Is Temperature Real?
or is it just moving bodies?

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Temperature is a real *quality* of a body.[1] Nonetheless, temperature has been found to be associated with the motion of atoms and electrons. Indeed, for those that have absorbed the modern scientific (empiriometric[2]) understanding of temperature as presented already in grade school books, temperature is *just* the random motion of the particles that make things up. Though widespread, this belief is false; temperature is *not* reducible to the motion of those parts. Rejecting the reality of the things we directly sense, such as warmness or color, began at early stages of the development of the modern scientific method. For example, Galileo thought all the things we sense: "tastes, odors, colors and so on are no more than mere names…they reside only in the consciousness."

We feel warmness. We feel the warm skin in a hand shake. We see that the warmness is a property of the man; it is one of his qualities (subcategory of power)[3] to have a certain temperature. We first know warmness. It is generic and vague but we know it. We don't later un-know it! However, later, we do ask what that warmness means more specifically. After much investigation, we learn that more specifics of its nature are revealed by a kind of generic motion of the parts. In so doing, we see more specifically the dynamism we have already seen directly through our senses is an effect of the property of "warmness." We see that warmness causes activity, such as boiling water, but only because we have first sensed warmness. Furthermore, we would not have even sought an energy (expressed in terms of speed) probability distribution[4] if we did not know first the quality of temperature that it seeks to further understand.

We must start with what we know directly. We must start with the things we get through the senses. We feel, for example, a warm aluminum bar. *We feel the warmness, not moving parts, let alone atoms moving according to an energy probability distribution*. Our sense of touch reveals to us that the block of aluminum, for example, is warm. We see that the warmness is an accident (property) of the

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[1] To be precise, by body we mean a physical substance. Quality is the second property of physical things. To understand substance and quality, and all the generic principles we get through the senses and their place in our thinking and acting, see A. Rizzi, *A Kid's Introduction to Physics (and Beyond)* Volumes I (2012) and II (2019) (KIPI&II) and *The Science Before Science: A Guide to Thinking in the 21st Century*, Anthony Rizzi (2004) (SBS).

[2] The empiriometric method looks at the "empirical" world through the first property of physical things (quantity), using a system of rules and symbols like equations. See KIP and SBS referenced in footnote 1.

[3] See KIP referenced in footnote 1.

[4] Empiriometrically, temperature, T, is defined as: $1/T = \partial S/\partial E$, where E is energy and S is entropy, the log of the number of possible states with E. Note we are not attempting to give an exhaustive treatment of temperature but just the next level of specification beyond what we get directly through the senses. In this way, we are undoing the false understanding (which arises from a wrong understanding of empiriometric physics) that makes us take "warmth" as being a feature of our minds, rather than a property of the body itself. This, thereby, subjectivizes our sense knowledge, breaking its contact with the physical world. And, since all we know comes through what we know through the senses, it subjectivizes all of our knowledge, including that of modern science.

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aluminum. It is not the aluminum itself but a property arising from the nature of the aluminum and its environment. Again, we apprehend a quality not a motion.

We find that warmness can also be a property of, for example, a copper bar. Thus, in this way we come to learn that "warmness" in various degrees (on a scale from cold to hot) is an analogically generic property of ordinary substances, from man to dirt. We see warmness is a power of a body that can cause my hand or other less warm bodies to get warmer. And, the same degree of warmness can be present in two different types of bodies.

I also see that bodies have parts one next to the other. Much later I learn that there are parts I cannot see called atoms. I later learn that these parts are moving under the action of quantum and electrical fields. In particular, some electrons move pretty freely and the atoms vibrate.

Now, since the warmness acts on other bodies and since locomotion is the first type of change (as things need to move next to each other to interact), we expect that warmness will involve motion of the parts of the body. Thus, we expect the quality of warmness to be responsible for motion of the parts so as to cause motion in other bodies that can, in turn, change in them in various ways, including qualitatively. Hence, we expect sensible powers will include, as part of their nature, analogs to impetus, mass, fields, and charge. The quality of "warmness" or temperature will then be further specified by the quantum and electrical powers revealed by the motion of the parts. Temperature is a real quality, further specified on the side of quantity[5] by the arrangement of the parts and the locomotive powers of the parts. This specification is made evident by the motions of the atoms and electrons and by their action on other bodies.

Now, we also say air is warm. Here, we mean something different than we mean when we say the water or the aluminum is warm. In fact, we mean that the air can warm up my hand (starting with the skin). I cannot feel still air like I feel an aluminum bar. I feel the air warm my hand (when the air is warmer than my hand). And, this is not the same as feeling the warmth of the aluminum bar. In the bar, I feel the bar and am primarily aware of the warmth of the bar and only secondarily aware of my increasing hand temperature. By contrast, in the case of the air, I'm aware of the warming of my hand not the air itself being warm. Again, I don't feel the (still) air. The air is the cause of the warming of my hand and in this sense I say the air is warm. This can be made most evident by noticing that I will say it is hotter in the sunlight than in the shade; but, actually, the air in the shade is in thermodynamic equilibrium with the air in the sun light and, in that empiriometric sense, it is at the same temperature. However, in the sun, the sunlight

[5] Impetus, mass and fields are qualities on the side of quantity because they are related to moving parts (i.e. parts of extension) through an extension. In empiriometric physics we focus on locomotion in this way. This focus can lead us to forget there are other kinds of physical change such as substantial changes and changes of sensible qualities. This, in turn, leads us to forget substances and sensible qualities themselves. Of course, the nature of the substance determines all the qualities. And, the nature of a sensible quality determines the underlying quantity including any internal and external changes natural for the quality to cause. For internal and external changes of quantity, the latter means the sensible quality includes in its nature analogical fields, mass and charge.

