

# The polysemy view of pain

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Philosophers disagree about what the folk concept of pain is. This article criticises existing theories of the folk concept of pain, that is, the mental view, the bodily view, and the recently proposed polyeidic view. It puts forward an alternative proposal—the polysemy view—according to which pain terms like “sore”, “ache” and “hurt” are polysemous, where one sense refers to a mental state and another a bodily state, and the type of polysemy at issue reflects two distinct but related concepts of pain. Implications with respect to issues in philosophy of pain are also drawn.

## KEYWORDS

folk concept of pain, pain, polyeidic view of pain, polysemy

## 1 | INTRODUCTION

Discussion on philosophical theories about the nature of pain is usually tied to discussion on the folk concept of pain. According to the traditional view, pain is a mental state or feeling that a sentient being undergoes. In the words of David Lewis (1980, p. 222): “Pain is a feeling. Surely that is uncontroversial.” Underlying this traditional view of pain endorsed by philosophers is the assumption that this is also how the folk understand pain. Let us call this corresponding view about the folk concept of pain the *mental view*. The traditional view of pain, encapsulated in Lewis' remarks, has met with resistance (e.g., Hyman, 2003; Massin, 2017). Correspondingly, the mental view of pain—understood as a view about the folk concept of pain—has been criticised by experimental philosophers, who appeal to empirical data to argue that the folk in fact treat pains as bodily states, not mental states (Kim, Poth, Reuter, & Sytsma, 2016; Reuter, Phillips, & Sytsma, 2014; Reuter & Sytsma, 2020). Let us call this latter view about the folk concept of pain the *bodily view*. In a recent article, Borg, Harrison, Stazicker, and Salomons (2020)

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provide a detailed assessment of the relevant experimental literature and argue that the existing empirical data do not support the bodily view (p. 29). Their own view, the *polyeidic view*, contends that the folk concept of pain is “an amalgam of many distinct dimensions” (p. 41), “with the bodily/mental dimension being just one strand among others” (p. 31).

This article is primarily concerned with theories about the folk concept of pain, rather than philosophical theories about the nature of pain. In discussing the former, philosophers are primarily concerned with our concept of *physical pain*. Physical pain is associated, though not exclusively, with physical damage to the body. Instances of physical pain can be acute or chronic. We use words like “burning” and “throbbing” to describe their qualitative aspects. Henceforth, the word “pain” is used to denote *physical pain* unless otherwise specified. Existing theories of the folk concept of pain disagree about what our concept of physical pain refers to. The mental view takes the folk concept of pain to pick out mental states; the bodily view bodily states. The polyeidic view maintains that our concept of pain can pick out both mental and bodily states, but what it picks out depends on contextual factors and each person’s tacit beliefs about pain. All these theories, nevertheless, agree that there is a single, shared concept of pain that features in our thoughts about pain.

The aim of the article is two-fold. First, I assess and criticise existing theories of the folk concept of pain. Second, I put forward an alternative theory, the *polysemy view*, according to which there are in fact two separate but closely related concepts of pain—a mental concept and a bodily concept. The structure of the article is as follows. Section 2 clarifies and assesses the mental view and bodily view. Section 3 turns to the polyeidic view. Section 4 argues for and elaborates on the polysemy view. Section 5 concludes the article by drawing implications from the polysemy view.

## 2 | THE MENTAL VIEW VERSUS THE BODILY VIEW

In the literature, the bodily view is sometimes characterised as incorporating the following two claims (e.g., Reuter et al., 2014; Borg et al., 2020, p. 31):

- a. The folk treat pain as having a non-brain-based location.
- b. The folk do not treat pain as an experiential state, where pain as an experiential state is thought to have the following three Cartesian characteristics:

*Privacy*: One has privileged access to one’s pain.

*Subjectivity*: If one has pain, then one feels pain.

*Incorrigibility*: If one feels pain, then one has pain.

In contrast, according to the mental view, the folk treat pain as an experiential state and do not treat it as having a non-brain-based location. It is worth noting that the three Cartesian characteristics are inadequate in defining pain as an experiential state as in (b). One can have a theory of pain where pain is not an experiential state that a subject undergoes, but a mind-dependent state of a body part, which satisfies these three characteristics (cf., Hyman, 2003). Nevertheless, the key difference between the bodily view and the mental view is clear. I propose to distinguish the two in the following way. According to the mental view, folk treat pain as a

state that a subject or experiencer undergoes. According to the bodily view, folk treat pain as a state that a body part undergoes. This way of distinguishing the two also makes the difference clear with respect to how the location of pain is conceived. If people treat pain as a bodily state, then pain may be thought of as located where the body part is located. If people treat pain as a mental state, then they may be nudged to think of pain as located where the subject or experiencer is located. If the latter is identical to the brain, then pain, as a mental state, may be conceived as located in the brain.

Having clarified these two views, let us now turn to their problems. The main objection faced by the mental view concerns people's intuitive judgement about the *location of pain*. If we are asked where a pain is, we intuitively judge that it is located in a non-brain-based body part. To quote Borg et al. (p. 30): "When someone stubs their toe or cuts their hand the pain is (or at least said to be) *in the toe* or *in the hand*" (p. 30). This judgement would be inconsistent with the view that pain is a mental state since mental states are "not the kind of entities that inhabit [non-brain-based] body parts" (Reuter, 2017, p. 265).

The mental view also faces problems with respect to alleged experimental data on folk's judgments about pain. For instance, it has been reported that folk admit the existence of *shared pain*, that is, token pain that is shared by two individuals (Sytsma, 2010). When asked whether conjoined twins whose shared leg is injured have "one and the same pain", many respond positively (Ibid.). On the assumption that folk have a coherent view of pain, this makes the mental view puzzling. Presumably token mental states—which are states of a person—are private in the sense that they cannot be shared by different individuals.

