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Perceptual science and the nature of perception

(La ciencia y la naturaleza de la percepción)

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ABSTRACT: Can philosophical theories of perception defer to perceptual science when fixing their ontological commitments regarding the objects of perception? Or in other words, can perceptual science inform us about the nature of perception? Many contemporary mainstream philosophers of perception answer affirmatively. However, in this essay I provide two arguments against this idea. On the one hand, I will argue that perceptual science is *not* committed to certain assumptions, relevant for determining perceptual ontology, which however are generally relied upon by philosophers when interpreting such science. On the other hand, I will show how perceptual science often relies on another assumption, which I call the 'Measuring instrument conception' of sensory systems, which philosophers of perception should clearly reject. Given these two symmetric lines of argument, I will finally suggest that we ought to think differently about the relationship between perceptual science and the philosophy of perception.

KEYWORDS: perceptual science; perception; ontology; content; measurement.

RESUMEN: *¿Puede una teoría filosófica de la percepción dejarle a la ciencia de la percepción la tarea de fijar sus compromisos ontológicos con respecto a los objetos de la percepción? En otras palabras, ¿puede la ciencia de la percepción informarnos sobre la naturaleza de la percepción? En la filosofía de la percepción dominante hoy día, muchos filósofos ofrecen una respuesta afirmativa. Sin embargo, en este ensayo ofrezco dos argumentos en contra de esta idea. Por un lado, argumentaré que la ciencia de la percepción no tiene ciertos presupuestos que, aunque relevantes para determinar la ontología perceptual, son comúnmente utilizados por los filósofos cuando interpretan dicha ciencia. Por otro lado, mostraré que la ciencia de la percepción sí suele presuponer que los sistemas sensoriales son "instrumentos de medición". Este presupuesto claramente debería ser rechazado por los filósofos de la percepción. Dadas estas dos líneas paralelas de argumentación, al final sugiero que debemos pensar distinto sobre la relación entre la ciencia de la percepción y la filosofía de la percepción.*

PALABRAS CLAVE: ciencia de la percepción; percepción; ontología; contenido; medición.

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1. *Introduction*

Philosophical theories of perception aim to answer ontological and epistemological questions about their subject matter. Questions about, for example, what kind of things we perceive, whether we perceive the external world directly or through some mediating entity (e.g. sense data) or process (e.g. mental representation), whether perception can ever justify belief or directly provide knowledge about the world, etc. In answering these kinds of questions, philosophers of perception take themselves to be providing an account of what we may call the 'nature' of perception, that is, what this faculty we call perception most fundamentally is and does.

Additionally, many contemporary philosophers of perception see in perceptual science (whether it is psychology, neuroscience, cognitive science, or others) a very important dialectical interlocutor and source of evidence for or against their theories, in both their ontological and epistemological aspects. It is by looking at how perceptual science conceptualizes and operationalizes perceptual processes, their functions, and their outcomes that, according to these philosophers, we will find out about the nature of perception, just like, intuitively, one would look at how chemistry and physics classify substances and explain their properties in order to find out about the nature of matter. Moreover, perceptual science has so far been mostly successful in providing explanations and issuing predictions about perceptual states and processes, and this alone should convince us that philosophy should defer to science, its concepts, and its methods. For example, Tyler Burge (2005, p. 9) wrote that "there is no reason to doubt that [perceptual science] provides insight not only into the mechanics of perception, but into aspects of its nature".

My main goal in this essay is to argue that the gap between the ontological commitments of perceptual science (if any) and the ontological commitment of a philosophical theory of perception is much larger than contemporary mainstream philosophers think. In particular, while mainstream perceptual science takes up —often deliberately— commitments regarding the nature of sensory systems that are incompatible with what we know about perception as an individual-level faculty, on the other hand it is likely *not* committed to certain important assumptions that, however, shape the contemporary mainstream philosophical account of perception. I will start with the latter.

