

Ontology: Innovative Approach to Orofacial Pain Classification

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*Satellite Symposium on Orofacial Pain Assessment: Classification, Biobehavior, QST, and Biomarkers, IADR –
Seattle 2013 - Tuesday, March 19, 2013*

Ontology

The word ‘ontology’ - as mass noun - was originally used to denote a philosophical discipline devoted to the study of what entities exist in reality and how these entities relate to each other. Within that context, the word is sometimes also used as a count noun to refer to one’s account for how reality is structured, thus allowing statements such as ‘Aristotle’s ontology differs from Plato’s ontology’. It is also as count noun that the word ‘ontologies’ became popular in computer science in general and biomedical informatics in particular, but then in the meaning of representational artifacts of various sorts each one describing some part of a domain relevant for a particular purpose. Examples of what nowadays are claimed to be ontologies are controlled vocabularies, nomenclatures, terminologies (formal or not), and also classification systems. It is however unfortunate that most authors of these artifacts lack a background in the discipline of ontology itself, and this often on top of insufficient insight in terminological principles [1] and in the semantics of the representation language they use [2]. It is as a result very often unclear what - if anything at all - the representational units (usually terms) of these artifacts actually represent, and to what degree the structural organization of these units corresponds to how reality is organized in contrast to our perception thereof, or the way we talk about reality [3].

The Ontology of General Medical Science

Ontological Realism offers a principled methodology to build representational artifacts that mimic the structure of reality to our best scientific understanding [4]. It allows authors of representational artifacts, when sufficiently trained, to describe unambiguously and reproducibly what is generic in their domain of interest in line with relevant scientific theories, and to classify discovered entities as, for example, *processes*, *objects*, *qualities*, *dispositions*, and so forth. The method resulted for instance in the Ontology of General Medical Science (OGMS) which provides now a collection of carefully defined representational units that allow biomedical researchers to describe and classify what they observe in terms of, for instance, *disorders*, *diseases*, *diagnoses*, *clinical pictures*, and so forth, or, not less important, identify where terminology as currently used goes astray [5]. This methodology allowed, for example, to distinguish six types of pain-related phenomena implicitly present in the IASP definition for ‘pain’ [6] and to provide an ontologically adequate description of what is called ‘persistent dento-alveolar pain disorder’ (PDAP) [7].

Ontology-Based Classification

Even when clinicians and biomedical researchers are experts in their domain, there is no guarantee that they are also experts in designing terminologies or classifications for use in their domain. That the publication of a (new version of a) classification is based on consensus is also not a guarantee for quality. Moreover, quality is usually measured in terms of (1) how well users are able to classify cases in the same way, (2) whether all cases can be classified - an easy solution to guarantee this being the introduction of ‘other’ or ‘not elsewhere classified’ type of classes - or, (3) if the classification uses criteria, whether following the criteria may nevertheless lead to cases being classifiable in more than one class such that, in case of a diagnostic classification, a patient may be diagnosed as having two disorders at the same time while there is no evidence for that being the case. Quality from an Ontological Realism perspective is more demanding. It means for classifications that the definitions for classes must follow certain principles, and that these classes correspond to pre-defined ontological categories. If the classification is designed for the medical domain, then the classes should be based on OGMS. The main goal for these extra quality criteria is to ensure that ontology-based classifications cannot only reliably be used by humans, but also that datasets collected in their terms can be fully integrated.

Ontological Realism and Pain Classifications

It is painful to see how currently well-known and widely used pain classifications fall short of good ontological and even terminological design in many respects. This will be illustrated by listing some important principles and demonstrating how these principles are violated in the International Classification of Headache Disorders (ICHD) (<http://ihs-classification.org/en/>), specifically in the newly revised Chapter 13.

P1: Be explicit whether assertions are about particulars or types.

Ontological Realism distinguishes between *particulars* (entities that carry identity such as me and the headache I suffered from yesterday evening) and *types* (such as human being and pain) of which the former are instances. Assertions should be construed in such a way that the terms used therein are unambiguous, including whether types or particulars are intended. The description for ‘13.11 Persistent idiopathic facial pain (PIFP)’ which reads ‘*persistent facial pain with varying presentations and without clinical neurological deficit*’ violates this principle. The term ‘*persistent facial pain*’ in the latter can be interpreted as denoting a particular - though an arbitrary one as clearly not the specific pain of a specific patient is intended here - which means that for a specific patient to have such a pain, that pain - i.e. that very same patient’s pain and not some other patient’s pain - should present itself in various ways, for instance dull now, throbbing then, and so forth to qualify for being an instance of the type PIFP. But the term can also be interpreted as denoting a type in which case instances can be themselves invariant, thus some instances being dull, others throbbing, and so forth.

P2: Be precise about the sort of particulars to be classified using the classification.