By contrast, the bodily view nicely explains the experimental data concerning *shared pain* and *the location of pain*. If we conceive pains as states of body parts, then we would naturally judge pains to be located in body parts. If a body part can be shared, then in principle a state of that body part can also be shared. However, the bodily view runs into problems in accounting for our intuition about *phantom pain*. A subject with phantom pain feels as if there is pain in a limb which has been amputated. In such a case, it seems correct to describe such a subject as "having pain" or "suffering from pain" even though the pained limb does not exist (e.g., Hyman, 2003; Tye, 2017). The mental view nicely explains our intuition with respect to *phantom pain*. A phantom limb subject can undergo an experience of pain, and thus be said to "have pain." But our intuition seems puzzling on the bodily view. If we think pains are states of body parts, how can we also consistently think that the phantom limb subject has pain without having the corresponding limb? In response, advocates of the bodily view might appeal to a distinction between *feeling pain* and *having pain* and describe the phantom pain subject as feeling pain but not having pain. However, it is far from clear that this is a distinction that ordinary language speakers pre-reflectively and systematically draw. After all, the locution "John feels pain but has no pain" sounds very odd.<sup>1</sup>

The inadequacy of these two proposals about the folk concept of pain has led some theorists to talk of the *paradox of pain*, the claim that the folk concept of pain is paradoxical or internally inconsistent (Hill, 2005, 2017): We treat pains as both mental states and bodily states; yet pains cannot be mental states while also being states of body parts, because body parts are not the sort of the entities that can have mental states. However, it would seem strange that the paradoxical

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<sup>1</sup>Regarding the bodily view, Borg et al. (2020) argue that the existing empirical data do not support the contention that the folk exclusively treat pain as a bodily state. They raise a number of worries regarding the relevant experimental designs and the significance of the results. They also conducted pilot experiments, with revised wordings (p. 40), to show that the folk treat pain as both bodily and mental.

nature of a mundane concept like the concept of pain could go largely undetected in everyday contexts. We should probe deeper into our folk concept of pain before we concede to the paradox of pain.

### 3 | THE POLYEIDIC VIEW

In response to the inadequacy of previous views, Borg et al.'s (2020) recently proposed polyeidic view contends that the folk concept of pain is polyeidic or multi-dimensional, “containing a number of different strands or elements (with the bodily/mental dimension being just one strand among others)” (pp. 30–31). The other dimensions are: public/private, conscious/unconscious, aversive/non-aversive, purposeful/non-purposeful, motivational/non-motivational and various sensory or affective dimensions (Borg et al., 2020, p. 43).

According to the polyeidic view, subjects hold a *tacit theory* about pain which incorporates these dimensions. Borg et al. (2020) write:

On the Polyeidic view, folk come replete with something like an unreflective, personalised theory of pain, whereby they tacitly take a stand across a range of different philosophical questions one could ask about pain (so that the mind/body dichotomy ... might turn out to be just one of the dimensions of pain to which people are sensitive). (Borg et al., 2020, p. 41):

This “unreflective, personalised theory of pain” consists of a set of *tacit beliefs* with respect to each of the dimensions. A clinician might have the tacit belief that pain is a bodily state, and a patient might have the tacit belief that pain is a mental state, although they still “share a common concept of pain (given by the dimensions)” (p. 45).

Several points are worth noting regarding the polyeidic view. First, our tacit beliefs regarding different dimensions are subject to change over time (p. 44). For instance, on the difficulty surrounding the communication of pain in the clinical context, Borg et al. suggest that we may “bring patients’ and clinicians’ conceptions of pain more into line with one another, improving communication and ensuring patient pain is seen” (p. 45).

Second, our tacit beliefs about pain are subject to contextual or framing effects (p. 43). They can be “activated, enhanced or suppressed” in different contexts (Borg et al., 2020, p. 31). For instance, regarding the *conscious/non-conscious* dimension, I might have the tacit belief that pains are consciously felt. But I might still judge a wounded soldier who does not feel pain to be in pain because the relevant tacit belief is *suppressed*. Relatedly, proponents of the polyeidic view insist that their view does not commit to the paradox of pain, because, on their view, while one might take pain to be a mental state in one context and a bodily state in another, no one would take it to be both mental and bodily at the same time (p. 44).

Third, while the polyeidic view commits to the idea that the concept of pain has a multi-dimensional structure, it does not commit to the claim that the concept of pain represents a list of “stereotypical” properties from these dimensions. In other words, the polyeidic view does not commit to the idea that a pain that is conscious, aversive, purposeful, motivational and so forth, is considered a prototypical case of pain.

On the face of it, the polyeidic view faces some challenges. First, because the view states that two subjects share the same concept of pain insofar as they conceive pain in terms of the dimensions posited (Borg et al., 2020, p. 45), it counterintuitively entails that two subjects can

be said to share the same concept of pain even if they hold polar opposite positions regarding each dimension. It seems odd to say that a person who treats pain as an unconscious, non-aversive, non-purposeful and non-motivational bodily or mental state possesses the concept of pain like the rest of us.

Even if this last problem is adequately addressed, the polyeidic view faces a second challenge. The polyeidic view, as a response to addressing the inadequacies of the mental and bodily views, posits that the folk concept of pain contains a bodily/mental dimension such that pain can be treated as a bodily state by some thinkers in some contexts and a mental state by other thinkers in other contexts. Moreover, a thinker's tacit belief regarding the bodily/mental dimension can also change from treating pain as a bodily state to treating it as a mental state and vice versa. But it seems strange that our concept of pain is like this. That is, those who possess the concept can have radically inconsistent beliefs about *what it is*—whether a subject or a body part—that pain is supposed to be predicated of. Many of our other everyday concepts do not seem to be like this. That is, those who possess a concept do not usually radically diverge or change views on what types of entity the concept applies to. Those who possess, say, the colour concept RED do not hold radically inconsistent beliefs about what it is—whether a conscious experience or a mind-independent thing—that is *red*.<sup>2</sup> Those who possess the psychological concept BEING JEALOUS do not hold radically inconsistent beliefs about what it is—whether a person or a thing—that is *jealous*. Nor does a thinker's belief regarding what it is that can be said to be *red* or *jealous* change over time. So, the polyeidic view, by positing a mental/bodily dimension within a single unified concept of pain, presents a puzzling picture about the folk concept of pain.

The polyeidic view is an attempt to explain why pain is sometimes treated as a bodily state and sometimes a mental state. But the latter, as we shall see, can be explained by another hypothesis, that is, the polysemy view, according to which there are in fact two concepts of pain—a bodily concept and a mental concept. In the next section, I shall argue for the polysemy view.

#### 4 | THE POLYSEMY VIEW

All three views surveyed so far share the common assumption that there is only *one* folk concept of pain. The polysemy view rejects this assumption. Instead, it argues that there are two separate but related concepts of pain—a bodily concept, that is, PAIN<sub>B</sub>, which treats pain as a state of a body part, and a mental concept, that is, PAIN<sub>M</sub>, which treats pain as a state of a person or sentient being.

