brislin et al. (2022) applied pressure to the finger or thumbnail and collected self-report data on pain tolerance (see Table 1 for specific measures). While Anestis et al. (2022) found positive correlations between boldness and self-reported pain tolerance, Brislin et al. (2016) found only meanness to be positively associated with pain tolerance, whereas Brislin et al. (2022) found positive associations for both boldness, meanness and pain tolerance (see Table 2). However, Berluti et al. (2020) found no associations between psychopathy and ratings of pain experience during neuroimaging when pressure was administered between knuckles of 2 fingers. Meanwhile, when pressure was administered to the supinator muscle of the non-dominant upper arm, callous affect and total psychopathy scores showed positive correlations with pain tolerance in the form of pressure (Miller et al., 2013). In summary, the studies suggest that higher psychopathic traits, but especially boldness and meanness, may underlie the differences seen in experiencing pressure stimuli. In addition, significant pain findings may be dependent upon how data is collected, as there were significant findings for self-report responses and EEG, but not when using fMRI.

3.4.2. Temperature and electric stimuli

Miller et al. (2013) assessed temperature and electrical stimulation in a sample of 104 participants. For temperature assessment, participants were asked to submerge their non-dominant hand in cold water of 3 °C. For electric stimulations participants were administered brief shocks via electrodes attached to the index and middle fingers of non-dominant hands. Cold temperatures showed no correlations with psychopathic traits, whereas electric shock stimuli were positively correlated with callous affect, erratic lifestyle, and total psychopathy score. These findings suggest that electric shock stimulations produce significant pain responses, whereas cold temperatures do not.

3.5. Empathy for pain

Empathy for pain was assessed in 5 studies (Berluti et al., 2020; Brislin et al., 2022; Decety et al., 2015; Marcoux et al., 2013; Seara-Cardoso et al., 2015). Four of the five studies assessed empathy for pain via images depicting hands and feet in painful and non-painful situations (Brislin et al., 2022; Decety et al., 2015; Marcoux et al., 2013; Seara-Cardoso et al., 2015), while one used a confederate paradigm (Berluti et al., 2020). Three of the studies collected EEG data, while the remaining two used fMRI (see Table 1).

When comparing mean energy ratios during EEG, Marcoux et al. (2013) did not find significant effects of pain or no pain conditions, or psychopathy levels. However, there was a significant interaction between pain condition and psychopathy group, showing that the high psychopathy group interpreted pain and no-pain conditions significantly differently compared to the low psychopathy group, who did not show a significant difference. In addition, Brislin et al. (2022) found boldness positively associated with early sensory processing (N100 component of event-related potential; ERP) and later-stage sensory processing (N240 component of ERP) for both painful and non-painful scenes, while meanness negatively related to a later-stage cognitive and emotional processing (late positive potential; LPP) for painful scenes. Meanness was also negatively associated with ratings of others' pain scenes. This suggests higher levels of boldness and meanness contribute to pain processing in different ways, such as deficient responses to other's pain. Decety et al. (2015), on the other hand, found total psychopathy score positively predicted modulations in LPP response for painful versus neutral scenes in empathic concern. In addition, total psychopathy score was negatively associated with LPP differences in empathic concern conditions. This means that those with psychopathy showed less brain activity in areas associated with empathic concern, suggesting it may influence responses to other people's distress.

Meanwhile, in fMRI studies, Seara-Cardoso et al. (2015) found increased levels of affective-interpersonal traits were associated with a decrease in neural responses to others' pain in anterior insula (AI), inferior frontal gyrus (IFG), midcingulate cortex (midCC) and anterior cingulate cortex (ACC) when controlling for lifestyle-antisocial traits. In addition, when controlling for affective-interpersonal traits, increased levels of lifestyle-antisocial traits were associated with an increase in neural responses to others' pain in the same regions as above. This shows that the differing levels of psychopathic traits in males may influence how they respond to the pain of others. Moreover, when observing a partner in pain, Berluti et al. (2020) found psychopathy was not significantly associated with how much pain they believed their partner may be experiencing, even after an empathy prompt. However, evidence was found showing diminished self-other mapping of others' pain. This was shown by less patterns of activity in brain regions associated with empathy for pain.