In §2, I will present a popular paradigm in contemporary perceptual science (deriving from 19th century psychological and physiological orthodoxy), and argue that, while philosophers tend to interpret scientific results within this framework on the basis of two assumptions, we have reasons to think that such assumptions are not meant to be 'mixed up' with the scientific framework in question at all. Then, in §3, I will turn to discussing an assumption which, on the contrary, seems to be indeed at least implicitly endorsed by the scientific framework; I call this assumption the *Measuring instrument conception* of sensory systems. The problem, this time, is reversed: even though science does endorse the assumption in question, this assumption is also one that contrasts sharply with many aspects of the philosophical understanding of perception, accepted even by those same philosophers who want to defer to science. The final result is that perceptual science and philosophy of perception seem to operate in two different logical dimensions due to a mismatch in their key assumptions. Consequently, the relationship between perceptual science and philosophical accounts of perception should be re-considered.

2. *Constructivism, computation, and content*

According to contemporary physiology, all sensory receptor-types share a property called 'Labelled line principle', i.e. the idea that "Sensory systems function by responding only to stimuli they are specific for and subsequently transducing it into a neural message which follows a discrete path to the brain" (Marzvanyan & Alhawaj, 2020). In other words, each different type of sensory receptor cell (e.g. retinal cone cells vs. 'hair cells' in the inner ear) makes it possible to detect certain external features of the world "in virtue of the manner in which it interacts with them physically, as a body with other bodies" (Isaac, 2019, p. 15). And because the human body has only a limited number of sensory receptor-types and a limited number of nerves connecting sensory receptors to brain areas, this view entails that there are only a limited number of genuinely *perceptible* qualities, and that these must be simple enough to enter in direct physical interaction with specific cells in specific sensory organs and to be 'translated' into electric impulses.

The most illustrious ancestor of this idea is, arguably, Johannes Müller's *Doctrine of specific nerve energies* (Müller, 1840), in which he argues that there is a sort of 'causal homogeneity' between a type of external stimulus and the physical features of the sensory system responding to it. For example,

> The eye is structured to focus and respond to light; there is a chain of interactions from light source, through intervening medium, to surface, again through intervening medium, through lens of eye, through medium of the vitreous humor, to receptors at the retina. This chain of interactions is causally homogeneous: each stage involves the same type of causal process, the transmission of light. Likewise, the ear is structured to amplify and respond to vibrations in the air, and there is a chain of interactions from initial vibratory source, reflections off surfaces, through an intervening medium, until the vibrations impinge on the ear drum, and are transferred via the ossicles to receptors in the cochlea. This chain of interactions is also causally homogeneous, each interaction being of the same causal type, yet the causal type involved is not the same as that manifest in the chain of causal interactions which typically passes through the eye. (Isaac, 2019, p. 15)

Müller's 'doctrine' has influenced perceptual scientists going back to the early days of psychology, and in particular to the constructivist school of Wundt and Titchener (Chirimuuta, 2016a; Hatfield, 2015; Titchener, 1899). Early constructivists famously endorsed the so-called *constancy hypothesis*, that is, the claim that the same external sensory stimulus will produce the same internal sensation, independently of spatiotemporal context, state of the perceiver, co-presence of other stimuli, etc. A more modern version of this claim is at the core of what could be considered the contemporary 'heir' of constructivism: namely, the computational framework originally created by David Marr (Marr, 1982). Despite facing recurring objections and criticisms since its very early days, focusing especially on the fact that the constructivist paradigm uses unrealistic and ecologically inadequate stimuli (e.g. Koffka, 1935; Wertheimer, 1938), constrains perceivers' ability to use their whole body during the experiments, and makes large use of abstraction and idealization in their models, constructivism (and the insights it inherited from Müller's doctrine) remains the orthodoxy in perceptual psychology and cognitive science to this day.