The polysemy view rests fundamentally on the claim that words such as “sore”, “ache” and “hurt” are polysemous, where one sense refers to a bodily state and the other a mental state. Call this the *linguistic thesis*. The type of polysemy associated with these pain words, as I argue, reflects distinct concepts of pain. Call this the *conceptual thesis*. This section clarifies and argues for the polysemy view by providing considerations for the two theses.

<sup>2</sup>One might insist that colours are just properties of experiences. But this is certainly not the pre-philosophical, common-sense view. Note that even in Jackson's (1982) Mary case, what Mary learns upon leaving her black-and-white room is *what it is like* to see something red—which is the phenomenal property—but *red* itself is taken to be a property of mind-independent objects.

## 4.1 | The linguistic thesis

There are four primary pain terms in English: “pain”, “sore”, “ache” and “hurt.” These are words that are specifically dedicated to denoting pain (Fabrega Jr. & Tyma, 1976; Reznikova, Rakhilina, & Bonch-Osmolovskaya, 2012).<sup>3</sup> Here, I focus on the three predicates: “sore”, “ache” and “hurt”, which apply to both a person and a person’s body part.<sup>4</sup> According to the *linguistic thesis*, these words are polysemous between a mental sense and a bodily sense.

*Polysemy* is a linguistic phenomenon where a word has multiple, related meanings or senses (Sennet, 2016; Vicente, 2018). Polysemy is contrasted with *homonymy*, where the same word form has distinct but unrelated meanings, for example, *BANK* (financial institution vs. river edge). Homonymy and at least some cases of polysemy fall under what is sometimes called “ambiguity” (Rodd, 2018; Sennet, 2016; Vicente & Falkum, 2017). An expression is *ambiguous* if it has multiple meanings, where the meanings are either related (in case of polysemy) or unrelated (in the case of homonymy). The thought here is that pain words like “sore”, “ache” and “hurt” are ambiguous in the sense that they are polysemous. In arguing for the *linguistic thesis*, I shall put forward three considerations.

### 4.1.1 | First argument

The first consideration draws on the ellipsis test for ambiguity. I have addressed this consideration elsewhere (Liu, 2021). I shall briefly summarise it here and turn to some objections.

Our three primary pain words, that is, “sore”, “ache” and “hurt”, apply to both a person and a person’s body part:

- (1) a. Kate’s leg is sore/aching/hurting.
- b. Kate is sore/aching/hurting.

A question naturally arises as to whether these pain terms are ambiguous when applied to different types of things. A common test for ambiguity is the *ellipsis test* (Lakoff, 1970; Sennet, 2016; Zwicky & Sadock, 1975). An ambiguous expression fails the test. That is, the elliptical construction encompassing the two different senses of an ambiguous word results in oddness or “zeugma.” Consider:

- (2) a. The verdict is fair.
- b. The girl’s hair is fair.
- c. \*The verdict is fair and so is the girl’s hair.

The word “fair”, plausibly a homonym, means “impartial” in (2a) and “light-coloured” in (2b). (2c) is an elliptical construction of (2a) and (2b). It is zeugmatic because there is no cross-interpretation immediately available where the elliptical phrase “so” is understood in the same

<sup>3</sup>Primary pain terms are contrasted with *secondary pain terms* such as “burning”, “stinging”, “shooting”, which are not exclusively tied to pain reports.

<sup>4</sup>Elsewhere I have also argued that “pain” itself may be polysemous (Liu, 2021).

sense as the word “fair” occurring in the first conjunct. The two noun phrases (NPs)—“the verdict” and “the girl’s hair”—require different interpretations of the predicate “fair.”

The three pain terms mentioned, that is, “sore”, “ache” and “hurt”, also fail the ellipsis test. Consider:

- (3) a. \*Kate’s leg is sore/aching/ hurting and so is John.  
b. \*John is sore/aching/hurting and so is Kate’s leg.

All variations of (3)-sentences sound odd. In contrast, when the two NPs refer to the same type of entities, the corresponding ellipses sound fine:

- (4) a. Kate’s leg is sore/aching/hurting and so is John’s arm.  
b. John is sore/aching/hurting and so is Kate.

What then explain the oddness of (3)-sentences? Here is an explanation which appeals to the *linguistic thesis*. They are odd because the two NPs—“Kate’s leg” and “John”—require different interpretations of the relevant predicate. On this explanation, “sore”, “ache” and “hurt”, are *ambiguous*; more specifically, they are *polysemous*, having two related senses. When applied to a person, they indicate a mental state that an experiencer undergoes; when applied to a body part, they indicate a state that a body part undergoes.<sup>5</sup>

While the above proposal offers an explanation for the oddness of (3)-sentences, one might worry that this does not establish that our pain words are polysemous in the sense outlined above, for there might be better alternative explanations for the oddness at issue. Below I consider four alternative explanations.<sup>6</sup>

According to the first explanation, locutions like “John is hurting” are less frequent than locutions like “John’s leg is hurting”, and the oddness of (3)-sentences is due to frequency effects. However, it is unclear how this proposal is supposed to work. Granted that our pain predicates apply less frequently to persons, it is unclear how the oddness at issue is to be explained by the frequencies of the relevant locutions. Moreover, infrequent constructions, say, involving metaphors or archaic phrases, do not necessary sound odd; nor are they necessarily rendered odd when combined with a frequent locution.

According to the second alternative explanation, the relevant pain terms are polysemous, but it is not the case that one of the senses refers to a mental state. Instead, one sense refers to a state of a whole body (as in “John is hurting”), and the other a state of a specific body part (as in “Kate’s leg is hurting”). A proponent of this explanation might motivate their view by arguing that with utterances like “John is hurting”, we often mean “John’s whole body is hurting” or “John is hurting all over his body.” However, it is far from clear that the latter claim is true. Utterances like “S is sore/aching/hurting”, where “S” indicates a person, are frequently

<sup>5</sup>Elsewhere (Liu, 2021), I also discuss the *conjunction reduction test* for ambiguity and provide empirical evidence for the armchair linguistic intuitions reported here. Seventy-six native English speakers on Amazon Mechanical Turk were asked whether elliptical constructions like (3)-sentences and (4)-sentences sounded odd on a 7-point Likert scale where “1” means “This sentence definitely does not sound odd” and “7” means “This sentence definitely sounds odd”. The average ratings for (3)-type and (4)-type sentences were 2.15 ( $SD = 1.63$ ) and 4.88 ( $SD = 1.89$ ), respectively. A paired-sample *t*-test showed significant differences between the average ratings of the two groups [ $t(67) = 13.64, p < 0.001$ ].