4. Discussion

This systematic review synthesised the literature on experiencing nociceptive pain and empathy for pain in psychopathic traits in the general population. A total of 8 papers were eligible for inclusion; 3

Table 1
Summary of study characteristics.

References	Title	Country	Participants	Psychopathy measure	Empathy measure	Comparison	Pain assessment	Empathy assessment	Data collection method
Anestis et al. (2022)	Assessing physical pain perception and psychological distress tolerance through the MMPI-2-RF: A comparison of multimethod measures	USA	115 Female (n = 87) Male (n = 19) Gender unknown (n = 9) Age: M = 21.14, SD = 5.81	Minnesota multiphasic personality inventory-2-restructured form (MMPI-2-RF; Ben-Porath & Tellegen, 2008)	N/A		Physical pain tolerance using pressure algometer below first knuckle on second finger of right hand	N/A	Self-report pain tolerance on 5-point scale
Brislin et al. (2016)	"Do unto others"? Distinct psychopathy facets predict reduced perception and tolerance of pain	USA	100 Female (n = 58) Male (n = 42) Age: M = 19.4	Triarchic Psychopathy Measure (TriPm; Patrick et al., 2009)	N/A		Physical pain tolerance using pressure algometer on dorsal side, medial placement between knuckles of pointer and middle finger on dominant hand	N/A	Self-report 10-point pain appraisal visual analogue scale (pain VAS)
Miller et al. (2014)	Examining the relations among pain tolerance, psychopathic traits, and violent and nonviolent antisocial behaviour	USA	104 Female (n = 30) Male (n = 74) Age: M = 36.8, SD = 17.3	Self-Report Psychopathy (SRP-III; Paulhus et al., 2016) scale The Elemental Psychopathy Assessment (EPA; Lynam et al., 2011)	N/A		Pain tolerance to pain algometer, cold pressor and electric stimulation	N/A	Self-report pain tolerance
Marcoux et al. (2013)	The modulation of somatosensory resonance by psychopathic traits and empathy	Canada	30 Males (n = 30) Low psychopathy (n = 15) Age: M = 23.7, SD = 2.9 High psychopathy (n = 15) Age: M = 22.3, SD = 1.44	Levenson Self-Report Psychopathy Scale (LSRP; Levenson et al., 1995)	Interpersonal Reactivity Index (IRI)	Participants in the upper third (n = 15) and participants in the lower third (n = 15) of the Levenson Self-Report Psychopathy Scale	N/A	30-colour pseudo-dynamic pictures depicting hands of male and female adults in three different conditions: painful, non-painful, and neutral situations	EEG Self-report visual rating scale and verbally evaluate level of pain recorded by researcher
Seara-Cardoso et al. (2015)	Neural responses to others' pain vary with psychopathic traits in healthy adult males	United Kingdom	46 Male (n = 46) Age range 19–40, M = 27.93	Self-Report Psychopathy Scale, Short Form (SRP-SF; Paulhus et al., 2016)	N/A	Pain versus no pain stimuli and levels of psychopathic traits	N/A	192 digital photographs showing another person's hand or foot in painful or non-painful situations	MRI
Brislin et al. (2022)	Pain processing and antisocial behaviour: A multimodal investigation of the roles of boldness and meanness	USA	118 Female (n = 58) Male (n = 60) Age: M = 19.5, SD = 3.8	Triarchic Psychopathy Measure (TriPm; Patrick et al., 2009)	N/A	TriPm scales (boldness, meanness, disinhibition)	Hand operated and automatic pain algometer on dorsal side of dominant hand (medial placement between knuckles of pointer finger and middle finger)	128 colour pictures, each depicting either the right hand or right foot of people in various painful and nonpainful situations	EEG Self-report pain severity on 4-point Likert scale

(*continued on next page*)

Table 1 (*continued*)