One of constructivism's basic assumptions is that perceptual systems, in order to do their job and enable conscious experience of the external world, must 'figure out' the actual distal causes of proximal stimuli and the corresponding sensations. Since many combina-

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tions of external causes may be responsible for the current pattern of proximal stimulation, however, perceptual systems are said to face so-called underdetermination problems. Color vision, for instance, is thought to work in the following way: the visual system seeks to accurately recover colors of external surfaces from what's available at the retina, and in doing so it has to 'figure out' which one of many possible colors compatible with the current retinal image the surface in question has.[1] To use a toy example to illustrate underdetermination, we could say that a white ball illuminated by red light causes the same impression on the retina as a red ball illuminated by white light, and because of this the retinal image alone is ambiguous with respect to whether it is being caused by a white ball in red light or by a red ball in white light.

When philosophers discuss the issue of underdetermination and how perceptual systems deal with it, they often do so by simultaneously endorsing the view according to which the faculty of perception —like many other individual-level mental faculties— is inherently representational, that is, perceptual states always represent external objects and their properties as being one way or another (Schellenberg, 2011). Additionally, this view is committed to the idea that perceptual states can be more or less accurate in representing the world: if, to use our previous example, we seem to experience a red ball in natural white light while, in fact, what's in front of us is a white ball illuminated by red light, our experience is representing the world inaccurately, i.e. as containing a red ball when in fact it does not.

To explain where individual-level perceptual states get their representational features from, usually it is assumed that sensory systems themselves have the goal to *represent* the distal causes of proximal stimuli in a way that's 'descriptively accurate' (or 'veridical'). As a consequence, the idea of sensory systems having to solve underdetermination problems is automatically understood as a matter of recovering or 'reconstructing' the correct external array based on the ambiguous data available to sensory receptors. Once again consistently with the overall picture, this recovery is assumed to take place through 'reverse-inference-like' operations where the proximal stimulus is analyzed into (i.e. represented as the combination of) simpler components which are then recombined to create a 'hypothetical model' of the external array, which may or may not be accurate. According to this description, then, perceptual systems themselves have representational powers, using inference-like procedures to form hypotheses regarding the distal causes of stimuli, and attributing simpler properties to particulars as the very way they process incoming sensory information. This interpretation can be summarized by the following thesis, endorsed by most contemporary representationalist philosophers of perception:

> **Content**: Sensory systems are representational systems: they have the goal of recovering the true array of objects and properties out there, and thus their states have representational *content*, i.e. correctly or incorrectly represent their external causes.

Moreover, because the Content thesis is taken to be among the assumptions of constructivist-computational perceptual science, which models sensory states and processes as (pseu-

[1] The 'subfield' of constructivist-computational psychology which studies visual perception is called Inverse optics (from the idea that vision is a matter of performing inverse inferences to solve underdetermination problems).

do-inferentially obtained) solutions to underdetermination problems, this second assumption is also endorsed and attributed to science itself:

> **Correspondence:** The contents of individual-level perceptual states stand in a relation of correspondence with the contents of the states of sensory systems, and the structure of the latter determines the structure of the former (including fixing its accuracy conditions).

To clarify these theses and their implications, I will use the example of a perceptual capacity that has been extensively studied within the constructivist-computational framework: color constancy. Rescorla (2015, p. 2) understands color constancy as "the capacity to perceive surface colour as constant despite large variation in viewing conditions, including background illumination". The visual system, then, solves retinal underdetermination by performing an inference-like operation in which illumination is first estimated (on the basis of previous experience or 'hard-wired' biases) and then discounted in order to recover the correct surface color. Once the correct surface color is recovered, it is used to 'interpret' subsequent changes in color appearance, thus achieving constancy.

Importantly, on this view the 'objective' surface color, which allegedly is part of the content of an experience of color constancy, is represented by the visual system itself – since it is the visual system, and not the individual, that 'faces' underdetermination problems in the first place; hence, the Content thesis. Moreover, notice that Rescorla *defines* color constancy as the capacity to represent the context- and perceiver-independent surface colors of external objects across changes in illumination, arguably because it is the way constructivist psychology generally models the underlying sensory processes (i.e. as reverse inference-like procedures with the goal of recovering the right distal array despite proximal underdetermination): this move is a direct consequence of assuming the Correspondence thesis.