<sup>6</sup>I thank two anonymous reviewers for raising them.

used when only part of the person is sore/aching/hurting. Moreover, even granted that these utterances are often made when the person's whole body is hurting, it does not follow that the relevant pain terms are polysemous between a general sense when applied to persons and a specific sense when applied to body parts. Pain predicates, when applied to persons, do not have a fixed sense that picks out a state of a person's whole body. The sentence "John is hurting" is not semantically equivalent to "John is hurting *all over his body*." The former can be true when the latter is false, for example, when only John's leg is hurting. Thus, this proposal fails to identify the relevant polysemous senses at issue.

The third alternative explanation draws on examples of the following kind:

- (5) John is sunburnt/tattooed/hairy and so is Kate's leg.

According to this explanation, (5)-sentences sound odd, plausibly not because the relevant predicates are polysemous, but because we do not usually make comparative judgments between a person and a person's body part, and the oddness of (3)-sentences, which involve pain predicates, are of the same kind as that of (5)-sentences. However, it seems that while (5)-sentences may sound infelicitous, one can immediately make sense of them. After all, "sunburnt", "tattooed" and "hairy" all refer to conditions of the body. Indeed, corresponding sentences involving pain predicates, that is "John is sore/aching/hurting and so is Kate's leg", sound much odder.<sup>7</sup> So this proposal fails to explain the oddness pertaining specifically to (3)-sentences.

According to the final explanation, when we interpret a sentence like "John is hurting", we tend to take the predicate to refer to an emotional rather than physical pain. On this explanation, (3)-sentences are odd because it would not make sense to attribute an emotional state to a

<sup>7</sup>This linguistic intuition is empirically confirmed by an experiment conducted on Amazon Mechanical Turk. A total of 104 native English speakers participated in the experiment and 21 were excluded for failing to pass attention and comprehension checks, resulting in a final sample size of 83 (48.2% female). Using the same scale reported in fn. 5, all participants were asked to rate (A)-sentences in the first section of the survey, and (B)-sentences in the second section. Sentences in each section were randomised.

- A. i. Michael is hurting and so is Jeremy's leg.  
 ii. Jess is sore and so is Sam's finger.  
 iii. Charlotte is aching and so is Judy's arm.
- B. i. Max is tattooed and so is Shaun's arm.  
 ii. Charlotte is sunburnt and so is Anne's face.  
 iii. Charlie is hairy and so is Daniel's chest.

Average ratings for (A)-sentences and (B)-sentences were 5.02 ( $SD = 1.65$ ) and 3.80 ( $SD = 1.70$ ). A paired-sample  $t$ -test showed significantly higher oddness ratings for (A)-sentences compared to (B)-sentences [ $t(82) = 6.23, p < 0.001$ ], with a medium effect size [Cohen's  $d = 0.73$ ]. Average ratings for each of the (A)-sentences and (B)-sentences were: 4.95 ( $SD = 1.91$ ), 5.10 ( $SD = 1.72$ ), 5.02 ( $SD = 1.80$ ), 4.11 ( $SD = 1.99$ ), 3.36 ( $SD = 2.03$ ) and 3.93 ( $SD = 1.97$ ). Two additional ANOVAs were run to test for homogeneity between sentences within each section. The ANOVA on the three sentences in (A) yielded no significant difference [ $F(2, 246) = 0.13, p = 0.88$ ], but the ANOVA on the three sentences in (B) yielded a significant difference [ $F(2, 246) = 3.16, p = 0.04$ ], with post-hoc  $t$ -tests showing sentence (B-ii) to have lower ratings than (B-i) [ $t(82) = 3.92, p < 0.001$ ] or (B-iii) [ $t(82) = 2.90, p < 0.005$ ]. To ensure that the paired-sample  $t$ -test difference between (A) and (B) was not solely driven by the low ratings of (B-ii), another paired-sample  $t$ -test was run to compare between the average ratings of (A)-sentences and the average ratings of (B)-sentences excluding (B-ii). This again resulted in significantly higher oddness ratings for (A)-sentences compared to (B)-sentences [ $t(82) = 4.99, p < 0.001$ ], with a medium effect size (Cohen's  $d = 0.59$ ).



body part. However, this explanation is not necessarily incompatible with the polysemy explanation which take the relevant pain terms to have two senses—one referring to a mental state and one a bodily state. Plausibly, the mental sense incorporates instances of emotional pains. Consider the following scenario: Kate injured her leg severely at work, and her housemate John recently lost his beloved pet dog. It seems correct to say that “Kate is hurting and so is John.” The same interpretation of “hurting”, that is, “undergoing a mental state of pain or distress”, can be applied to the two NPs, though one indicates a person with a physical pain and the other indicates a person with an emotional pain.

To sum up, the oddness of (3)-sentences can be explained by appealing to the *linguistic thesis*, according to which our pain predicates are polysemous between a mental sense and a bodily sense. The alternative explanations, as I argue, are either implausible (first and second), fail to explain the relevant oddness (third) or are plausibly compatible with the proposed explanation (fourth). The *linguistic thesis* will be further strengthened by two additional considerations to which I now turn.

#### 4.1.2 | Second argument

The second consideration for the linguistic thesis appeals to the existing literature on emotion descriptions of music and draws on a close analogy between emotion words and pain words. Emotion words like “sad”, “happy”, “joyful” and so forth, can denote an emotion of a subject, for example, “Kate is sad”, as well as a property of a thing or event, for example, “sad music”, or “joyful celebration.” Emotion words are plausibly polysemous with at least two different senses, where one picks out an emotion of a person and the other a state of an object. The latter view has been well argued for in the literature on musical expressiveness (see Davies, 2011). According to Stephen Davies (2011), emotion terms have two uses. Their primary use is to denote mental states which sentient beings undergo, for example, “Sally is sad.” Emotion words also have a secondary use, such as when we use them to describe human behaviour, for example, “Her voice is sad”, or music, for example, “Chopin’s Funeral March is sad.” In the latter case, as Davies contends (2011, p. 10), they denote features of musical movements which are analogous to the configurations of bodily compartments typically associated with the relevant emotions. Davies (op. cit.) writes:

Just as someone who is stooped over, dragging, faltering, subdued and slow in her movements cuts a sad figure, so music that is slow, quiet, with heavy or thick harmonic bass textures, with underlying patterns of unresolved tension, with dark timbres and a recurrently downward impetus sounds sad (Davies, 2011, p. 10).