References	Title	Country	Participants	Psychopathy measure	Empathy measure	Comparison	Pain assessment	Empathy assessment	Data collection method
Berluti et al. (2020)	Reduced multivoxel pattern similarity of vicarious neural pain responses in psychopathy	USA	21 Females (n = 9) Males (n = 12)	Psychopathy Personality Inventory—Revised Short Form (PPI-R SF; Lilienfeld & Windows, 2005)	N/A	Total psychopathy scores	Pneumatic pressure pain on thumbnail	Observed a stranger (confederate) receive painful pressure stimulation	fMRI Self-report 7-point Likert scale rating perceived pain intensity
Decety et al. (2015)	Specific electrophysiological components disentangle affective sharing and empathic concern in psychopathy	USA	39 Female (n = 20) Male (n = 19) Age: M = 19.4, SD = 1.9	Levenson Self-Report Psychopathy Scale (LSRP; Levenson et al., 1995)	Interpersonal Reactivity Index (IRI)	Total psychopathy scores, primary psychopathy scores, secondary psychopathy scores	N/A	100 pictures of hands and feet in painful or neutral situations	EEG Self-report visual analogue scale rating empathic concern or pain intensity (VAS)

assessed experiencing nociceptive pain, 3 assessed empathy for pain, and 2 examined both experiencing nociceptive pain and empathy for pain. Findings are discussed below.

4.1. Experiencing nociceptive pain

The papers reviewed looked at how those with psychopathic traits experienced and responded to nociceptive pain stimuli (Anestis et al., 2022; Berluti et al., 2020; Brislin et al., 2016; Brislin et al., 2022; Miller et al., 2013). Taken together, the results showed that psychopathic traits affected experiencing nociceptive pain. More specifically, boldness (i.e., risk-taking and fearlessness) and meanness (i.e., a lack of empathy; Patrick, 2022) showed to underlie the differences in a higher tolerance for nociceptive pain. Research has shown boldness negatively relates to a fear of pain (Brislin et al., 2016), while meanness has shown associations with antisocial behaviours (Brislin et al., 2022). Consequently, a higher tolerance for nociceptive pain in those with higher traits of boldness and meanness may help to explain violent and antisocial behaviours seen in such individuals (Brislin et al., 2016; Brislin et al., 2022). As a result, future work should focus on examining these traits further which will help to disentangle the complex relationship between psychopathic traits and violent and antisocial behaviours.

In addition to specific traits of psychopathy impacting pain processing, experiencing nociceptive pain may be dependent upon the type of stimulus delivered. Findings showed significant effects for pressure and electric shocks (Anestis et al., 2022; Berluti et al., 2020; Brislin et al., 2016; Brislin et al., 2022; Miller et al., 2013) but not cold temperatures (Miller et al., 2013). These distinctions suggest that cold temperatures are not as salient as pressure and electrical stimuli when stimulating pain in those with psychopathic traits. While pressure and electric shocks are often used to elicit nociceptive pain in experiments involving individuals with psychopathic traits (e.g., Alshukri et al., 2024; Atanassova et al., 2024), in comparison, cold temperatures remain largely unexplored. However, even though psychopathic traits are associated with lower levels of fear to pain (Brazil et al., 2022; Durand & Plata, 2017), one may suggest that cold temperatures may have less of a punishing effect than pressure or electric shocks in those with psychopathic traits. However, as this possibility is yet to be investigated, future research should investigate the differences in tolerances for different modes of nociceptive pain stimulation, and potential explanations for why.

Furthermore, significant results in pain processing may be subject to the method in which data is collected. Findings showed significant effects between psychopathy and pain when collecting data via self-report measures and EEG (Brislin et al., 2016; Brislin et al., 2022), but no significant associations were found between psychopathy and pain experience when collecting data via fMRI (Berluti et al., 2020). EEG and fMRI capture brain activity in different ways. For instance, EEG records electrical signals from the scalp (Cohen, 2017), whereas fMRI captures blood oxygenation (BOLD signal) activity within the brain (Logothetis, 2008). Additionally, EEG is better at capturing brain activity in real time, whereas fMRI can better localise activity within specific brain areas (Michalopoulos & Bourbakis, 2015). For these reasons, the data that is captured by both approaches is very different from one another and may lead to a significant difference in results. Due to this, researchers have called to combine EEG with fMRI to help balance out each other's strengths and limitations (see Huster et al., 2012 for review), which could help to develop a more comprehensive understanding of pain processing in psychopathic traits.