But does the fact that inverse optics scientists produce computational models of color constancy and its underlying sensory processes as reverse inference-like and as solutions to underdetermination problems automatically commit them to the Content and Correspondence theses as philosophers like Rescorla seem to assume? And relatedly: Are Content and Correspondence in fact backed up by perceptual science, whether or not scientists themselves endorse them? As a matter of fact, both ideas have faced quite some skepticism. Regarding the first question, for instance, Frances Egan (2010, 2018, 2020) argues that computational theories in cognitive science are committed only to the *mathematical* content of the models they use to study various psychological and sensory capacities. In turn, this implies that interpreting constructivist-computational theories accounting for a psychological capacity in intentional/representational terms (as the Content and Correspondence theses do) is not necessary in order to make sense of computational cognitive science's empirical success.

Indeed, Egan argues that domain-specific representational contents should be understood as providing an *intentional gloss* on a computational model of a certain psychological capacity. The computational "theory-proper", i.e. the one scientists are primarily interested in and —according to Egan— take to be all they are committed to, is constituted only by abstract, domain-general, and environment-neutral mathematical structures, in addition to a few environmental facts specifying the conditions in which the designed function can be materially carried out. The intentional gloss, on the other hand, is added to the theory-proper for the purpose of illustrating, "in a perspicuous and concise way, how the computational/mathematical theory addresses the intentionally characterized phenomena with which we began and which it is the job of the theory to explain" (Egan, 2020, p. 253). Different intentional glosses can accompany the same mathematical content when this is used to explain different psychological capacities. The appropriate intentional gloss on a given computational theory of a psychological capacity takes into account pragmatic considerations such as salience and tractability, with the overall goal of making the mathematical structure more intelligible to the scientist *given the particular process or system the scientist is currently interested in modelling*.

Going back to the example of color constancy, Egan's proposal entails that the computational structure underlying inverse optics models of color constancy can be *associated* with a representational content (e.g. a representation of 'objective' surface color) for the purposes of narrowing down possibilities and making the mathematical structure intelligible within the domain to which it is being currently applied. However, this by itself does not justify the claim that the psychological capacity *itself* is representational and 'possesses' that content in any strong metaphysical sense. Indeed, different, non-representational theories of color constancy have been proposed and seem to be equally empirically successful: for instance, the theory called Relational color constancy (Amano *et al.,* 2006; Foster, 2003; Foster & Nascimento, 1994), according to which the visual system, instead of recovering 'objective' surface colors, merely tracks the invariance in color contrast relations among adjacent surfaces under the same lighting conditions. On this relational view, the representation of the 'objective' surface color of a specific surface is taken to be either produced at a later stage of processing or not produced by any sub-personal system at all, resulting instead from explicit reasoning (i.e. a judgment).[2]

The presence of different scientific theories with different mathematical contents and different (potential) ontological implications aiming to explain a single psychological capacity suggests that empirical success itself is not enough to grant ontological truth and that, in turn, the move of interpreting perceptual science through the lenses of Content and Correspondence is not mandatory. If Egan and the scientists claiming Relational color constancy is just as empirically successful as inverse optics models are right, it would be inappropriate to simply assume that perceptual science endorses a thesis like Content. And if Content is not included in the background assumptions of constructivist perceptual science, Correspondence isn't, either: indeed, Correspondence is intelligible (and needed for explanatory purposes) only if we assume Content in the first place. By negating Content, the very need for a thesis like Correspondence simply vanishes.

Of course, one can be attracted to Egan's deflationary proposal only if one is willing to question (and perhaps altogether abandon) the idea that sensory systems 'care' about the same features of the world as us conscious subjects. In the next section, I will provide some reasons in favor of this idea by highlighting a different but equally important aspect of the relationship between perceptual science and the nature of perception as an individual-level faculty. I will start by introducing the 'Measuring instrument conception' of sensory systems, followed by a few examples that show how such a conception is in fact incompatible with a lot of what we know about the content of individual-level perceptual experiences.

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[2] This hypothesis has been defended in the context of size-distance constancy by Carl Granrud and colleagues (Granrud, 2004, 2009, 2012; Granrud & Shmechel, 2006).