On this view, the word “sad” as in “the music is sad” does not denote a mental state, but a feature of the music itself.

Regardless of what we think of Davies’s view of music’s expressive character, it is no surprise that emotion terms—when applied to a sentient subject and when applied to music—are polysemous, given a simple ellipsis test. Consider (6):

- (6) \*Sally is sad and so is the music.

(6) is zeugmatic although one can imagine it uttered as a pun. In contrast, the following sentences, where the two NPs in the subject position indicate things in the same category, are not odd:

- (7) a. Sally is sad and so is Luke.  
b. Chopin's Funeral March is sad and so is Schubert's Serenade.

This discussion on the use of emotion terms is particularly relevant to the proposed linguistic thesis regarding pain terms, because the two types of words behave in a similar way. As we saw, pain terms are like emotion terms in that they apply to persons and non-mental entities, though they only apply to body parts when the subject of the sentence is a non-mental entity. Consider also the parallel between pain reports and emotion descriptions of music:

- (8) a. My arm is sore/aching/hurting.  
b. The music is sad.  
(9) a. There is a pain in my arm.  
b. There is sadness in the music.

Emotion terms, as we saw, are polysemous between a mental sense (when applied to persons) and a non-mental sense (when applied to things like music). Given the close parallel, pain terms are plausibly also polysemous in a similar way, where one sense picks out a mental state of an experiencer and the other a state of a non-mental thing (in this case a bodily state).

The case of emotion words also helps us sharpen the distinction between the polysemy view and Borg et al.'s polyeidic view. It seems very odd to insist that our concepts of emotions, say the concept of sadness, encompass a *subject/object dimension* and that we treat sadness as a property of a sentient subject in some contexts, and as a property of a non-sentient object like music in others. It seems more intuitive to claim, à la Davies, that emotion terms are polysemous—they are used in different senses when describing a person and describing a piece of music. The close analogy between pain words and emotion words thus provides additional support for the linguistic thesis.

### 4.1.3 | Third argument

The third consideration draws on cross-linguistic evidence and the translation test for ambiguity (see Brogaard, 2012). An ambiguous word in one language is translated as multiple words/phrases in some other languages. Furthermore, a homonym (e.g., “bank” in English), where the relevant meanings are unrelated, is translated into multiple words/phrases in most other languages; whereas a polyseme, where the relevant meanings are related, is translated as multiple words/phrases only in some languages and as a single word in other languages (Brogaard, 2012, pp. 12–13).

Earlier on, we saw that English words—“sore”, “ache” and “hurt”—have the syntactic feature of following either a NP indicating a person or one indicating a body part. This is not the case with many European languages. For instance, the Spanish adjective “adolorido”, meaning *sore*, only applies to a person, not a body part. (10a) is fine but not (10b).

- (10) a. Kate está adolorida  
           “Kate is sore”  
 b. \*La pierna de Kate está adolorida  
           “Kate’s leg is sore”

When the subject of the sentence indicates a body part, it is more common to report pain using the transitive verb “dolor”, for example, “A Kate le duele la pierna” (“The leg hurts (to) Kate”). Italian behaves in a similar way such that (11a) is fine but not (11b):

- (11) a. Kate è dolorante  
           “Kate is aching”  
 b. \*La gamba di Kate è dolorante  
           “Kate’s leg is aching”

In Italian, “Kate’s leg hurts” is rendered as “A Kate fa male la gamba.” (10b) and (11b) are odd because they make it sound as if the corresponding body part, that is, “the leg”, is sentient or capable of having feelings, which indicates that the relevant predicates when applied to a person, as in (10a) and (11a), pick out a mental state.

Dutch makes a systematic difference between “doen pijn” (“do pain”) and “hebben pijn” (“have pain”) when applying to a person and a person’s body part:

- (12) a. Kates been doet pijn  
           “Kate’s leg hurts”  
 b. Kate heeft pijn  
           “Kate has pain”

Similarly, German marks a clear distinction depending on whether the subject of the sentence indicates a body part or a person.

- (13) a. Kates Bein tut weh  
           “Kate’s leg hurts”  
 b. Kate hat Schmerzen  
           “Kate has pain”

So does Polish:

- (14) a. Kate boli noga  
           “A leg hurts (to) Kate”  
 b. Kate cierpi  
           “Kate hurts/suffers”

But there are other languages which behave like English, where the same pain word applies to both persons and body parts. Consider the Mandarin Chinese word “痛” (“tòng”):

- (15) a. 凯特的腿很痛  
kǎitè de tuǐ hěn tòng  
Kate ligature leg very hurt  
“Kate’s leg hurts badly”
- b. 凯特很痛  
kǎitè hěn tòng  
kate very hurt  
“Kate hurts badly”

The Korean word “아파” (“appa”) works in a similar way:

- (16) a. 케이트 다리가 아파요  
Kate dariga appa-yo<sup>8</sup>  
Kate leg hurt-particle  
“Kate’s leg hurts”
- b. 케이트는 아파요  
Kate neun appa-yo  
Kate topic. maker hurt-particle  
“Kate hurts”  
So does “seer” in Afrikaans:

- (17) a. Kate se been is seer  
Kate poss. leg is painful  
“Kate’s leg is hurting”
- b. Kate is seer.  
Kate is painful  
“Kate is hurting”

The word “sakit” in Standard Malay, meaning “painful”, also applies to both body parts and persons:

- (18) a. Kaki Kate sakit  
leg Kate painful  
“Kate’s leg hurts”
- b. Kate sakit  
Kate painful  
“Kate is hurting”

<sup>8</sup>“요” (“yo”) is a particle indicating politeness.

Finally, the Greek word “πονάω” exhibits the same pattern:

- (19) a. πονάει το πόδι της Κέιτ  
 ponai to pothi tis Kate  
 hurts the leg (nom.) the Kate (gen.)  
 “Kate’s leg hurts”
- b. Η Κέιτ πονάει  
 I Kate ponai  
 the Kate (nom.) hurts  
 “Kate hurts”

So, the translation test for polysemy provides direct support for the claim that English pain predicates like “sore”, “ache” and “hurt” are polysemes. Given the previous two arguments, the claim that pain predicates are polysemous is best understood to mean that they are polysemous between a mental sense and a bodily sense. So, the translation test also adds support to the *linguistic thesis*.