4.2. Empathy for pain

The studies in this review investigated empathy for other people's pain, and how psychopathic traits may have influenced this. In EEG research, those with higher psychopathic traits interpreted the pain of others differently compared to those with lower levels of psychopathic traits. This was demonstrated by less brain activity and diminished neural responses in the areas associated with empathy (Brislin et al., 2022; Decety et al., 2015; Marcoux et al., 2013). Again, boldness and meanness traits played a significant role in diminished responses to others' pain, suggesting these facets may underlie the deficiencies in empathy. While there is limited research investigating empathy for pain, these findings can be corroborated by physiological studies showing impaired facial muscle activity to the negative emotions of others (Khvatskaya & Lenzenweger, 2016) and reduced startle potentiation to violent films (Fanti et al., 2016). These findings are significant as they suggest deficits in empathy may have a biological basis. If this is the case, research could aim to better understand the underpinnings of a lack of empathy in psychopathic traits.

Next, there was limited fMRI research looking at empathy for other people's pain (Berluti et al., 2020; Seara-Cardoso et al., 2015). However, evidence has found a reduction in brain activity in the regions associated with empathy in those with higher levels of psychopathic traits (Berluti et al., 2020; Seara-Cardoso et al., 2015). Moreover, weaker brain mirroring was found when observing someone else in pain, suggesting that those higher in psychopathy are less able to empathise with others in

Table 2
Summary of Newcastle-Ottawa Scale ratings and findings by article.

References	Newcastle-Ottawa scale rating	Findings
Anestis et al. (2022)	Satisfactory	Positive weak correlation between boldness and self-reported pain tolerance ($r = 0.37$, $p < .005$) No significant correlations between meanness, disinhibition and self-reported or behavioural pain tolerance, or boldness and behavioural pain tolerance
Brislin et al. (2016)	Satisfactory	Meanness significantly associated with pain tolerance via both correlation ($r = 0.30$, $p < .005$) and regression ($\beta = 0.33$, $p < .005$) Meanness sole predictor when predicting pain tolerance when TriPm entered, but not in follow up tests Disinhibition negative associations with pain VAS in follow-up tests ($r = -0.23$, $p < .05$) TriPm scales not significantly associated with pain VAS ratings
Miller et al. (2013)	Satisfactory	Both self-reported ($r = 0.30$, $p < .001$) callous affect, self-reported ($r = 0.28$, p ⟨001) antisocial behaviour, and self-report ($r = 0.27$, $p < .001$) and total psychopathy score showed weak positive correlations with algometer pressure pain Callous affect ($r = 0.27$, $p < .001$), erratic lifestyle ($r = 0.29$, $p < .001$) and total psychopathy score ($r = 0.23$, $p < .05$) showed weak positive correlations with electric shock pain Psychopathic traits showed no correlations with pain tolerance via cold temperatures
Marcoux et al. (2013)	Satisfactory	Empathic concern was inversely related to total psychopathy score ($r = -0.561$, $p = .001$) No significant difference on behavioural ratings of painful scenarios between high and low psychopathy groups No significant main effects found for pain gating for condition (pain, no pain) or group (low psychopathy or high psychopathy), nor it's interaction When mean energy ratios were compared, no significant main effects of condition (pain, no pain) or group (low psychopathy or high psychopathy). Interaction between condition and group was significant [$F(1, 28) = 4.8$, $p = .042$], with post hoc tests showing a significant difference between pain and no pain condition for high psychopathy only ($p = .014$) No significant main effect found for (1300:1500 ms) period for condition or group. Post hoc tests showed significant different between pain and no pain conditions in high psychopathy group only ($p = .001$; low psychopathy group: $p = .086$).
Seara-Cardoso et al. (2015)	Good	After controlling for lifestyle-antisocial traits, unique variance associated with affective-interpersonal traits were negatively related to BOLD response in AI [$t(43) = 1.87$, $p = .03$], IFG [$t(43) = 2.68$, $p < .01$], and midCC [$t(43) = 2.38$, $p = .01$], and was at trend in ACC [$t(43) = 1.24$, $p = .11$] - That is, when holding levels of lifestyle-antisocial behaviour constant, increased levels of affective-interpersonal traits were associated with a decrease in neural responses to others' pain in these regions. After controlling for affective interpersonal traits, unique variance associated with lifestyle antisocial traits were positively related to differential BOLD response in AI [$t(43) = 2.51$, $p < .01$], IFG [$t(43) = 3.16$, $p < .01$], midCC [$t(43) = 2.64$, $p < .01$], and ACC [$t(43) = 1.92$, $p = .03$] - That is, when holding levels of affective-interpersonal traits constant, increased levels of lifestyle-antisocial behaviour traits were associated with an increase in neural responses to others' pain in these regions.
Brislin et al. (2022)	Good	Boldness ($r = 0.32$, $p < .001$) and meanness ($r = 0.25$, $p < .05$) positively associated with algometer pain tolerance Boldness and meanness not associated with either perspective ratings of non-painful scenes Meanness negatively associated with ratings of self-perspective painful scenes ($r = -0.27$, $p = .01$) and other perspective scenes ($r = -0.20$, $p = .04$) Unique negative association with meanness for ratings of both self ($\beta = -0.24$, $p = .02$) and other ($\beta = -0.23$, $p = .03$) perspective painful situations Boldness positively associated with N110 and N240 for painful scenes and negatively associated with boldness for non-painful scenes Meanness negatively related to LPP for painful scenes ($r = -0.21$, $p < .05$) and showed unique association in LPP response model ($\beta = -0.15$, $p < .05$) The change in R^2 at Step 2 was not significant for any of the models, indicating that the addition of TriPM Boldness and Meanness scales did not contribute significantly to pain-scene ERP response
Berluti et al. (2020)	Satisfactory	Ratings of partners' experiences of pressure pain was not significantly different from own reported pain, $t(20) = 1.67$, $p = .11$, $d = 0.37$ Total psychopathy scores not associated with objective level of pain, $r(19) = 0.02$, $p = .93$ selected as slightly intense, or subjective reports of experienced pain

