Building Continents of Knowledge in Oceans of Data: The Future of Co-Created eHealth
A. Ugon et al. (Eds.)

doi:10.3233/978-1-61499-852-5-551

On Defining Bruxism

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Abstract. In a series of recent publications, orofacial researchers have debated the question of how 'bruxism' should be defined for the purposes of accurate diagnosis and reliable clinical research. Following the principles of realism-based ontology, we performed an analysis of the arguments involved. This revealed that the disagreements rested primarily on inconsistent use of terms, so that issues of ontology were thus obfuscated by shortfalls in terminology. In this paper, we demonstrate how bruxism terminology can be improved by paying attention to the relationships between (1) particulars and types, and (2) continuants and occurrents.

Keywords. Bruxism, Ontology, Terminology

1. Introduction

The exponential increase in the number of PubMed indexed papers that have 'bruxism' in their title suggest that it is not only patients who are being kept awake at night by the phenomenon of bruxism. But what *is* bruxism exactly? A consensus proposal was issued in 2013 by experts in the field to set matters straight [1]. In 2016, however, the lead author, after deliberation with other researchers, partly retracted the initial proposal [2], and this then led to a heated discussion with the other experts involved [3, 4].

The proposed consensus definition sees bruxism as '*a repetitive jaw-muscle activity characterized by clenching or grinding of the teeth and/or by bracing or thrusting of the mandible*' [1, p2]. This definition was supplemented by a comment to the effect that: '*Bruxism has two distinct circadian manifestations: it can occur during sleep (sleep bruxism) or during wakefulness* (*awake bruxism*)' [1, p2]. The definition was supplemented further by a '*diagnostic grading system*', distinguishing '"*possible*", "*probable*" *and* "*definite*" *sleep or awake bruxism*' [1, p2]. It was this grading system which led to the retraction in [2]. This is because it was taken to imply that bruxism is a *disorder* rather than an *activity* (a type of behavior), the reason being that '*Behavior alone is not diagnosed; disorders are*' [2, p791].

The proposed consensus definition of bruxism as an activity had been advanced precisely in order to '*move away from the concept of bruxism as an abnormality, as even a statistical abnormality is not a clinical abnormality unless it is clearly associated with a negative health outcome*' [2, p792]. Unfortunately, this was then in turn interpreted by the authors of [3] as a reason for contesting the retraction because, they held, it might be taken to imply a viewpoint '*too strongly oriented towards the*

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definition of bruxism as a "*behavior*"'. The contestants' held that '*bruxism should not be categorically classified into either a disorder or a behavior or whatever else*' [3, p799]. Rather: '*bruxism should be viewed as a "disorder", viz. a condition that requires to be managed or prevented, only when it has consequences*' [3, p800]. This led the authors of [2] to believe that the primary issue raised against their views in [3] rested on '*a semantic misunderstanding*' for which they then offered in [4, p. 802] this clarification: '*Stating that (sleep) bruxism is a* '"*behavior*" *in no way precludes the possibility (at some to-be-specified and validated cut point) of it being more than a behavior, either a risk factor or disorder*' [4, p802].

These discussions as to the nature of bruxism parallel similar debates pertaining to the nature of mental disorders. We thus hypothesize that a framework similar to the one developed for the latter in [5, 6] would allow the identification of confusions and conflations in the terminology of bruxism and provide a means to clearly identify the entities on the side of the patient that need to be addressed if confusions of the sorts illustrated in the above cited passages are to be prevented.

2. Methodology

We performed a discourse analysis of [1-4] in order to identify which later statements were made in response to which statements made in earlier papers. As a first step we attempted to identify where the terminology and phrasing used in statements combined in arguments within a single paper, or in chains of assertion and response across multiple papers, were suggestive of intrinsic ambiguities or non-intended interpretations. We then attempted to use the categories of entities defined in the Basic Formal Ontology (BFO) [7] and in the Ontology for General Medical Science (OGMS) [8] to identify the possible resolutions of these ambiguities and non-intended interpretations within a single carefully defined and logically consistent framework. Lastly, we tried to formulate what the experts had in mind in a way that follows closely the ontological and terminological principles set forth in [7, 8].