The ICHD and its documentation do not present a coherent view of what the most generic type of which all particulars to be classified should be instances of might be. In the preface we are first told it is *disorders* and later *patients*, while some of the definitions indicate that it is *pains*. The recently revised Chapter 13 has as title ‘*Painful cranial neuropathies and other facial pains*’, thus indicating that is both *pains* and *disorders* that are classified therein. Inspection of the hierarchy adds other types to the mix such as, for example, *palsies* and *syndromes*. Although certain instances of patients, pains, palsies, syndromes and disorders are related to each other, most of these instances cannot be instance of more than one of these types. It makes therefore no sense to classify all these entities in a mono-axial system.

P3: Particulars that correctly can be classified at a certain class level, and thus are instances of the corresponding type, should also be instance of all the types that correspond with higher level classes.

The newly revised Chapter 13 exhibits several violations of this principle. It lists for example the class ‘13.1.2 Painful Trigeminal Neuropathy’ as a subclass of ‘13.1. Trigeminal Neuralgia’. While ‘*Neuralgia*’ is defined as being pain in the distribution of nerve(s) and pain as a sensorial and emotional experience, a ‘*Neuropathy*’ is defined as a disturbance of function or pathological change in a nerve. There is no way that one can be a special kind of the other as emotional experiences do not happen in the distribution of a nerve. Of course, when a neuropathy is painful, there is an emotional experience *involved*, i.e. *related* to the neuropathy, but that does not mean that the neuropathy *is* an emotional experience.

P4: Keep knowledge separate from what the knowledge is about.

Several classes have labels of the form ‘*X attributed to Y*’, as in ‘13.1.2.4 Painful Trigeminal neuropathy attributed to MS plaque’ which is then further described as ‘*Trigeminal neuropathy induced by MS plaque*’ (note that ‘*attributed to*’ is not consistent with ‘*induced by*’, an issue dealt with in P5). ‘*Attributed*’ means, in this case, that it is somebody’s opinion that the neuropathy is caused by MS plaque, leaving open the possibility that the neuropathy is not caused by MS plaque at all. The problem here is that a feature on the side of the clinician - his believing, probably with some degree of confidence - is presented as if it were a feature of the neuropathy, which is of course absurd. Each instance of neuropathy either is, or is not induced by MS plaque. It is true that this sort of classes are pervasive in classification systems but they nevertheless rest on a mistake: a confusion of ontology with epistemology [8].

P5: Class descriptions should be consistent with class labels.

There are several instances where the descriptions contain conflicting (see example in P4), inaccurate or incomplete (e.g. ‘13.1.2.4 Painful Trigeminal neuropathy attributed to MS plaque’ leaves the pain out in the description) information compared to the class label. Sometimes it is additional information. It would make sense to be more consistent in the use of what is called ‘*description*’.

P6: Use Aristotelian definitions.

Classes should have - in addition to a label and a description - a definition which provides the necessary and sufficient conditions for an instance to be a member of the corresponding class. These definitions should be in

Aristotelian form, roughly: an X is a Y which Z, where Y is the immediate less specific class above X. An example would be: *a Painful Post Traumatic Trigeminal Neuropathy is a Painful Trigeminal Neuropathy which occurs after trauma* (or is caused by trauma, whatever the domain experts feel appropriate). Definitions of this form prevent odd shifts to happen such as between ‘13.3.2. *Secondary Nervus Intermedius Neuropathy attributed to Herpes Zoster*’ and ‘13.3 *Nervus Intermedius (Facial Nerve) Neuralgia*’ which would lead to the rather odd Aristotelian definition (shortened) ‘a ... Neuropathy ... is a ... Neuralgia ... which is attributed to Herpes Zoster’” no neuropathy can *be* a pain.

P7: Clinical criteria do not replace Aristotelian definitions.

Whereas definitions should describe what the entities that fall under a class *are*, clinical criteria help in *recognizing* whether a particular entity might fall under the class. Such criteria are typically more restrictive than definitions should be. ‘13.1.1.1 *Classical trigeminal neuralgia, purely paroxysmal*’, for example, exhibits the criterion ‘*at least three attacks of facial pain fulfilling criteria B-E*’. This criterion should not be interpreted to mean that patients who had only two such attacks do not have this form of neuralgia. They might indeed have the disorder, but the criterion does not allow a clinician to make the - perhaps correct - diagnosis. This line of thinking applies to all time-related criteria, an often encountered one being the criterion for chronic pain as pain that is present for longer than three months: if a patient does suddenly have a pain for the first time in his life, it might very well be a chronic pain, but we have no way to tell at that point in time whether that is the case unless we wait three months. If so, it would also be wrong to state that the patient’s pain *became* chronic after three months since, again, it was chronic all the time, but we didn’t know.

Conclusions

We have outlined - without being exhaustive - a number of important ontology-based principles for building classifications. We also have shown that they are violated by the newly revised chapter 13 of the ICHD. It is easy to show that they are violated throughout the entire ICHD. Although we recognize that the ICHD in its current form is better for the advance of research than no headache classification at all, its usefulness for making patient data automatically comparable cross institutions and linguistic borders can be improved dramatically if the principles were applied.

Acknowledgements

The work described is funded in part by grant 1R01-DE021917-01A1 from the National Institute of Dental and Craniofacial Research.

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