(*continued on next page*)

Table 2 (*continued*)

References	Newcastle-Ottawa scale rating	Findings
		during pain epochs during neuroimaging, r (19) = −0.08, p = .74 When observing partner in pain, psychopathy not associated with perceptions of pain, r (19) = −0.31, p = .17 or following empathy prompt, r (19) = −0.29, p = .21
Decety et al. (2015)	Satisfactory	Total empathy score positively predicted modulations in LPP response over central and parietal midline locations for painful vs neutral stimuli in empathic concern, (Cz/CPz/Pz/POz cluster, r = 0.355, p < .05 but not affective sharing, p > .23) Total psychopathy score negatively related to differences in LPP in empathic concern but not in affective sharing (p > .35) Psychopathy (total LSRP and primary psychopathy) negatively associated with LPP differences in empathic concern condition, POz (Total score: r = − 0.388, p < .05; LSRP primary psychopathy subscale: r = − 0.340, p < .05) LSRP secondary psychopathy scores negatively predicted LPP effect, (Cz/CPz/Pz/POz cluster, r = −0.344, p < .05) LSRP primary psychopathy subscale scores negatively predicted left frontal to right parietal coherence (r = −0.383, p < .05) and left frontal to right temporal coherence (r = −0.370, p < .05) LSRP total score also predicted coherence between left frontal and right temporal regions (r = −0.333, p < .05) Psychopathy positively related to degree of mu suppression when perceiving pain versus neutral stimuli in affective sharing condition, with lower mu predicted by LSRP total score (r = −0.472, p < .01), primary psychopathy score (r = −0.441, p < .01), and secondary psychopathy score (r = 0.336, p < .05)

