Prescribed Title number 3: "Labels are a necessity in the organization of knowledge, but they also constrain our understanding" Discuss this statement with reference to two areas of knowledge

Word count: 1600

In biology class we had to learn a lot of terms: every muscle, tissue and bone had a name; a label. Those labels were certainly very useful because they allowed us to talk about very specific things. However, there were several subjective sensations which those labels could hardly account for, or could only do so in a highly complex way that seemed to draw attention away from the phenomena they were describing. For example, when I go out without a jacket my mom usually says that I will get sick because "a cold wind" will get inside me; she has been right several times. This sensation of wind making me feel cold from the inside might be explainable as an experience emerging from many phenomena described accurately by biological vocabulary, but I always felt there was a "loss in translation". Hence, I will briefly analyze -in the context of mathematics and natural sciences- this epistemological duality between the benefits of organizing knowledge using labels, and the constrains, or "losses in translation" which that system brings. Furthermore, I will evaluate the extent and conditions under which this systematic labeling is necessary for the organization and use of knowledge.

The image most of us have of a "label" is the physical item used to name an object, but on a more abstract level it is simply the name given to an item of reality. Just as we (humans) put a label on a T-shirt to know its price, we also put the label "T-shirt" on that specific piece of clothing. If every word is a label for an aspect of reality, then language is a systematic way of labeling knowledge about reality using a specific code that other people can understand.

But labels as means of organizing knowledge go beyond words; in mathematics there exists a complex system of symbols to talk about mathematical properties and logical flow of ideas. For example, the definition of a limit[1]:

$$\lim_{x \to c} f(x) = L \Leftrightarrow \forall \epsilon > 0, \exists \delta > 0 \; s.t. \; 0 < |x - c| < \delta \rightarrow |f(x) - L| < \epsilon$$

[1] "The Precise Definition of a Limit", Libretexts, November 17, 2020, https://math.libretexts.org/Bookshelves/Calculus/Map%3A_University_Calculus_(Hass_et_al)/2%3A_Limits_and_Continuity/2.3%3A_The_Precise_Definition_of_a_Limit

Can be written without "words" *per se*, so let´s expand our definition and say labels are the name given to linguistic items, including -but not limited to- words and symbols, so that language includes mathematical and scientific notation. This definition is certainly very broad and could therefore lead to including items not everyone would agree on including. However, it allows the particular features of the areas of knowledge discussed to be taken into account, thereby making it more "natural" to draw connections to them.

Labels play a crucial role in acquisition and communication of knowledge, to the point to which the first things taught in most school curriculums are the labels for the concepts discussed[2]. Specialized vocabulary is hardwired into every specialized body of knowledge, because it allows people to understand and communicate specific ideas; furthermore, a common vocabulary allows for richer collaboration in the building of shared knowledge. The first page of the topic "waves" in my IB physics[3] book is composed exclusively of definitions (frequency, wavelength, phase difference, etc.). Waves are a very abstract phenomena, with diverse applications, yet the first step to understanding them is to put labels on their specific characteristics. This suggests that language is our reductionist approach to understanding reality by turning it into thoughts and then thoughts into linguistic items (with a label on them), which we can then exchange with other humans. Furthermore, this property of language is especially visible in natural sciences because they also have a reductionist methodology(reduction to smaller parts = more labels needed to name and organize those parts). This use of labels as building block for shared knowledge suggests the main reason scientific knowledge has even been able to transcend a single human mind and shape our modern lives is the existence of a labeling system.

Although this argument is valid, it does not hold true for personal knowledge. There are many examples in which knowledge has been acquired, organized and put to use without this labeling system called language. A recent study on 12 to 19 month old infants revealed that the ability to reason logically is developed far earlier than the ability to speak, suggesting that

[2]Marisa T. Cohen, "The importance of Vocabulary for Science Learning", ERIC, *Institute of Education Sciences,* consulted December 14, 2020, https://eric.ed.gov/?id=EJ993005#:~:text=Science%20is%20a%20discipline%20that,of%20imagery%20makes%20learning%20fun

[3] Tim Kirk, *Physics for the IB diploma (Reino Unido, OXFORD University Press, 2014), page 26.*

knowledge exists *a priori* of language[4]. Some philosophers have even proposed a "language of thought".[5]

So, empirical and peer reviewed -therefore reliable- scientific evidence, shows that knowledge CAN exist and be organized without labels, but it is very limited. Language and thus labels, are, to a very big extent, indeed necessary for the construction of knowledge.

We must now consider whether encapsulating knowledge into discrete linguistic items make it impossible to construct knowledge outside of these items, thus constraining our ability to engage with reality. As Wittgenstein put it:

"The limits of my language mean the limits of my world"[6]

A barrier labels pose to the construction of knowledge and to understanding is the fact that people categorize different pieces of knowledge under the same label, or use different labels to categorize the same piece of knowledge. But does the labeling and organization system affect the knowledge itself? A recent study found that Himba tribe people, whose language does not have different words for green and blue, can´t tell the difference between the two[7]. This implies that labels do affect whatever knowledge they categorize, suggesting our perception of reality -and therefore our understanding-is indeed constrained by language.

However, this ambiguity might only exist when there is no fixed referent for the linguistic items: introspective and subjective experiences, can be elusive to ourselves when we don´t have a label to put on them, but this is a problem for areas of knowledge, like arts, dealing closely with subjectivity, because linguistic items in those cases don´t have a fixed referent above all contexts. But this is not the case of mathematics nor natural sciences.