3. *The 'Measuring instrument conception' and interactionist perceptual ontology*

The idea of understanding sensory systems as analogous to measuring instruments has accompanied perceptual science since its origins. Wilhelm Wundt, one of the 'founding fathers' of scientific psychology, used the analogy as the foundation of his method. Wundtian perceptual psychology was grounded in the idea that subjects could be trained to notice via introspection and subsequently report simple sensations generated by specific localized stimuli. This paradigm for the study of subjective mental awareness also entailed that the simple sensations isolated by subjects within their 'stream of consciousness' could be not only ordered, categorized, and compared by subjects themselves, for instance with respect to subjectively experienced intensity or qualitative character, but also literally measured with the help of instruments similar to those used to measure physical quantities. This branch of constructivist psychology, called psychophysics, is still popular today, as technological advancements made it possible to build more sophisticated instruments, and a better understanding of physical reality allowed scientists to develop more complex measurement procedures and techniques. The core assumption, however, has remained the same: sensations are something that can be quantified and ordered according to an independently constructed scale of values, which represent the relationships between the sensation and its external physical cause.

For example, Isaac (2014, p. 8) argues that a sensation of heat "stands in the same relationship to temperature as the outcome of a simple thermometric measurement". Even though the 'readings' of the thermometer may differ depending on the conventional system used (e.g. in the Fahrenheit or Celsius systems), what remains fixed is the way in which the values (of the quantities attributed to the measured object) are ordered on a linear scale and against a neutral baseline. Because of this, the relations among values stay fixed and correspond to how our sensory system responds to different temperatures and compares them with each other. Therefore, Isaac claims, "it appears that the relationship between heat as *we experience it* and heat *as it is in the world* is one of structural correspondence." (2014, p. 9; emphasis in the original).

In analogy with temperature, Isaac provides a similar account for color, claiming that "the relationship between color sensations and properties in the world is analogous to the relationship between a measuring space and a measured space" (2014, p. 10). Thus, similarity in color sensation (expressed through judgments, which supposedly track subjective appearance) corresponds to proximity in value on the measurement scale, which in turn provides us with knowledge of what colors fundamentally are: sections of the so-called "color solid", which is a multidimensional representation of objective physical properties assumed to correlate with perceived color (e.g. hue, saturation, and brightness).

In short, psychophysics, and consequently constructivist psychology (recall that constructivist psychology has historically endorsed Müller's doctrine of specific nerve energies and its psychological analog, the 'constancy hypothesis'), derives its *raison d'être* from the conception of sensory systems as 'magnitude detection' devices which can play the role of measuring instruments once the detected magnitudes are associated with and ordered according to an independent but structurally identical scale. We can see an example of the measuring instrument analogy at work in computational psychology's treatment of the cochlea (i.e. a soft tissue and bone structure in the inner ear fundamental for hearing sounds) as a 'Fourier analyzer', i.e. as an instrument capable of breaking down an auditory

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stimulus into simpler wave-like components standing in precise, mathematically specifiable relations with each other. If the ear works as a Fourier analyzer, the separate sinusoids resulting from the analysis must then be re-assembled into different groups, supposedly corresponding to the different perceived sounds.

But if this were the entire story about auditory perception, it would remain "rather mysterious how the ear, on the one hand, can separate the sinusoids originating from different sources, yet on the other, works to blend into a single percept the harmonics of the same tone" (Plomp, 2002, p. 18): what exactly 'tells' the system which harmonics go together and which ones don't? How does the system parse the global acoustic stimulus in the right way so that we can perceive discrete sounds coming from different sources instead of a disorganized bundle of sinusoids? As Paolo Palmieri (2012, p. 532) notices, "the idea that auditory perception relies on frequency detection has not been updated". On the other hand, however, it is widely accepted in hearing science that the auditory experiences that we have at the individual level stand in very complex and unsystematic relationships with the direct outputs of 'ear mechanics', including cochlear physics and physiology.