distress (Berluti et al., 2020). As pain empathy research using fMRI in the general population is limited, findings in incarcerated offenders and youths can offer valuable insights. For instance, when incarcerated individuals high in psychopathic traits were asked to imagine another person in pain, the corresponding neural regions were not activated (Decety et al., 2013). Further, 14 adolescents with psychopathic traits and associated disorders showed less responsiveness in brain regions implicated in affectively responding to another's pain, even as pain intensity increased (Marsh et al., 2013). Together with EEG research, empathy findings from this review demonstrate that those higher in psychopathic traits have diminished neural responses to the pain of others, thus leading to a reduction in empathy. This may indicate that individuals with psychopathic traits demonstrate a neurological basis to empathy deficits. As a result, future research may want to investigate the potential neurological differences that exist regarding empathy in those with psychopathic traits. This would help to develop treatment and interventions to aid those struggling with deficits in empathy for others.

4.3. Strengths and limitations of the systematic review process

Overall, the methodological quality of the evidence base was "satisfactory" to "good", with most of the studies not including a representative sample. Participants were recruited from undergraduate communities, primarily from a white background and some male-only samples. This means that the samples were limited and unlikely to represent a full range of psychopathic traits. Therefore, future work should be extended to include more diverse samples in terms of age, gender, ethnicity, cultural background, and education level to make findings more generalisable (Roberts et al., 2020). Most studies also lacked an adequate sample size or had low statistical power which may have hindered the findings in the present studies, and larger replication studies should be conducted to validate results. In addition, some studies did not allow for a comparison group as psychopathy scores were used to group subjects. This can be problematic as arbitrary grouping can lead to homogeneity of groups if there is a cross-over in psychopathy scores. Nevertheless, a strength of this review is that all studies used objective and validated laboratory techniques and validated psychopathic traits measures. Additionally, each study clearly and appropriately used statistical tests to analyse its data.

4.4. Limitations of eligible research

Most studies used pressure as a method to assess pain tolerance. While this is a validated method of pain stimulation (Jackson et al., 2020; Lacourt et al., 2012), physical pain is multifaceted and should be assessed through multiple modalities such as temperature (e.g. heat and cold), pressure and electric shocks as each stimulus can be interpreted differently (e.g. Miller et al., 2013). In addition, although associations were found between psychopathy, pain tolerance and empathy, research is still lacking about the possible mechanisms behind such findings. The neurological studies used in the current review (Berluti et al., 2020; Brislin et al., 2022; Decety et al., 2015;Marcoux et al., 2013; Seara-Cardoso et al., 2015) did show potential areas in the brain that may be affected during nociceptive pain and pain empathy stimuli, however, more research is needed to understand the complex relationship between them. Moreover, some studies used a male-only sample (Marcoux et al., 2013; Seara-Cardoso et al., 2015), which limits the generalisability of the findings, thus populations should be diversified. Lastly, the presence of a researcher in pain tolerance assessments may have an influence on willingness to withstand pain (Kállai et al., 2004). As a result, future research should consider controlling for the effects of a researcher being present and being absent.

4.5. Conclusions & implications

The systematic review highlights that a tolerance for nociceptive pain may be modality specific. This was demonstrated via significant differences for pressure and electric shock stimuli, but not cold temperatures. Additionally, significant pain findings may be dependent upon the method used to collect data; there were significant pain tolerance findings in psychopathic traits when data was collected via self-report and EEG, but there were no significant findings when pain data was collected via fMRI. Furthermore, neural findings indicate that a reduction in empathy for the pain of others may stem from neurological basis. Lastly, boldness and meanness traits may play a specific role in experiencing pain as well as in empathy for other people's pain. As a result, future research should aim to explore a variety of nociceptive pain and data collection methods in individuals with psychopathic traits and investigate how facets of psychopathy influence responses. In addition, more neural research should be conducted in those with psychopathic traits to further investigate a potential neurological basis for a lack of empathy.

CRediT authorship contribution statement

Sophie Alshukri: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Victoria Blinkhorn:** Writing – review & editing, Supervision. **Rachel E. Warsaw:** Writing – review & editing, Data curation. **Minna Lyons:** Writing – review & editing, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data is openly available as this is a review article of published, peer-reviewed work

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