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Visual Perception and the Origin of Objectivity

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Abstract

In this paper, I discuss a specific claim by Tyler Burge that perception delineates the lower border of representational mind and exhibits the most basic form of objectivity (2010). According to this claim, perception is the most primitive type of representation that, when veridical, accurately attributes properties to the mind-independent physical world. I will call this view the Primitive Thesis. My goal in this paper is to argue against the Primitive Thesis *in the case of visual perception*. I argue that visual perception is not the most primitive type of objective representation. This

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will not refute the Thesis completely, but it would undermine the most prominent case for the Thesis. My approach will be interdisciplinary. I show that the current best empirical accounts strongly suggest that how perceivers represent their bodily conditions plays a key role in the biological functions of perception. Then I argue that the lower border of objective representation is not given by visual perception, but by *body representation*. Visual perception is not the origin of objectivity. Based on this investigation, I will conclude with some remarks on perception in general.

Keywords: Visual Perception, Biological Function, Body Representation, Objectivity

Visual Perception and the Origin of Objectivity

In this paper, I investigate a specific claim by Tyler Burge that perception delineates the lower border of representational mind and exhibits the most basic form of objectivity (2010: 10, 12).[1] According to this claim, perception is the most primitive type of representation that, when veridical, accurately attributes properties to non-perspectival, mind-independent subject-matters (3, 46-47). I will call this view the Primitive Thesis. On the one hand, Burge advocates that perception does not require that the individual have any capacity to represent some preconditions for mental representation to be objective. In relation to this, he forcefully criticizes various versions of Individual Representationalism, all of which, according to him, over-intellectualize the constitutive requirements of perception (12-23, Part II). On the other hand, he argues that perception and representation are distinctive psychological kinds (10, 318, 327). Perceptual representation cannot be deflated or reduced to mere sensory registration (292-308). Perception, he suggests, "is situated just above the lower border of that 'cut'" (xii), and "no other empirical representation is more basic" (23). To substantiate this claim, Burge proposes a theory of perception that draws heavily on empirical research, especially vision science. This theory underpins his claim that

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[1] Unless indicated otherwise, all the page numbers in this paper refer to Burge (2010) *Origins of Objectivity*.

"Perception, representation, and objectivity begin together" (11).

While I agree with Burge's refutation of over-intellectualization and his representation-registration distinction, it is my contention that visual perception of the external world is *not* the most primitive type of objective representation. One thing needs to be clarified immediately. Although the Primitive Thesis is about perception in general, the central case that Burge makes for this view is about visual perception. Burge (2010) mentions other sensory modalities as well, but he takes vision as the paradigm case of perception.[2] When Burge argues for the claim that perception of the external world is the most primitive form of objective representation, he focuses on visual perception. Not only does he apply this claim to vision; more importantly, the strengths of his arguments significantly rely on empirical studies of vision science.[3] So my critical examination will center on vision. My goal in this paper is to argue against the Primitive Thesis *in the case of visual perception*. If I succeed,

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[2] Burge: "Since vision is the best understood type of perception, I center on it in what follows" (89). He argues that his theory of perceptual anti-individualism is presupposed by vision science (98-101). Also, when he discusses perceptual constancy as a criterion for objective representation, the main examples that he articulates in depth are all about vision (347-366).

[3] Readers of *Origins of Objectivity* can easily find that, among other things, the most prominent empirical resources that Burge uses are from vision science. He says that "The account of perception in Part III … is the heart of the book. I draw not only on philosophy but on perceptual psychology (*mainly vision science*)" (xiii, my emphasis). Also, when Burge argues that perception is the origin of some basic representational categories, visual perception plays an essential role in his discussion. For example, regarding object tracking, he says that "Visual perceptual systems track whole bodies that maintain integrity of their boundaries" (461, cf. also 446-448, 460-463). Regarding spatial representation, he says that "Spatial representation is probably the most impressive and widespread type of primitive perceptual representation. It occurs in *visual* systems throughout the animal kingdom" (496, my emphasis; cf. also 502, 507).

it would not refute the Thesis completely. But it would undermine the central case for the Thesis.

My approach will be interdisciplinary. After presenting Burge's theory of perception, I show that the current best empirical accounts strongly suggest that how perceivers represent their bodily conditions plays a key role in the biological functions of perception. Then I argue that the lower border of objective representation is not given by visual perception, but by body representation.[4] Objective representation does not begin with visual perception. Based on this investigation, I will comment on perception in general in the final section.

I. Perceptual Anti-individualism

Burge's theory consists of two parts. The first is a set of theses describing the constitutive nature of perception. he second part depicts an overview of vision science, which is meant to show how the science presupposes this theory. The constitutive theses are the following.