Given the translation test, as well as the ellipsis test and the close analogy between pain terms and emotion terms, we can reasonably conclude the *linguistic thesis* that our pain terms are polysemous, where one sense picks out a mental state and the other a bodily state.

## 4.2 | The conceptual thesis

In this subsection, I argue for the *conceptual thesis* that the kind of polysemy associated with our primary pain terms reflects distinct concepts of pain. First, a clarification on how the notion of *concept* is understood is in order. I take concepts to be constituents of thoughts just as meanings of words are constituents of the meanings of sentences. *Concept* is distinguished from *conception* (e.g., Rey, 1983, 1985). A concept is what features in truth-evaluable thoughts (e.g., Fodor, 1998; Rey, 1983), whereas when we speak of a *conception* of something, we often mean a set of beliefs, associated with a concept, “that may be commonly held in a community” (Rey, 1985, p. 297).

Let us now take a closer look at the phenomenon of polysemy and the type of polysemy our pain words display. Polysemy comes in two main varieties—*regular* and *irregular*. Here is a canonical characterisation of the distinction (Apresjan, 1974, p. 16):

Polysemy of the word A with the meanings  $a_i$  and  $a_j$  is called regular if, in the given language, there exists at least one other word B with the meanings  $b_i$  and  $b_j$ , which are semantically distinguished from each other in exactly the same way as  $a_i$  and  $a_j$  and if  $a_i$  and  $b_i$ ,  $a_j$  and  $b_j$  are nonsynonymous ... Polysemy is called irregular if the semantic distinction between  $a_i$  and  $a_j$  is not exemplified in any other word of the given language.

Regular polysemes exhibit systematic patterns. Cruse (2004, pp. 110–111) notes that in many cases, one sense of the polyseme is specialisation of a more general sense, where the

relationship between the two senses may either be *part/whole*, for example, “door” (the leaf itself which is a single panel that fills the doorway vs. the whole set including hinges, jambs, etc.), or *subtype/general-type*, for example, “dog” (male dogs vs. the canine type).<sup>9</sup> Another common mechanism in generating regular polysemy is *metonymy*, where a word for one thing is used to denote a contiguous thing (Apresjan, 1974; Vicente, 2018). Metonymic relations include *animal for meat*, for example, “chicken”; *container for content*, for example, “DVD”; *producer for product*, for example, “I like this Picasso” (Apresjan, 1974; Falkum & Vicente, 2015; Vicente & Falkum, 2017).

Regarding the generation of irregular polysemy, *metaphor* is usually thought of as the dominant mechanism (Apresjan, 1974; Vicente, 2018). A metaphor creatively draws a comparison, usually one-off, between two distinct things in certain respects. When the metaphorical meaning is conventionalised, the resulting polyseme would typically be an instance of irregular polysemy, and the different senses of polyseme are thus related by similarity (Vicente, 2018, p. 953; Vicente & Falkum, 2017). Consider the word “expire”, which means *die* in “John expired” and *become invalid* in “The card expired.” Through metaphorical extension, the first meaning gives rise to the second. A person expiring is similar to a card expiring in the sense that both come to the end of a period.<sup>10</sup>

In the literature, it is also customary to distinguish between so-called *logical polysemy* from *ambiguity* which, as we already saw, includes instances of polysemy (Asher, 2011; Falkum & Vicente, 2015; Pustejovsky, 1995; Vicente & Falkum, 2017). Logical polysemes, which form a subtype of regular polysemy, are generally thought to pass the co-predication test (op. cit.). Consider:

- (20) a. The book is still relevant though yellowed with age.  
b. Dinner was delicious but took a long time.

“Book” denotes either *text* or *tome*, whereas “dinner” denotes either *food* or *event*. Other examples of logical polysemes include words for institutions (e.g., “school” can refer to an institution, a building, a body of people) and country or place names (e.g., “France” can refer to a geographical place, a political entity, a national team, a population). Theorists have given different explanations as to why logical polysemes pass the co-predication test. Some opt for an ontological explanation, according to which logical polysemes encode what they call “dot objects”—composites with different aspects (Asher, 2011; Pustejovsky, 1995). For instance, *book* is said to be of the type “text•tome.” Ortega-Andrés and Vicente (2019) have argued for a psychological explanation, according to which the closely related senses of a logical polyseme form an “activation package” such that all the senses of the word are activated when encountering the word, and the activation of one sense does not inhibit the other senses. This, as they contend, explains why logical polysemes pass the co-predication test. The latter feature clearly

<sup>9</sup>In Cruse’s terminology (2004, pp. 110–111), when the general sense denoting a whole gives rise to the specialised sense denoting a part, the relation is called “automeronymy”, and the inverse phenomenon is called “autoholonymy”. If the general sense denoting a general type gives rise to the specialised sense denoting a subtype, the relation is called “autohyponymy”, and the inverse “autosuperordination”.

<sup>10</sup>The distinction between regular and irregular polysemy is not always clear-cut (Falkum & Vicente, 2015; Vicente & Falkum, 2017). Some instances of creative metonymy are not regular, for example, “Kate is a pretty face”, whereas some everyday metaphors are regular, for example, words for body parts denoting corresponding parts of inanimate objects (“mouth of the river”).

distinguishes logical polysemy from ambiguity. Ambiguous words—which include homonyms and non-logical polysemes—fail the co-predication test. Consider:

- (21) \*The verdict and the girl's hair are fair.

(21) is zeugmatic.<sup>11</sup>

Let us now turn to our pain terms. They are *regular* polysemes rather than *irregular* polysemes. As we saw in the previous subsection, “sore”, “ache” and “hurt” can denote either a mental state or a bodily state. Other sensation words in English, for example, “itch” and “tingle”, also behave in a similar way, applying to both a person when denoting a mental state and a person's body part when denoting a bodily state. Consider:

- (22) a. Kate's leg is itching/tingling.  
b. John is itching/tingling.

Our primary pain terms are *not* logical polysemes like “book”, because they fail the co-predication test.

- (23) \*Kate's leg and John are sore/aching/hurting.

Similarly, the above sensation words also fail the co-predication test. (24) is odd.