Probably the most striking example of the observable asymmetry between the output of mechanical workings of the inner ear and auditory qualities experienced at the individual level is constituted by *timbre*. Timbre is the perceptible quality that allows us to distinguish, for instance, two different musical instruments playing the same note at the same loudness. This quality seems to depend on an indefinite number of global features of the auditory scene (sometimes called the 'soundscape'), plus the perceiver (Roden, 2010; Siedenburg & McAdams, 2017). Indeed, factors like the physiological features of the perceiver's auditory system but also aspects like musical training, cultural background, attention level, listening strategies and more have been shown to affect timbre perception in various unsystematic ways (Lavengood, 2017; McAdams, 2013; McAdams *et al.,* 1995). At the same time, however, hearing science hasn't given up on finding a plausible enough physical correlate of timbre (Isaac, 2018), even while acknowledging that finding a single repeatable one is basically impossible.

Palmieri uses the latter idea to claim that hearing science as it is currently performed is inadequate and should be updated to reflect the 'active' and 'creative' nature of cochlear functioning:

> the active sense of hearing will merge the natural modes of vibrations of the organ of Corti[3] with an active control of the overall cochlear motions. The sense of hearing is at the same time both being shaped by the external acoustic stimulus and itself actively shaping the stimulus once it has entered the ear canal. It is the concurrent occurring of the activity of shaping and the passivity of being shaped that allows the experience of sound to emerge in consciousness. (Palmieri, 2012, p. 540)

However, a larger number of hearing scientists (and philosophers of auditory perception) tend to appeal to what we might see as a 'divide and conquer'-type of principle: science can do its job under the assumptions and idealizations that allow it to construct empirically tractable and intelligible models of psychological capacities, which might have practical ap-

[3] The 'organ of Corti' —named after its discoverer, the 19th century Italian anatomist Alfonso Giacomo Gaspare Corti— is a structure internal to the cochlea responsible for producing nerve impulses in response to incoming sound vibrations.

plications precisely in virtue of such assumptions and their idealized nature (for example, in the context of the construction of sensory substitution devices or other sensory prosthetic technology like cochlear implants). On the other hand, we can recognize the role of a more philosophical branch of psychology in explaining individual-level perception as an essentially interactive, multisensory, holistic, embodied, and engaged activity, the 'products' of which (i.e. perceptible qualities) are thus just as interactive, multisensory, and holistic.

Another example of the measuring instrument conception at work in empirical accounts of perceptible qualities which however falls short of explaining how such qualities are experienced at the individual level is constituted by the visual quality of *gloss* (Chadwick & Kentridge, 2015; Fleming, 2014; Leloup *et al.,* 2014). After a long history of attempting to explain gloss perception by detecting and measuring the 'glossiness' of material surfaces (Hunter, 1937; Ingersoll, 1921; Pfund, 1930), psychologists now tend to consider perceived gloss as a much more fluid phenomenon with no fixed physical correlate. It is now commonly accepted that gloss perception is influenced in a variety of (not entirely systematic) ways by the context in which the glossy object is presented, as well as by other visual properties of the object itself, such as shape, color, texture, motion, and by the ways in which the visual system combines and interprets the different cues from time to time (Chadwick & Kentridge, 2015; Hartung & Kersten, 2002; Ho *et al.,* 2008; Marlow *et al.,* 2012; Olkkonen & Brainard, 2011; Wendt *et al.,* 2010).

The fact that gloss perception stands in complex and often unpredictable relationships of mutual influence (Harrison & Poulter, 1951; Olkkonen & Brainard, 2011) with other visual properties prompted theorists to recognize the perceiver- and context-dependence —in one word, the *interactive* nature of this quality— and to understand it more as a *gestalt*.[4] On the 'gestalt-view' of gloss, empirical models relying on the measuring instrument conception for practical purposes (such as the industrial production of 'glossy' materials and paints) can still be acknowledged as important and not necessarily deemed outdated or 'wrong' while at the same time recognizing that there is no measurable scale of glossiness for single surfaces, as experienced gloss depends on many more factors than the localized physical properties of such surfaces.[5]

Along these same lines, Mazviita Chirimuuta (2015) proposes an 'adverbialist' account of color perception which explicitly rejects the measuring instrument conception of the visual system and the detection model of sensory processing.[6] The main motivation un-

[4] I don't mean to use the term in the same way as it was used in classic Gestalt psychology. In this context, by gestalt I simply mean a multi-dimensional perceptual unit shaped by how multiple cues located in the whole scene are combined by the visual system.