Consider, for example, the statement that '*all bruxism forms may potentially be a phenomenon without any clinical consequences or a treatment/prevention-demanding disorder*' [3, p800]. This statement can be interpreted as reflecting the belief on the part of its authors that (a) bruxism is a subtype of *phenomenon* and (b) has at least two subtypes, namely (b1) *bruxism without any clinical consequences* and (b2) *treatment/prevention-demanding bruxism*, where (c) b1 is also a subtype of *phenomenon without any clinical consequences*, (d) b2 is a subtype of *disorder*, and (e) the subtypes (b1 and b2) distinguished in (c) and (d) are disjoint. The first problem here is that (a), (b), (d) and (e) are logically inconsistent (since no disorder is a phenomenon). A second problem is that expressions of the form 'X without Y' should only be construed as representing subtypes of X if the absence of Y implies a change in the pertinent X ('smoking without tinnitus' is not a special type of smoking) [9].

3. Results

Our analysis revealed that the authors of [4] are correct in arguing that the main cause of the objections raised in [3] is indeed '*semantic misunderstanding*'. But it revealed also that the main cause of the latter is the use of a jargon replete with terms not

precisely defined and often denoting constructs far removed from the reality that they are intended to describe. Thus we found that collections of unrelated entities are erroneously perceived as one single entity; that relationships are mistaken for entities in their own right; and that the verb '*to be*' is used in ways that run together ontological relations expressed in natural language by means of constructions such as '*X is a B*' or '*Xs are Bs*', which should more properly be seen as distinct. What most of the problems have in common is that the distinctions between particulars and types on the one hand, and continuants and occurrents on the other hand, are ignored.

4. Discussion

4.1. Ignoring the particular / type distinction in assertions

A first problem is that the viewpoints expressed in [1-4] are all phrased as being about generic entities. Consider the assertions '*Bruxism is a continuously distributed behavior*' [4, p802] and '*Sleep Bruxism is best viewed as quantifiable activity occurring on a continuum*' [2, p795]. Here '*bruxism*' is clearly used in the generic sense – thus the assertions are not about some specific patient's bruxism. When the particular/type distinction is deployed along the lines formalized in BFO, then we can replace 'is a' with '***subtype of***' where it expresses a relation between types, and by '***instance of***' where it expresses a relation between an instance and a type. We can then formulate statements such as: 'John Doe's repetitive jaw-muscle activity of last night ***instance of*** bruxism', and this would allow us to infer from 'bruxism ***subtype of*** behavior' that John Doe's repetitive jaw-muscle activity of last night is an ***instance of*** behavior.

Although in [1-4] this distinction is not explicitly expressed, we are nonetheless confident that the authors are aware of the distinction and indeed that they strive to use expressions at the level of types to make assertions only concerning what must be true for all instances of those types. But then a difficulty arises with the assertion '*Bruxism is a continuously distributed behavior* [4, p802]. It is indeed hard to imagine that '*continuously distributed behavior*' would denote a type in the ontological sense, since it would entail that John Doe's repetitive jaw-muscle activity of last night is an instance of Continuously Distributed Behavior. What could it mean for an individual behavior – thus one single entity – to be continuously distributed? The problem arises because the authors attempt at one and the same to classify particulars into types, and to classify types into supertypes, where the latter are special sorts of constructs references to which are used to assert how the instances of the relevant type are distributed (for example along a continuum). Unfortunately, they thereby, unwittingly, run together forms of speech governed by different logical rules. The resultant problems are familiar in the literature on the so-called 'dimensionalist' approach in psychiatry, where they have led advocates of this approach to argue that there is in fact only one type of mental disorder and that all particular mental disorders – such as John's depression or Mary's dementia – are merely instances of that one single type [6].

What the experts seek to express is that Bruxism instances exhibit features which allow them to be ranked in a way reminiscent of how temperatures or heart rates of different people can be ranked, for example yesterday at 5pm John's body temperature was 37.1°C, Mary's was 37.6°C, Pete's was 38.1°C, and so on. Observing the way in which temperature instances are distributed across sick and healthy people allows us to

set cut-off points for pathologically low, normal and high temperatures. A similar distinction can be made to group bruxism instances into subtypes, as in Figure 1.