(1) The nature and individuation of perceptual states constitutively depend on relations, including causal relations, between perceivers and

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[4] The notion of body representation in this paper refers to representation of animal's biological body. This should not be confused with Burge's usage in chapter 10 of *Origins of Objectivity*. When Burge speaks of "body representation" and "perception of body", what he means is representation of physical object in the environment. He says that "I understand bodies to be relatively compact material entities" (437), and speaks of "object" and "body" interchangeably as object of vision and touch when he comments on Spelke's work (438-449).

the environment. This is the basic statement of Burge’s perceptual anti-individualism, and he considers it as a “necessary truth” (85, 87). (2) Perceptual representation has veridicality conditions. Having veridicality conditions is part of “what it is to *be* a perceptual state” (535). (3) The representational function of perceptual states and perceptual systems is to produce veridical representation (309). (4) The representational content of perception has two elements. The *singular* element refers to particular objects, and the *general* element attributes properties to them (83, 380). (5) “Perception is a capacity constitutively attributable to individuals” (369, 373, 536). It is individuals who perceive, not subsystems in the brain. The last thesis leads to the view that, in addition to the representational function, perception also has biological functions. The biological functions of perception contribute to fitness or benefit survival and reproduction (301, 303). Burge emphasizes that the representational and biological functions of perception are dissociable (302, 308, 411). A perception can be non-veridical but biologically useful. As he says: “Evolution does not care about veridicality. It does not select for veridicality *per se*”(303). Hence the representational function cannot be reduced to biological functions.

The second part of the theory includes an overview that depicts three key aspects of vision science. The first is *the underdetermination problem* of vision. Various patterns of light, reflected from external 3D objects, strike the photoreceptors on the retina and form 2D images of objects. These patterns of light are converted into neural impulses, which travel through the lateral geniculate nucleus and enter into the visual cortex. The key is that, from 3D objects to 2D images, depth information about objects is forever lost. This creates a problem for the visual system. Different objects from different distances and orientations can project exactly the same 2D image on the retina. Theoretically, for any 2D retinal image there can be infinitely many possible distal causes. How does the visual system "figure out" which external object is the right one? This is called the "inverse problem", and Burge correctly characterizes it as a problem of underdetermination (90).[5]

What is the solution to this "primary problem for the psychology of visual perception" (89)? According to Burge, the mainstream of vision science suggests the following account: the ways in which visual information is processed in the brain can be characterized as constrained or guided by what he calls *formation principles*.[6] These principles "privilege" or "bias" the neural process such that the underdetermined retinal inputs trigger a unique perception that (often but not always) represents the actual external object. The content of a perception is then determined by the operations of the formation principles embedded in the visual processing. This, of course, is not the whole story. The formation principles themselves require explanations. It is here that perceptual anti-individualism plays an essential role. These principles do not simply

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[5] Retinal information, Burge says, "significantly *underdetermine[s]* the distal causes of those registrations, hence the objects and properties that are represented in perception, hence representational content as of those objects and properties … The initial sensory registration of proximal stimulation in itself also underdetermines what perceptual representations the perceptual system will form" (90).

[6] Burge: "The dominant scheme in the psychology of vision … is to explain a series of unconscious, largely automatic transformational processes that lead from registration of the array and spectral properties of light striking the retina to the formation of perceptions as of specific aspects of the distal environment … The transformations operate under certain principles that describe psychological laws or law-like patterns. These laws or law-like processes serve to *privilege* certain among the possible environmental causes over others … I call psychological principles that describe, in an explanatory way, these laws or law-like patterns *formation principles*" (92).

come from nowhere. Burge holds that they can be explained "only by reference to the way in which patterns in the perceptual system's natural environment have molded the nature of the perceptual system and its perceptual states"(100).[7] That is, they stem from perceivers'long-term interactions with the world, and hence reflect regularities in the environment. According to Burge, this account of the underdetermination problem shows that the mainstream of vision science decisively supports his perceptual anti-individualism (98-101).

The second aspect is a research tenet in the practice of vision science that Burge calls *the proximality principle* (2005: 22). According to this principle, the causal process of perceptions depends exclusively on proximal stimulation and visual processing in the brain.[8] Since the visual system does not have infinite capacities to process innumerable distal objects, it responds to similar objects or situations with similar patterns of processing. It is quite possible that the proximality principle captures how the visual system in the brain actually works.

The third aspect is *perceptual constancy*. According to Burge, the

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[7] Burge: "In every case, formation principles … mirror basic facts in the broader physical environment. These are facts regarding spatial relations, natural forms of motion, the way light patterns tend to correlate with shadows and edges, the way surfaces tend to have unseen backsides, and so on. They mirror either environmental laws or deep environmental regularities that hold for the most part … So the natures of specific perceptual states are constitutively associated, via causal relations, with specific attributes, laws, and patterns in the environment" (98-99).