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[4] Bret Stetka, „Babies Think Logically Before They Can Talk", *Scientific American,* March 15, 2018, https://www.scientificamerican.com/article/babies-think-logically-before-they-can-talk/

[5] "The Language of Thought Hypothesis", *Stanford Encyclopedia of Philosophy*, May 18, 2019, https://plato.stanford.edu/entries/language-thought/

[6] Ludwing Wittgenstein, *Tractatus Logico-Philosophicus* (London: Kegan Paul, Trench, Trubner & CO., 1922), page 74, PDF, https://www.gutenberg.org/files/5740/5740-pdf.pdf

[7] DEBI ROBERSON, JULES DAVIDOFF, IAN R.L. DAVIES & LAURA R. SHAPIRO, "COLOUR CATEGORIES AND CATEGORY ACQUISITION IN HIMBA AND ENGLISH", ResearchGate, *University of Essex, Goldsmiths College, University of Surrey and University of Warwick,* January 2006, DOI: 10.1075/z.pics2.14rob

The referents of all labels used in sciences are tightly bound to physical reality; scientists use language to describe specific things that happen in the tangible world, so there is no room for ambiguity. The rate of reaction in chemistry, will always be the change of concentration of reactants over time, regardless of the language spoken[8]. On the other hand the referents of labels used in mathematics are bound to purely abstract systems, however, these are ruled by formal laws and axioms, so there is also no room for ambiguity. Mathematical definitions make sure to expose the referent of the linguistic items used so that **everyone** knows what is meant by them. No ambiguity = no constrains of understanding.

But this lack of ambiguity is simply not true for natural sciences. Thomas Kuhn[9]´s view of paradigm change, and Popper's[10] falsification principle, suggest that the labeling system, and the pieces of knowledge contained inside the linguistic items **will** change over time. "Aether" changed to "fabric of spacetime" as labels to describe what fills the void of space, and the concepts encapsulated by those labels changed as well[11]. So, language in natural sciences is, over time, subjected to a similar ambiguity as language in more subjective areas of knowledge. Mathematics' method of generating knowledge by rigorous proof excepts them from this barrier, because what is proven remains true and unchangeable within the axiomatic system. Furthermore, labels used to categorize the features of a mathematical system enable the construction of more mathematical knowledge on top of the previous one rather than constraining it.

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[8] "Rate of Reaction", Kognity, accessed February 3rd, 2021, https://app.kognity.com/study/app/chemistry-sl-fe-2016/chemical-kinetics/collision-theory-rates-of-reaction/rates-reaction/

[9] Saul McLeod, "Thomas Kuhn – Science as a Paradigm", Simply Psychology, published 2020, https://www.simplypsychology.org/Kuhn-Paradigm.html

[10] Saul McLeod , " Karl Popper - Theory of Falsification", Simply Psychology, published 2017, https://www.simplypsychology.org/Karl-Popper.html#:~:text=The%20Falsification%20Principle%2C%20proposed%20by,by%20observing%20a%20black%20swan

[11] Matt O'Dowd , "How Luminiferous Aether Led to Relativity", *´Public Broadcasting Services", May 11, 2020,* https://www.youtube.com/watch?v=M3GQM7tuq2w

Nevertheless, the biggest problem that a labeling system poses to understanding could be one which comes back to Wittgnestein´s quote. Labels can lead to systematically leaving outside a body of knowledge things which can´t be explained, either by not giving a name to them at all, or by encapsulating every piece of knowledge which cannot be explained in one, or few linguistic items. At the beginning of the 20th century, many claimed that there was a magical force which fueled life and evolution, an *élan vital*[12], which science could simply not explain. This might have given many biologists an excuse to stop thinking about potential paradigm-changing mechanisms of life, because there was already an "unexplainable by science" label on them. This clearly shows labels constraining the understanding.

Mathematics is not exempt from this limitation. The existence of so rigidly defined systems and labels is a barrier to the creation of knowledge that goes against the status quo. For example, many mathematicians found themselves with a wall when trying to describe non-Euclidian geometry, and it took great mathematicians like Gauss and Riemann, to do so[13]. It seems like mathematics traded the zero ambiguity of labels within an axiomatic system, for the immense work that it takes to expand or work outside the axiomatic system. Thus, the rigorousness in the definition of the labels also constrains mathematical knowledge.

To conclude, we have seen throughout this essay that labels are not a necessity in the organization of personal knowledge, but they **are** in the organization of shared knowledge. No area of knowledge escapes the discrepancy between the stream of knowledge in our minds and the discrete linguistic items imposed by the labeling system, but the characteristics of each area influence the constraints each one experiences. Nevertheless, the paradigm shifts could potentially minimize these constraints in the long run for natural sciences because they provide a way for labels to adapt as knowledge progresses. Likewise, the rigorousness and precision of mathematical labels also implies that the constraints can be minimized through time, because the body of knowledge will just keep growing, expanding the horizons of the

[12] Lacey, A.R., "Bergson, Henry-Louis (1859-1941)", Routledge Encyclopedia of Philosophy, consulted December 14, 2020, https://www.rep.routledge.com/articles/biographical/bergson-henri-louis-1859-1941/v-1/sections/science-and-metaphysics-the-elan-vital

[13] Daniel Marshall & Paul Scott, " A brief history of Non-Euclidean Geometry", ERIC, *Institute of Education Sciences,* consulted December 14, 2020, https://files.eric.ed.gov/fulltext/EJ717835.pdf

unambiguous labeling system. Hence, the key to end the constraints language poses to understanding may lie within language itself.

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