[5] I should add that nothing prevents one from taking a different position regarding this issue. In particular, one might think that the fact that properties like glossiness do not seem to correlate exactly with any physical property of surfaces depends on perceptual processing being "noisy" and perhaps always "imprecise" or "inaccurate" to an extent. In response, I will say this. While it is certainly possible to tell a story about the evolutionary "payoff" of systematic inaccuracy, it seems more reasonable to me to think that perceptual systems are tracking something we might not even currently have a concept or a name for, but which in certain explanatory contexts can be approximated to a "close enough" familiar concept. I am more inclined to see the lack of perfect physical correlates for perceptible properties as a feature of sensory systems, rather than a bug. I thank an anonymous reviewer for inviting me to clarify this point.

[6] See also (Buccella, 2017).

derlying Chirimuuta's proposal is what she calls "perceptual pragmatism", that is, the view that guiding behavior is the most fundamental function of perception and that, as a consequence, perception should be explained at the level at which it guides the behavior of the perceiver, which is, of course, the individual level. Chirimuuta argues that perceptual scientists, and especially those working on color, are generally friendly to perceptual pragmatism, independently of whether their practices and methodologies are, as they see the pragmatist framework as beyond the scope of what they take themselves to investigate and explain. She also argues that the action-guiding function of color vision (and visual perception more generally) can be successfully fulfilled only if color vision itself, as a psychological capacity possessed by individual perceivers, is understood not as a detection capacity, but as an interactive one.

Consequently, for a perceptual pragmatist, colors are relational properties of the perceiver-environment interactions which constitute color vision. On this view, color is not a perceiver-independent physical property of surfaces, and the visual system does not detect structures or measure external magnitudes. In sum, Chirimuuta's arguments lead to the following conclusion: if perceptual pragmatism is plausible, then the conception of sensory systems as measuring instruments should be understood as an empirical hypothesis at the service of specific practical purposes, thus leaving it out of philosophical accounts and explanations of individual-level perceptual experience.

Joining a quite long, albeit minoritarian, tradition in philosophy of perception (e.g. Kalderon, 2017; Merleau-Ponty, 2013; Noë, 2004), Chirimuuta's interactionist account of color perception emphasizes the similarities between vision and touch, which questions even more whether the measuring instrument conception 'belongs' in an explanation of individual-level perception (Chirimuuta, 2016b). Indeed, the sense of touch works through dynamic interaction between the perceiver and the object touched: we reach, grasp, rub, poke, squeeze, etc., and most of the time we do this deliberately, as intentional actions performed by us individuals rather than by our sensory subsystems. Indeed, in touch we see a fusion between the 'level' of information registration by sensory receptors and individual-level experience of our entire body as engaged in exploration of the world. Chirimuuta stresses this same point when she says: "The hand is both the primary sense organ for touch and our most basic means for affecting changes in the world" (Chirimuuta, 2016b, p. 754). This is the essence of perceptual pragmatism, echoed by Palmieri when, in discussing auditory perception, he says that "in a pragmatist perspective, the knowing that goes on in experiencing the world is an active engagement with the world that presupposes both the willingness to manipulate external objects and the willingness to suffer the consequences of the engagement" (Palmieri, 2012, pp. 540-541).