[8] Burge: "The formation of perceptual states depends causally, in any given instance, on registration of proximal stimulation. The same attributional kind of perceptual state, with the same attributional representational content, can be caused by the same type of registration of proximal stimulation, whether or not the perceptual state has perceptual *representata*—whether or not it is a perception *of* anything at all" (389).

notion of objectivity in vision science is explained by the distinction between registration of sensory information and perceptual representation. For example, when I move towards a car, the visual information registered on my retina changes in a systematic way, and the 2D images gradually occupy a larger area in my visual field. However, the size of the car does not appear to change; it does not look to me as if it is getting bigger. This is size constancy. When I look at the Eiffel Tower and walk around it, the proximal visual stimulations registered on my retina change systematically with respect to my pace, direction, and eye orientation. Yet the position of the Eiffel Tower does not seem to alter at all; it appears to me as being located in the same place. This is position constancy. Burge' s point is that objectivity is embedded in perceptual constancy studied by vision science. Perceptual constancy provides a substantial reason to say that what perception represents is a non-perspectival objective reality. For Burge, perceptual constancy is both necessary and sufficient for objective perceptual representation (413). It is a set of capacities shared by many animals. Perceptual constancy draws the line between mere sensory information and perception, and it is this line that marks the beginning of perception, representation, and objectivity (396, 401, 409).[9]

[9] This section is adapted from my another paper, "Perceptual Anti-Individualism and Vision Science". As we can see in this section, there are several issues involved in Burge's theory that deserve thorough investigations. For example, Burge has specific and controversial accounts regarding the notion of veridicality, perceptual norms and the singular element of visual representation. I address these issues in that paper.

II. Biological Functions of Perception and Body Representation

Burge (2010) discusses in great detail the relations between the representational functions and biological functions of perception. His main concern is to argue that the former cannot be reduced to the latter. However, little is said concerning *how* the biological functions of perception actually work. As we will see, the current best empirical accounts converge on the following view: In order to realize the biological functions of perception, animals must not only represent the environment, but also represent their own bodily conditions. Moreover, the biological functions require that perceptual representation of the world must be integrated with body representation.[10] Let me summarize some scientific studies, and then draw out their implications.

Animals engage in various types of actions, such as eating, mating, navigating, predating, etc., for the purpose of survival. From the physiological perspective, survival means animals maintaining their homeostasis within a stable range. Homeostasis, as researchers characterize it, is "a dynamic and ongoing process comprising many integrated mechanisms that maintain an optimal balance in the physiological condition of the body, for the purpose of survival. In

[10] Burge acknowledges that body representation is important when he addresses touch (414). We will see that the empirical considerations in this and the next sections, especially on the neural mechanisms of body-part and whole-body representations, not only add new material to the discussion, but also help articulate the relationship between perception and body representation.

mammals, these include autonomic, neuroendocrine and behavioral mechanisms" (Craig 2003). In this regard, for animals the ecological environment is essentially characterized by its homeostatic values.

Damasio (1999, 2010) and Panksepp (1998, 2005) propose that the functions of homeostatic values are causally mediated by animals' neural systems, and they are coded as *emotions* in the brain. They also suggest that humans and other mammals have particular neural systems that they call *proto-self* and *core-self*, which regulate homeostasis by integrating internal information from the body with external information from perception. According to Damasio, the most primitive form of feelings is tied to how animals register and respond to homeostatic values of the environment.[11] They are generated by the proto-self system, defined as "a dynamic collection of integrated neural processes, centered on the representation of the living body" (2010: 9). These integrated processes represent "moment by moment, the most stable aspects of the organism's physical structure" on the one hand, and "the externally directed sensory portals" on the other (2010: 190). By interacting with the environment, the core-self system is activated, which enhances attention and gives rise to a minimal form of self-consciousness (2010: 203).

Both the proto-self and the core-self systems involve areas in the brain stem, including the nucleus tractus solitarius, the parabrachial

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[11] Damasio says: "For whole organisms … the primitive of value is the physiological state of living issue within a survivable, homeostatic range … Optimal workings of an organism, which result in efficient, harmonious states of life, constitute the very substrate of our primordial feelings of well-being and pleasure. On the contrary, disorganized, inefficient, inharmonious life states, the harbingers of disease and system failure, constitute the substrate of negative feelings" (2010: 49, 56).

nucleus, the periaqueductal gray, the hypothalamus, and the superior colliculus (Damasio 2010: 98-99, 191-192; 1999: 180-183). Why these brain regions? According to Damasio, it is because they receive input from many other areas associated with the processing of information about external objects and internal body conditions. These brain regions integrate multiple types of information and provide representations of the whole body (2010: 68, 94-97, 244-245). This suggests that the biological functions of perception are mediated by a particular sort of information integration in the brain that involves both perception and body representation.

Panksepp also suggests that animals' interactions with the environment are essentially characterized by affective feelings, which are internally generated by neural mechanisms to respond to life-challenging events. The underlying neural systems of emotions compute and monitor homeostasis by evaluating an organism's adaptation to the environment (1998: 48). Panksepp posits seven basic innate emotional systems in mammals: SEEKING, RAGE, FEAR, LUST, CARE, PANIC, and PLAY. Each refers to a specific neural network in the brain, mainly in the sub-cortical areas.[12] He also proposes an account of the proto-self and core-self systems that monitor and regulate homeostasis. Both of these neural systems are constituted by what he calls "affective self-related

[12] For example, Panksepp says, the SEEKING system "promotes a certain class of survival abilities. This system makes animals intensely interested in exploring their world and leads them to become excited when they are about to get what they desire. It eventually allows animals to find and eagerly anticipate the things they need for survival" (1998: 52). The main neurochemical in this system is dopamine, and the critical brain areas are in the extended lateral hypothalamic corridor. This system responds to homeostatic imbalances and environmental incentives (1998: 54, 145).

processing", which describes the integration of interoceptive and exteroceptive stimuli from the body and the environment.