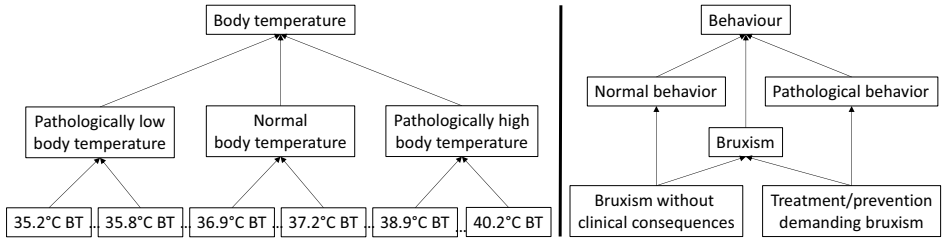

Figure 1. Types instantiated by particulars over which a partial ordering can be defined.

4.2. Ignoring the distinction between continuants and occurrents

Clearly, John's body temperature can instantiate the types Normal and Pathologically Low/High Body Temperature at different times. Are Bruxism particulars such that they, similarly, can instantiate Bruxism Without Clinical Consequences at one time, and Treatment/Prevention Demanding Bruxism at another time? An analogue would be the case of a bent spine: John's spine was fine until at some point in time it started to bend. From that point onwards, the spine became an instance not only of Spine but also of Bent Spine, and thus also of Disorder (in the OGMS sense). Can we, in a similar way, interpret '*that (sleep) bruxism is a* "*behavior*" *in no way precludes the possibility of it being more than a behavior, either a risk factor or disorder*' [4, p802] as an assertion that a particular that is an instance of Behavior at one time can become an instance of Disorder at a later time, while still remaining an instance of Behavior? To see why this will not work, we need to pay attention to the continuant/occurrent distinction. Behavior instances are process occurrents: at every moment that they exist, they exist only partially as they unfold themselves in phases. An instance of Teeth Grinding has temporal parts which are movements of the jaw, now in one, now in another direction. These parts have further parts: smaller movements in a specific direction. All these parts are themselves process occurrents. Occurrents now cannot change because they ***are*** changes [10]. A process which is an instance of some process type cannot become an instance of another process type later on. Only continuants – e.g. material objects such as spines, and also enduring qualities such as temperature or height – can do so, as when an instance of Human Being changes from being an instance of Child to being an instance of Adult, while remaining an instance of Human Being.

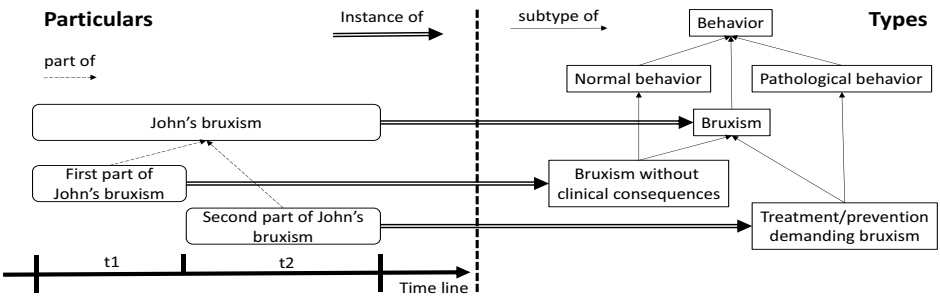

Figure 2: Bruxism with a physiological and pathophysiological phase.

Figure 2 illustrates a better way to understand what is involved when an instance of bruxism changes from being harmless into being such as to require treatment or prevention. It does this by recognizing bruxism as a process composed out of other, smaller processes of different but related types. Of course, whether one would use 'bruxism' to refer only to the whole larger process or also to the smaller *pathological phase* of that larger process, is something that bruxism experts need to agree upon. But this is a terminological choice; it does not impact the ontology as outlined here.

5. Conclusion: getting our teeth into the heart of the bruxism matter

There are two reasons why experts in a given scientific discipline can disagree about what to conclude from observations they all consider accurate: (1) the science in that domain is not yet sufficiently well developed, or (2) the associated terminology is ill-defined or not consistently adhered to, so that what appear to be disagreements are in fact just beliefs about different portions of reality which are erroneously assumed to be the same. Although the bruxism experts themselves contend that (1) is the main source of problems, we believe that the fault lies primarily under (2). The next step is to reformulate *all* the assertions in [1-4] in a BFO-OGMS formalism that allows us to mimic the structure of reality in the bruxism domain along the lines outlined in [7, 8]. This would allow the experts to identify which views they hold within a framework which provides less room for 'semantic misunderstanding'.

Acknowledgement

This work was supported in part by Award NIH 1 UL1 TR001412-01.

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