- (24) \*Kate's leg and John are itching/tingling.

The two senses of the pain terms seem to exhibit similar patterns to those of nouns like “door”, where one sense of the polyseme is a specialisation of the other. The mental sense is the more general sense whereas the bodily sense is specialised. One of the ways for someone to be in  $\text{pain}_{-m}$  (i.e., to have a mental state of pain) just is to have a  $\text{pain}_{-b}$  in a body part. Another way is that of a phantom pain subject who has an experience of  $\text{pain}_{-m}$  that is subjectively indistinguishable from the experience of having a  $\text{pain}_{-b}$  in a body part. A third way, perhaps, is to undergo an emotional pain, for example, “John is hurting because he recently lost his beloved pet dog.”<sup>12</sup> So, mental pain, that is,  $\text{pain}_{-m}$ , is a general type of mental state which is multiply realised, and one of the realisers is having a  $\text{pain}_{-b}$  in a body part.

<sup>11</sup>A point on terminology: In the literature, co-predication usually understood as occurring where a nominal polyseme “has simultaneous predications selecting for two different meanings or senses” (Ortega-Andrés & Vicente, 2019, p. 2). Here the term “co-predication” is used broadly to include predicative and adjectival polysemes which can apply in different senses to different noun phrases without the relevant sentence sounding zeugmatic.

<sup>12</sup>In Section 4.1.1, I suggested that the mental sense of pain predicates might incorporate instances of emotional pain. A further consideration in favour of the view that our mental concept of pain, that is,  $\text{PAIN}_{-M}$ , is a unitary concept that applies to both physical and emotional pains comes from the fact that our concept  $\text{PLEASURE}$ , which tracks a pleasant mental state of a person, seems to be unitary, regardless of whether it refers to physical pleasure or intellectual/emotional pleasure. Similarly,  $\text{PAIN}_{-M}$ , in contrast to  $\text{PLEASURE}$  where both are understood as picking out mental states, is arguably unitary regardless of whether emotional pain or physical pain is referred to (Wierzbicka, 2012).

Let us now turn to the issue regarding polysemy and concepts and the question of whether the polysemy of our pain words reflects distinct concepts of pain. Given the notion of concepts at issue, that is, constituents of thoughts, not all instances of polysemes express distinct concepts. Logical polysemes like “book”, though having discrete senses, seem to express a unified concept (see Cruse, 2004, p. 116).

First, logical polysemes pass the co-predication test. Consider (20a) which entails two propositions: (i) “The book is still relevant” and (ii) “The book is yellowed with age.” The acceptability of (20a) suggests that the meaning of the word “book” makes the same contribution to the meanings of (i) and (ii). If concepts constitute thoughts in the same way as meanings of words constitute the meanings of sentences, then it seems intuitive to say that “book”, which has a unified meaning in these sentences, expresses a unified concept BOOK.<sup>13</sup>

Second, and relatedly, the multiple senses of a logical polyseme are not normally or systematically distinguished (Cruse, 2004, p. 116). This latter claim may be spelt out in terms of cognitive processing. On Ortega-Andrés and Vicente's (2019) model, as we just saw, all senses of a logical polyseme are co-activated when the word is encountered and the selection of one sense does not inhibit the others. Indeed, the distinction between “book<sub>-text</sub>” and “book<sub>-tome</sub>” only becomes salient upon prompting. Furthermore, we may observe that in some cases all senses of a logical polyseme are required to be present (e.g., “Lin just published a book”) and it is the combination of all the senses that gives rise to a metaphorical usage of the word (e.g., “Lin is a closed book”) (Cruse, 2004, p. 116). These considerations suggest that there is only one concept, encompassing all the different senses of a logical polyseme, that features in our thoughts about the relevant category.

Let us turn now to our pain terms. One reason to think that they express distinct concepts of pain is that they fail the co-predication test. The oddness of the sentence “Kate's leg and John are hurting” suggests that the word “hurting” contributes different contents or meanings to the sentences “Kate's leg is hurting” and “John is hurting,” respectively. Correspondingly, one might then say that the word “hurting” expresses two concepts.

Relatedly, the two senses of a pain term—the mental sense and the bodily sense—express different concepts of pain because they are systematically distinguished. This is reflected in the thematic roles (“ $\theta$ -roles” for short) pain predicates like “hurt” (used as an intransitive verb) take on. Thematic roles, for example, *agent*, *patient*, *theme*, *experiencer*, and so forth, are associated with semantic functions of arguments with respect to the predicate of the clause; they are contrasted with *grammatical roles*, for example, *subject*, *direct object*, *indirect object* and so forth, which concern arguments' syntactic functions (Saeed, 2003, Chapter 6). A pain report describes a situation or event, which involves what linguists call “participants” (Halliday, 1998; Saeed, 2003, Chapter 6). The main participants in a pain situation include *body part* and *person*, and these participants take on different  $\theta$ -roles (Halliday, 1998). In a sentence like “John is hurting”, the subject of the sentence “John” is assigned the *experiencer  $\theta$ -role* by the predicate, where *experiencer* is a participant characterised as being aware of something. In a sentence like “John's leg is hurting”, the subject “John's leg” is assigned the *theme  $\theta$ -role* by the predicate,

<sup>13</sup>One might explain the apparent acceptability of (20)-sentences by appealing to the process of coercion and drawing a distinction between the content the speaker tries to convey in uttering the sentence and the literal content of the sentence. On this proposal, the polyseme “book” only has one literal meaning, either “book<sub>-text</sub>” or “book<sub>-tome</sub>.” (20a) is strictly speaking false although the speaker intends to convey something true: “The book<sub>-text</sub> is still relevant though the book<sub>-tome</sub> is yellowed with age.” The sentence is acceptable because the literal meaning is coerced into a new meaning, say, from book<sub>-text</sub> to book<sub>-tome</sub>. However, it is unclear precisely how and where the process of coercion operates and how to decide which sense is the literal meaning of the polyseme.



where *theme* is a participant, usually an object, which is characterised as changing its condition or being in a certain condition. So, the two senses of the intransitive verb “hurt” have different requirements for their  $\theta$ -roles, represented by their different  $\theta$ -grids: “hurt V: <experiencer>” versus “hurt V: <theme>.” In the former case, one conceptualises a sentient subject or experiencer undergoing the experience “hurting,” and in the latter case, one conceptualises something—in this case a body part—as being in the state of “hurting.”