Panksepp and Northoff (2009) suggest that the main neural mechanisms that underlie the affective self-related processing is a subcortical-cortical midline system (2009: 197). Some of the crucial brain areas in this system include the superior colliculi and the periaqueductal gray in the sub-cortical region. Like Damasio, Panksepp and Northoff believe they play important roles with regard to homeostasis because they are crucial areas where exteroceptive sensory information and interoceptive bodily information are integrated in the brain (2009: 201). Due to anatomical convergence and neurophysiological synchronizations within the subcortical-cortical midline system, "an archaic scheme of the entire body may be constituted in brain regions as low as the medial brainstem" (2009: 202). Again, this view suggests that perceptual representation requires integration with body representation in order to fulfill its biological functions.[13]

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[13] Other empirical studies also support this view. Craig's research on the insular cortex suggests that it contains "a sensory representation of the small-diameter afferent activity that relates to the physiological condition of the entire body" (2002: 660). This cortex, especially the anterior part, is also associated with the processing of various sorts of perceptual and cognitive information (2009: 65). Feinberg (2011) proposes three dissociable hierarchical systems in the brain, located anatomically from the central/medial to the peripheral parts of the brain. The innermost structure is what he calls "the interoself system", which "contributes to the organism's relationship to the internal milieu, and serves homeostatic and self preservative functions" (2011: 7). The outermost structure is "the exterosensorimotor system," which includes sensory and motor neural pathways that "respond to stimuli from the environment" (2011: 9). Between these two systems is "the integrative self system" which "serves to assimilate the interoself systems with the extero systems, and mediate the organism's internal needs with the external environment" (2011: 9-10).

All of these studies point in the same direction. That is, homeostasis requires body representation, and the biological functions of perceptual representation are realized by integrating with body representation. This challenges Burge's view that perception, especially vision, delineates the lower border of representational mind and objectivity. Body representation is in fact a more primitive type of objective representation than visual perception. As Burge suggests, animal action is phylogenetically and constitutively prior to perception (326). Many types of animal action are "pre-intentional, even pre-representational and pre-perceptual. Origins of agency precede those of perception and representation" (327).[14] However—here is the crucial point—many animal actions, as closely associated with homeostasis, involve *body representations* even when they are *not* incorporated with visual perception. On the one hand, eating, mating, navigating, predating, etc., often require animals to change their body positions. They need to move their body parts (head, mouth and legs, etc.) or the whole body in certain ways. Scientists agree that to perform these actions animals rely on various body representations, such as representations of head direction, limb and joint positions, the orientation and displacement of the whole body with respect to the environment, etc. (Lackner and Dizio, 2005). But on the other hand, many actions for survival, while depending on body representations, can be performed without vision (Etienne and

14 Burge: "Primitive agency forms a background for understanding both representation and representation-as in perceptual systems—hence for understanding perceptual kinds. Primitive organismic agency is phylogenetically prior to perception. It occurs in animals that demonstrably lack perception" (327).

Jeffery, 2004; Dizio and Lackner, 2000). For example, Etienne and Jeffery suggest that "During active walking without vision, the assessment of path length depends less on inertial information than on nonvestibular motion cues, such as proprioceptive feed back and efference copies" (2004: 184). Also, according to Dizio and Lackner, their experiments show that "motor adaptation to Coriolis perturbations can be achieved on the basis of proprioceptive, somatosensory, and motor information in the complete absence of visual experience" (2000: 2175). As Burges himself says, "Much exogeneously stimulated animal action derives not from perception but from sensory registration of information" (337).[15] These considerations strongly suggest that body representation is a more primitive type of objective representation than visual perception. The bottom line of representational mind should be drawn even lower than where Burge has suggested.

A defender of Burge's view might object that many neuroscientists employ what he calls the deflationary notion of representation (292). This notion seeks to understand representation solely on the basis of "sensitivity or discrimination, or co-variation, or causal co-variation, or structurally isomorphic causal co-variation, or information-carrying—together with the notion of biological function"

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[15] Burge discusses navigation by homing and path integration (423-426, 499-502), and says: "The sensory aspect of the homing method registers only the relative intensity and type of proximal stimulus on bodily locations. Such capacities do not involve perceptual constancies" (424). One of his examples of path integration is as follows: "Dogs can be blindfolded, deprived of auditory information, and led from a bait by a detour route. They return to the site of the bait (with the bait and its smell removed) by almost the most direct route possible" (499). This is an example of animal walking without vision. As I see it, this example in fact illustrates that navigation by path integration requires body representation rather than vision.

(294). Burge heavily criticizes this notion for failing to recognize that representational functions cannot be reduced to biological functions (295-308). It fails to recognize that perception is a genuine psychological kind, and that perceptual representation cannot be reduced to mere sensory registration (292-308). Hence, Burge might dismiss information about bodily conditions and neural information integrated in the brain as not being genuinely representational in his sense.