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warms my hand in addition to the air, so I say "it is warmer in the sunlight." Again, here I mean that there is a greater warming of my body in the sunlight.

What about when the air is moving relative to my hand? If I move my hand through the air outside on a warm day right after I put down a glass of ice water, I will be aware of the warming effect on my hand. Note that moving my hand doesn't appreciably change the (empiriometric) temperature of the air, but the motion does allow the air to more effectively warm up my hand. This is even more evident when we consider that air being blown by the fan is said to be cool even though it is the same air as before being blown; again it cools your body (starting with your skin) and you feel your body cooling; this is why we say it is cool air. Similarly, if I exit a highly air conditioned restaurant and breath in the outside air deeply, I will be aware of the warming effect on my lungs.

The air is not a single substance, but many substances.[6] It cannot have a property as such, but each molecule that makes it up can. And, we know that it is the motion of the molecules, not their internal vibration, that are most related to the "temperature of the air." Thus, air is not warm in the *first sense* of the word, because it is not a single substance. Neither is it called warm in a related *second* sense because it's composed of substances that are warm, like, for example, we would say a handful of rocks is warm. Instead, we say air is warm analogically, because air has the power to warm. It is composed of many molecules (and vacuum[7]) moving in such a way that they can warm your body. The molecules, due to their nature, which themselves have a certain temperature in their own way, have the power in this configuration to cause heat.[8]

Note, when I move my hand through the air, I do feel the pressure of the air acting on me! I might say the air has a certain fluidity. But, this is only analogical like the first meaning of fluidity, which is a property of liquids like water. This second meaning of fluidity is the same we would apply to sand. It is not properly fluidity because it is not a single substance but merely similar to fluidity in the way the parts of the pile move around with respect to each other. Individual sand grains are hard, but, acting on each other in the way they do, they can move around so that their hardness is not

[6] Explaining this fact is outside the scope of this article, but I hope this article will raise your curiosity about such things. It requires a knowledge of the KIP level physics (cf. footnote 1) as well as some modern chemistry.

[7] A better name for the vacuum is "plana," cf. KIP in footnote 1.

[8] Empiriometrically, we say: "in thermal equilibrium, the temperature of the motions of the molecules of the air is the same as that of their internal motions." However, it is clear that we are not feeling the warmth of the molecules themselves (reflected in their internal motions) because of the following. The level of motion caused in the hand by the air molecules' motion is a lot more than the small level of activity caused by their internal motions. Furthermore, for its proper activity, the sense organ requires activity of its parts to be caused by the thing which it senses. Now, the activity caused in the skin and thereby caused in the sense organ by a given molecule's motion will be a lot greater than that directly caused in the sense organ by its internal motion. Now, this greater activity of the skin will overwhelm the lesser activity of the molecule. This reveals, what we should have already known, that the temperature of a molecule, which we access and define empiriometrically, can only be analogically like that of the temperature of an ordinary body, which we can directly sense. Molecules are too small for us to know about *directly* through our senses. If we say a molecule is warm, it means something different than, for instance, when we say a man is warm. In the above analysis we see, for one thing, the molecule has a much weaker kind of warmth.

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as evident. By analogies the atoms have a certain hardness but being so loosely associated, one senses it only slightly.

The air, being multiple substances, cannot have a property of "pressure." We say the air has pressure because the molecules of the air do, so the air has pressure in the second sense outlined above.

The warmness is a generic property of ordinary substances. Every such body has a range of temperatures that are proper to it; being at a temperature within this range is a proper accident. Aluminum above a certain temperature will evaporate into many pieces; at an even higher temperature, the atoms will lose all their electrons; still higher and they will change to other types of substances. Man's temperature has to be within in a fairly narrow range of 98.6 ^{o}F for him to stay a man, i.e. not die. (The particular temperature a body currently has is a mere accident.) Without their warmth, their temperature,[9] bodies wouldn't interact. Their warmth is inseparable from their activity. This is already evident in the internal motion (of the body's parts) that arises from the body's own quality of warmth.

The internal motion of a body's parts is a sign of,[10] not identical with, its warmth. Temperature is real, a real quality that we directly perceive through our sense of touch. A quality is not a motion.

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[9] Note our body temperature is always present (it is the kind of starting or "neutral" point) so we, for the most part, feel a thing (other than my body) as hotter or colder than our sense organs. So, ultimately, when we say "coldness" we do not mean it has no warmth, just less warmth than our bodies. This is the core of the solution to the following paradox. Put your right index finger in cold water, and your left one in hot water for 1 minute, and then put both fingers in lukewarm water. The right finger will feel the water to be hot, whereas the left finger will feel it to be cold. Both are accurate sensations because the sense organ puts you in contact with the differential temperature. However, it is a disordered state because your fingers are not at body temperature.

[10] Empiriometrically, thus on this same quantitative side, warmth is reflected in the boundary and initial conditions of the relevant differential equations, as well as in the equations themselves.

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