Not only do pain predicates systematically take on these two different types of  $\theta$ -roles, similar behaviours are observed with other experiential predicates, such as emotion predicates, which we have already seen in Section 4.1.2, and temperature predicates, for example, “cold”, “hot.” They can denote either a mental state of a sentient being, for example, “Kate is sad”/“Kate is cold”, where the subject of the sentence is assigned an *experiencer*  $\theta$ -role, or a quality or condition of a thing, for example, “the music is sad”/“the food is cold”, where the subject is assigned a *theme*  $\theta$ -role.<sup>14</sup>

Given the above two considerations, we can reasonably conclude the *conceptual thesis* that the type of polysemy associated with primary pain words reflects distinct concepts of pain—a mental concept, PAIN<sub>M</sub>, which treats pain as a mental state, and bodily concept, PAIN<sub>B</sub>, which treats pain as a bodily state.

Here, it is worth emphasizing again the difference between the polysemy view and the polyeidic view. Advocates of the polyeidic view think that there is one concept of pain which has multiple dimensions, among which is a mental/bodily dimension. In contrast, the polysemy view does not treat the mental/bodily division on a par with other dimensions. It takes the division to reflect distinct concepts of pain. The polysemy view is, nevertheless, compatible with positing “multiple dimensions” like conscious/unconscious, aversive/non-aversive, and so forth, for each of the two concepts of pain, in the sense that people might have different tacit beliefs about what mental pains and bodily pains are generally like, and these tacit beliefs may be manifested in different contexts.<sup>15</sup>

As I have argued, there are good reasons for thinking that our pain terms are polysemous between a mental sense a bodily sense, and that the polysemy at issue reflects distinct concepts of pain. Furthermore, the polysemy view provides a better model of understanding the concept of pain and our pain terms than the polyeidic view, because the model can potentially extend to and fit better with emotion concepts and temperature concepts and corresponding predicates.

## 5 | IMPLICATIONS

In this concluding section, I want to draw three implications from the polysemy view for issues in the philosophy of pain. The first implication concerns the alleged *paradox of pain*, the claim that the folk concept of pain is incoherent because it treats pains as both mental states and bodily states simultaneously (Hill, 2005, 2017). As I have argued elsewhere (Liu, 2021), the

<sup>14</sup>Note that “Kate is cold” can also mean that “Kate’s body is cold”, in which case “Kate” is assigned a *theme*  $\theta$ -role.

<sup>15</sup>Some predicates may be multi-dimensional while being polysemous. For instance, “healthy” is a multi-dimensional adjective (Sassoon, 2013). A subject S can be said to be “healthy” in different respects, for example, blood, heart, cholesterol and so forth. But this does not mean that the word “healthy” tracks a single multi-dimensional concept which includes a subject/object dimension. In fact, “healthy” is a well-cited example of a polyseme with multiple senses (e.g., Sennet, 2016), for example, “having good health” as in “John is healthy”; “being conducive to health” as in “John’s food is healthy”; and “not diseased” as in “John’s blood is healthy.”

paradox dissolves on the polysemy view. Our folk view of pain is not confused. There are simply two concepts of pain—one reflects a mental state, and the other a bodily state.

The paradox of pain is reminiscent of the so-called “location objection” against the identity theory of the mind proposed in the late 1950s (Smart, 1959). The thought there was that if mental states are brain states, they must be located in the brain, but sensations like pain seem to be located in non-brain-based body parts (Malcolm, 1964). In response, Jaegwon Kim (1966) distinguishes pains as locatable entities, that is,  $\text{pain}_b$ , from the having of  $\text{pain}_b$ , which amounts to an instance of  $\text{pain}_m$ . The identity theory is a theory about  $\text{pain}_m$ , not  $\text{pain}_b$ , and the location objection hence does not apply to the identity theory. I have argued that both notions of pain are part of our ordinary discourse, but they ought to be kept apart conceptually. Once we have distinguished them, we can see that just as the location objection against the identity theory falls through, so does the alleged paradox of pain.

The second implication concerns the *metaphysics of pain*. Much of the recent literature on pain has been driven by the question of whether the traditional view of pain, which treats pain as a mental state (e.g., Lewis, 1980; Tye, 2017), is correct (e.g., Hyman, 2003; Massin, 2017), as well as whether it reflects the folk concept (Borg et al., 2020; Kim et al., 2016; Reuter et al., 2014; Reuter & Sytma, 2020). Given the polysemy view, it should be recognised that the question about the metaphysical nature of pain ought to proceed in two separate strands—one about the nature of  $\text{pain}_m$ , the of referent  $\text{PAIN}_M$  and the other about the  $\text{pain}_b$ , the referent of  $\text{PAIN}_B$ . Whether each of these two concepts of pain successfully refers to real features of the world, and what these features precisely are, should then be addressed by the metaphysics of pain; theories of  $\text{pain}_b$  should not be regarded as competing with theories of  $\text{pain}_m$ .

The third implication relates to the difficulty concerning the communication of pain, especially between patients and clinicians (see Borg et al., 2020; Borg, Hansen, & Salomons, 2019). Borg et al. (2019) note that “[m]any clinicians find it hard to accept pain without evidence of pathology and many patients feel stigmatised by clinicians who dismiss their reports or narratives of pain.” In putting forward their polyeidic view, Borg et al. (2020, p. 45) suggest that clinicians are likely to tacitly weigh “physical, bodily aspects more highly, while patients focus on the experiential and affective dimensions.” On the polysemy view, the possibility of operating with distinct concepts of pain can also help explain the difficulty of pain communication between clinicians and patients. While further empirical research is required to determine the circumstances in which the bodily or the mental concept of pain is more likely to be deployed, it is reasonable to conjecture that a clinician who is trained to investigate bodily symptoms of pathology may be likely to deploy the bodily concept of pain in clinical contexts, and may even adopt a reductionist conception of  $\text{pain}_b$  on which it is conceived as tissue damage or nociceptive activity. In contrast, a patient, who suffers from painful experience, might operate with the mental concept of pain with a focus on the phenomenal character of her experience and the goal of ceasing the experience. If no underlying bodily pathology is found, the clinician might undervalue the patient’s pain reports; in such cases, they merely talk past each other. Of course, even if they operate with the same concept of pain, difficulties concerning communication can still take place if they have different conceptions or beliefs associated with the relevant concept.

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## DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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