In the next section, I will make two claims to respond to this defense. First, there are good reasons suggesting that some types of body representation are genuine objective representations. Second, body representation is essentially different from visual perception because there is no underdetermination problem in the case of body representation at all. Together, these two claims will strengthen my view that body representation is a more primitive type of objective representation than visual perception.

III. Body Representation as Objective and Distinct from Visual Perception

There are at least two reasons suggesting that some types of body representation are genuine objective representations. First, misrepresentation can happen. Consider representation of *body ownership*, which concerns whether a body part or a whole body is represented as belonging to the subject. For instance, when typing this manuscript with both hands, I have a sense that these two hands are parts of my body. Body ownership can sometimes be misrepresented. For example: (1) In the *rubber hand illusion*, the subject sees a rubber hand while his own hand is blocked from view. The experimenter uses paint brushes to touch the real hand and the rubber hand synchronously for two to three minutes (Botvinick and Cohen, 1998; Tsakiris and Haggard, 2005). Based on proprioception, many subjects feel their real hand as being located closer to the rubber hand, not where it really is. This is called proprioceptive drift.[16] Many also report that, during the experiment, they feel as though they are being touched on the rubber hand rather than on their real hand. This is called touch referral. Finally, watching a rubber hand being stroked synchronously with one's own unseen hand causes the rubber hand to 'feel like it's my hand'. Many subjects feel as if the rubber hand is their own hand. (2) In the experiment that induced *out-of-body experience*, a stereo camera was placed two meters behind the subject who wore a head mounted display (HMD). The scenes registered by the camera were transmitted to the HMD such that the subject saw the back of his virtual body in front of him. Then the subject's back was stroked for one minute synchronously with respect to the virtual own body. Many subjects experience the illusion that the virtual body is their own, and that they see themselves from outside the body (Lenggenhager et al., 2007). Other types of misrepresentation include phantom limb pain (Ramachandran and Hirstein, 1998), and the body swap illusion (Petkova and Ehrsson, 2008).[17] All these cases involve mistaken body

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[16] Although proprioceptive drift is frequently taken by researchers to be an indication of RHI, it has recently been suggested that this aspect can dissociate from the feeling of the rubber hand as one's own (Rohde et al., 2011).

[17] Phantom limb pain is the phenomenon that the subject feels pain in a limb that has been amputated. In the body swap illusion, due to manipulation of visual perspective, the subject feels as if someone else's body or a fake body is his own.

representation of one kind or another.

Since subjective experiences of bodily illusions are often reported and measured by questionnaires, one might wonder whether they involve only erroneous *beliefs* or *judgments* about one's body rather than genuine body representations that are mistaken. If so, that will weaken my position. However, several empirical studies show that the cases mentioned above are not merely cognitive mistakes. Consider the rubber hand illusion: (1) Skin Conductance Response (SCR) is a physiological measure of anxiety that cannot be mentally controlled by the subject.[18] Armel and Ramachandran (2003) showed that, after synchronous stroking, the subject's SCR was significantly higher when the experimenter "injured" the rubber hand (e.g. bent one of the rubber fingers backwards to a "painful" position). (2) The brain imaging study by Ehrsson et al. (2007) indicated that, after synchronous stroking, a threat to the rubber hand (by a sharp needle) induced a stronger anxiety-related blood-oxygenation-level-dependent (BOLD) response in the anterior cingulated cortex and insula cortex. According to the authors, these brain areas are "known to be activated during anticipation and experience of pain", and that their findings "provide strong *objective neurophysiological evidence* that the rubber hand is incorporated into the body" (2007: 9830-9831, my emphasis). (3) Moseley et al. (2008) demonstrated that, when participants experienced the rubber hand illusion, the skin temperature of their real hand decreased, and the magnitude of

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[18] SCR is based on the fact that the sweat glands are controlled by the sympathetic nervous system. High arousal of the sympathetic nervous system increases the sweat gland activity, which in turn raises skin conductance of electricity.

this effect "correlates with the strength of the illusion" (2008: 13168). Again, the decrease in skin temperature cannot be controlled voluntarily by the subject. These physiological and neural measurements give strong evidence that the rubber hand illusion is not merely a cognitive mistake but a mistaken body representation.