Where does this leave the measuring instrument conception and perceptual science, then? My suggestion is the following. On the one hand, it is possible, and probably appropriate, to acknowledge the importance of the measuring instrument conception (and the detection model) with respect to certain explanatory tasks accomplished by perceptual science and, consequently, to attribute an at least implicit commitment to this conception to empirical theories of perception of the constructivist-computational variety.[7] On the

[7] I am aware that traditions like, for example, radical enactivism or embodied cognitive science (Chemero, 2009; Hutto & Myin, 2013) would probably make a stronger claim here, stating that

other hand, however, the fact that perceptual science is committed to the measuring instrument conception does not constitute evidence that such a conception should be endorsed when explaining individual-level perception and giving an ontological theory of perceptible qualities.

4. *Conclusion*

In this paper, I started by recognizing a tendency in contemporary mainstream philosophy of perception to 'defer' to perceptual science when theorizing about the nature of the individual-level faculty of perception. In other words, it is now common practice to refer to perceptual science's categories, methods, and theories to conceptualize, describe, and explain perceptual experiences and their contents. This tendency manifests itself most clearly when philosophers of perception interpret findings and theoretical models of perceptual science in light of the Content and Correspondence assumptions, thus implicitly attributing such assumptions to scientists themselves. I have criticized this last practice and suggested, based on Egan's proposal, that we refrain from taking Content and Correspondence to be innocent and straightforward background assumptions of perceptual science itself, rather than assumptions made by philosophers, who have different explanatory agendas and different ontological commitments, when discussing it.

Finally, in section 3 I took up an issue going in the opposite direction: this time, I suggested that perceptual science generally does work under an assumption which I called the Measuring instrument conception of sensory systems (accompanied by the detection model of perceptual processing). Conceiving of sensory systems this way seems necessary for the very notions of underdetermination and inverse inference —which are at the core of the constructivist-computational approach— to be intelligible in this context: they all form a unified network of metaphors which guide theories' inevitable abstractions and idealizations. However, I also pointed out that such an assumption is (and should be) generally rejected by philosophers, at least implicitly. Indeed, the Measuring instrument conception of sensory systems is incompatible with a lot of qualities we clearly perceive at the individual level (relevant examples are timbre and gloss), and in general with what we know about the active and 'creative' role that sensory systems play in shaping conscious perceptual experience (as per perceptual pragmatism). The perceptible qualities we experience are much more multidimensional and unsystematically generated than what the measuring instrument conception of sensory systems can support. The range of perceptible qualities included in our perceptual ontology exceeds the number of physical features sensory systems can respond to/detect through their receptors.

Therefore, I suggested that we understand perceptual ontology as an interactionist ontology. In an interactionist framework, sensory systems can still be treated as measuring in-

the computational-constructivist approach should be completely abandoned as it is committed to an overly simplistic picture of perceptual processing (I thank an anonymous reviewer for raising this concern). However, I am convinced that the computational-constructivist framework ought to stick around, at least for the moment. Indeed, in the absence of a fully developed alternative, it provides scientists with more 'tractable' and practically applicable models of cognitive capacities useful, for instance, in the field of artificial intelligence.

struments from time to time and in specific circumstances, without the measuring instrument conception directly affecting the ontology of individual-level perception. Once again, perceptual science and philosophers' understanding of perceptual science (as relied upon in their philosophical explanations) seem to show a mismatch in their key assumptions. On the one hand, philosophers but not scientists endorse Content and Correspondence. On the other hand, scientists but not philosophers endorse the Measuring instrument conception of sensory systems. This asymmetry in foundational assumptions invites us to reconsider what it means to do 'empirically friendly' or 'naturalistic' philosophy of perception. Deferring to or trusting the science to tell us what human perception is might not be the best strategy after all.

I am aware that all the points I made are not conclusive, and I am also open to the possibility that some of the worries I raised will be eliminated through terminological and logical clarifications on both the philosophy and the psychology sides. Hoping for this to be just a first step towards disentangling the commitments and dialectical strategies of these two disciplines, I put forward my overall provisional conclusion: it is not the 'job' of perceptual science (especially of the constructivist kind) to shape our views on the nature of perception. Science can, instead, give philosophers access to limited aspects of/perspectives on perceptual capacities. If we acknowledge this, then the mismatch in key assumptions I diagnosed can become a source of better understanding rather than an impediment thereof.

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