In the experiment of out-of-body experience, after synchronous stroking, the participants were blind-folded and passively guided by the experimenter to move backwards. When asked to walk back to their original position, many participants walked past the original position and "showed a drift toward the virtual body" (Lenggenhager et al., 2007: 109). In the body swap illusion, participants showed a significantly greater SCR when the fake body was threatened by a knife. The researchers consider this as providing "objective evidence for the illusion" (Petkova and Ehrsson, 2008: 3). Finally, the phantom limb patients know very well that the body part where they feel pain no longer exists. Also, as argued by Ramachandran and Rogers-Ramachandran, phantom pain cannot be explained by confabulation (1996: 383). All these suggest that the cases discussed here are not merely erroneous beliefs but genuine body representations that are mistaken.[19]

A second reason for the existence of objective body representations

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[19] An anonymous reviewer expresses the worry about whether the notion of objectivity involved here is different from the one that Burge uses in his book, *Origins of Objectivity*. I believe that this worry is unnecessary. Burge's idea of objectivity is partly embedded in his notion of veridicality. In this paper, I do not take issue with his notion of veridicality. In addition, he maintains the view that non-veridical perceptual states, like illusions or hallucinations, must be understood in terms of veridical perceptions (2010, 98). My discussion on misrepresentation here can sit well with his idea of objectivity.

is the following. Many types of body representation exhibit some sort of constancy that can draw the distinction between mere sensory information and body representation. Take proprioception as an example. Consider proprioceptive representation regarding where a limb is located relative to the whole body. When an animal moves, the proximal sensory stimulations regarding limb-positions change over time. Those limb-positions, while changing moment by moment, do not change randomly but exhibit certain patterns. That is, there are proprioceptive representations that represent the dynamic and, at the same time, *invariant* spatial relations between the limb and the rest of the body. For example, in human walking, the two legs take turns entering into the stance phase (contact with the ground) and the swing phase (leaving the ground) to move the body forward. The muscle spindles in the leg receive changing sensory stimulations, but they contribute to the proprioception that represents (i) the pattern of movement, (ii) the dynamic balance of the body, and (iii) an upright posture (Hutchinson and Gatesy, 2001; Grey, 2010).[20] This illustrates that certain constant aspects are represented, despite the fact that the proximal sensory stimulations are changing.[21] To be sure, these are not perceptual constancies studied by vision science. But this is indeed my point; that is, it is highly probable that body

[20] Muscle spindles are a major type of sensory receptor embedded in the muscle fibers of the animal's body. They are wrapped with the terminals of sensory neurons classified as primary or secondary endings (Grey, 2010: 2, Figure 1). As researchers describe them, "muscle spindles are the primary sources of information for limb position and movement sense" (Grey, 2010: 3). "Primary endings respond to the size of a muscle length change and its speed. They are therefore believed to contribute both to the sense of limb position and movement. Secondary endings … signal only the length change itself, so contribute only to the sense of position" (Proske and Gandevia, 2009: 4139).

[21] These constant aspects can be misrepresented as well.

representation (in this case, proprioception) involves constancy mechanisms that are *distinct* from the constancy mechanisms in visual perception.[22] As I will soon argue below, body representation is essentially different from visual perception. Here, the main point is that the distinction between registration of sensory information and proprioceptive representation can be made. This is sufficient to suggest that proprioception is objective body representation.

Once we see that body representation can be genuine and objective, a crucial difference between body representation and visual perception comes into view. That is, the underdetermination problem does not seem to arise in the case of body representation at all.[23] When describing the underdetermination problem, Burge remarks that "A major part of this problem is to explain the transformation of the registrations of light intensities on retinal receptors—a two-dimensional array—into perceptual representations of, and as of, entities in three-dimensional space" (91). As mentioned in section I, this is due to the fact that depth information

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[22] Burge explains perceptual constancies in terms of formation principles (400). But, as far as I know, no empirical accounts explain body representation in the similar way.

[23] Regarding the case of proprioception, I am not arguing that no forms of proprioception can be regarded as perception. My position is that (i) at least some forms of proprioception about which the underdetermination problem does not seem to arise. (ii) These forms of proprioception involve constancy mechanisms that are distinct from the constancy mechanisms in visual perception. Together, these two points suggest that at least some forms of body representation are both genuinely objective and essentially distinct from visual perception. As an anonymous reviewer points out, Burge maintains that the general and salient features which mark objective representation — most importantly constancy—are shared among other forms of perception as well, including proprioceptive perception. However, as we will see in the final section, Burge does not really offer any argument to defend the view that proprioception can be considered as a kind of perception.

about 3D objects is lost when they project 2D images on the retina. Nothing similar to this takes place in the case of body representation. Body representation is multi-tiered, and these multiple types of information come from different parts of the body (Knoblich et al., 2006). No empirical theories of body representation suggest that some specific and essential type of information *about the body* (or body parts) is lost such that an "inverse" processing is needed. Unlike visual perception, body representation does *not* have infinitely many distal objects as its potential causes. On the contrary, it represents one and only one object, that is, the biological body of the animal. In understanding the most primitive form of objective representation, the underdetermination problem is not as crucial as Burge suggests.[24]

This point applies to body parts as well as to the whole body. For example, one of the key areas in the brain that processes hand information is the ventral premotor cortex. The multisensory neurons in this area respond to and integrate the visual, tactile and proprioceptive information of a hand (Rizzolatti et al., 1981; Ehrsson, 2012). A neuroscientist has commented that "Crucially, these neurons typically had visual receptive fields (RFs) that centered on *specific body parts* and that were largely overlapping with the same neurons' tactile RFs. In other words, individual neurons that responded to touches applied to *the hand* would also respond to a visual object approaching the hand but *not* to objects

[24] The dispute here is more than just a verbal issue. Recall that Burge describes the underdetermination problem as the "primary problem for the psychology of visual perception" (2010, 89). The central case that Burge makes for the Primitive Thesis is about visual perception. More importantly, the strengths of his arguments significantly rely on empirical studies of vision science.

approaching other parts of the body" (Ehrsson, 2012: 776, my emphases). This supports the view that multiple types of information are integrated to represent properties of the same hand.[25] Regarding representation of face, a key brain region that performs multisensory integration is the ventral intraparietal area (Avillac et al., 2007). The multisensory signals are "combined in a head-centered coordinate system for the purpose of approaching, manipulating and avoiding objects with *the face*" (Sereno and Huang, 2006: 1341, my emphasis). Again, this suggests that the relevant types of information are integrated to represent properties of the same face. Finally, as mentioned in section II, Damasio, Panksepp and other neuroscientists have suggested certain brain areas or neural networks that are responsible for whole body representations. They share the view that representations of body parts are integrated to produce representations of the whole body.

It is worth emphasizing that the major accounts of body representation do not take it as solving the underdetermination problem at all. Petkova et al. (2011) propose a bottom-up "multisensory integrative hypothesis", according to which ownership of body parts is "mediated through integration of visual, tactile, and proprioceptive information in body-part-centered coordinates" carried out by neuronal populations in the ventral premotor and intraparietal cortices. Ionta et al. (2011) suggest their own multisensory integrative account of out-of-body experience,

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[25] Also, according to Ehrsson, hand representation "could be mediated by neuronal populations in the ventral premotor cortex, the intraparietal cortex and other key multisensory sites that integrate visual, tactile, and proprioceptive information in common reference frames centered on *the* hand and arm" (2012: 782, my emphasis).

which emphasizes the important role of the temporo-parietal junction. Tsakiris (2010) argues that bottom-up mechanisms are not sufficient for explaining body ownership. His account posits stored and online internal body models in the brain that modulate body ownership in a top-down manner. The point here is that none of these research programs explain body representation as involving anything analogous to the underdetermination problem as formulated by Burge. Body representation is essentially different from visual perception in this regard.

Let me conclude this section by discussing a possible objection. It stems from the idea that, in order for the underdetermination problem to arise, it does not really require *infinitely* many distal objects. *Multiple* distal causes would suffice. Based on this idea, phantom limb pain could be an empirical case against my position. It can be characterized as a case where one' s body representation of damage in a limb could have multiple distal objects as its potential causes. For example, the body representation "I have pain in my thumb" could be caused by damage in a normal subject's thumb, but it could also be caused by certain stimulation in a phantom limb patient's face. This is enough to say that the body representation in question is underdeterminated by multiple distal causes. Hence, in this regard, this sort of body representation is not fundamentally different from visual perception.

Let me point out that, first, this objection will work only if phantom limb pain is a type of perception. However, Burge himself contends that pains are neither perceptions nor representations (4, 416, 421, 422). He says that "capacities to feel heat and pain; the registration of information by pain that functionally correlates with bodily damage (even location of bodily damage) ⋯ these are not perceptual or representational in the senses of these terms that I have been developing" (421). This is because he thinks that pain does not involve perceptual constancies such that "There is no explanatory need to invoke veridicality conditions or representational content" (421).[26]

Here is a second response. Even if the location of pain can be considered as perceptual or representational,[27] I argue that there are simply no empirical grounds to say that phantom pain is a case of underdetermination. The most influential account explains phantom pain in terms of cortical reorganization (Ramachandran and Hirstein, 1998; Ramachandran and Altschuler, 2009; Flor et al., 2006; MacIver et al., 2008). Due to hand amputation, the cortical areas that originally processed sensory input from the hand are deafferented, which allows the functions of those areas to be "taken over" by neighboring brain regions such as face areas. Thus, touching the face may induce phantom sensations (Ramachandran et al., 1992) or phantom pains (Flor et al., 1995). Notice that, on this account, phantom pain is understood in terms of a specific and different type of sensory input rather than multiple distal

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[26] Burge also says: "The connection between a feeling of pain and a bodily location in itself seems to involve no perceptual constancies. … The feeling of location is surely there … But in itself I think that the feeling of the location of pain is a functioning, causally reliable sensory registration. No constancies, no distinction between proximal stimulation and a perceptual object, appear to occur in the operations of the system" (421).

[27] In relation to this, Burge says that "many animals probably associate the location of pain with a proprioceptive body image. … their systems map feelings of pain onto a continuing *representational* image of the whole body. Where this is so, at least the locational aspects of pain have, derivatively, a perceptual dimension. Still, the qualitative feeling *in itself* … is not, I think, representational. It does not in itself represent the pain (does not represent itself), or anything else" (422).

causes. According to another account, the structure and functional organization of the brain areas associated with the amputated hand are actually preserved. What is disrupted is the functional connectivity between regions *in* the primary sensorimotor cortex (Makin et al., 2013). Again, this account does not consider phantom pain as involving multiple distal causes. In fact, to my knowledge, there are no empirical accounts that explain this phenomenon as involving anything like the underdetermination problem formulated by Burge, or by appealing to any sort of formation principles.[28]

IV. Conclusion: Perception and Neural Synchrony

As I said in the beginning, my goal is to argue against the central case for Burge's Primitive Thesis—vision. I have argued that the lower border of objective representation is not given by visual perception, but by body representation. Visual perception is not the origin of objectivity. Based on this investigation, I will conclude with three remarks on the nature of perception in general.

First, I like to compare my views with similar criticisms against Burge recently made by Matt Nudds (2012). Nudds says that "There is no underdetermination problem to solve, and so no perceptual constancy mechanisms involved in producing these representations of the body" (2012: 167). He also thinks that body representation

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[28] Cf. Weeks et al. (2010) for a more comprehensive review.

"constitute[s] a potential counter-example to the claim that … 'objectivity and representation begin in perception'" (2012: 167). So far I agree with him. My views differ from his in the following aspects: (1) While Nudds simply asserts that there is no underdetermination problem regarding body representation, I have presented several empirical accounts above to explain why this is so. (2) As cited above, Nudds thinks that body representation does not involve perceptual constancy. But he also says: "Bodily awareness—awareness of body position and movement—seems clearly *perceptual* … So this appears to be a counter-example to Burge's claim that perceptual objectification necessarily involves constancy mechanisms" (2012: 167, my emphasis). This indicates that Nudds considers body representation as a type of perception that does not involve constancy mechanisms. This, I believe, is controversial and should not be taken for granted. For Burge, perceptual constancies are both necessary and sufficient for perception (431). Nudds' view will raise doubt about why there can be a type of perception without perceptual constancies. In contrast to Nudds, I argued above that body representation, by not being a case of underdetermination, is essentially different from visual perception. Also, as illustrated above by proprioception, I suggested that body representation involves constancy mechanisms that are distinct from perceptual constancy. Body representation is both genuinely objective and essentially distinct from visual perception. Although I only discussed vision, the worry that Nudds faces will not arise here.

Second, in this paper I only attack the Primitive Thesis in the case of visual perception. Whether there might be some other case that can uphold the Thesis is a broader issue that goes beyond the scope of this paper, and it would be a burden on the defender of the Thesis to establish such a case. One possible strategy to defend the Primitive Thesis is to construe body representation as a kind of perception. If this can be done, some might think that Burge's claim about perception as the lower border of representation still holds. For example, consider Burge's remark that "In the cases of touch and proprioceptive perception … Where there is perception in these sensory systems, versions of the underdetermination problem still arise" (344). Here, Burge seems to suggest two things: first, proprioception is a kind of perception; second, proprioception faces the underdetermination problem just like visual perception.

As I have argued in the last section, we have strong empirical reasons to believe that there is no underdetermination problem in the case of proprioception. Here, the main problem is that Burge does not really provide any argument for the view that proprioception can be considered as a kind of perception. In fact, Burge makes various remarks about proprioception, and most of them do not support the Primitive Thesis at all. In some places he says that proprioceptive information (e.g. "proprioceptive sense of gravity") amounts only to sensory registration (cf. 272, 318, 335, 500). In other places he says that, although proprioceptive input contributes to vision or other perceptual systems (e.g. "proprioceptive information regarding eye movement"), proprioception itself is not perceptual representation (cf. 343, 350, 372). There is one place where Burge says that proprioception "can also yield objective representation" (399). But he does not develop this remark, and it is compatible with the view that there can be *non-perceptual* types of objective representation and that proprioceptive representation is essentially different from perception. Obviously these remarks cannot defend the Primitive Thesis.

When Burge describes proprioception in a way that is more congenial to the Primitive Thesis, he does not offer any argument to defend it. In addition to the remark quoted above, he also says that "The methods of visual psychology apply to other perceptual systems besides vision—principally hearing and some aspects of proprioception and touch" (98), and that "Touch, hearing, and that grab-bag, proprioception, can exhibit autonomous perceptual capacities, and perceptual constancies, as well" (414). Again, although these remarks fit well with the Primitive Thesis, no arguments for these remarks are provided.

I have so far focused on proprioception as a paradigm case of body representation. Hence I have not completely refuted the strategy that attempts to construe body representation as a kind of perception. Nevertheless, we can still draw the following lessons: (1) It would be *ad hoc* to simply stipulate body representation as a kind of perception without further arguments. (2) For the sake of argument, even if we put these worries aside and regard body representation as a kind of perception, the critical differences still remain between body representation and other types of perception, especially vision. The underdetermination problem and its solution are not critical for understanding the most primitive form of objective representation. More importantly, my position would still hold, that is, the lower border of objective representation is not given by visual perception but by body representation.

My third and final remark is more constructive. I think that, when it comes to biological functions, a theory of perception must take body representation into consideration. To fully understand the nature of perception and its relations to the external world, we need to investigate how perception is integrated with body representation. How does this actually work? Many researchers, including Damasio (2010: 20, 86-87) and Panksepp (2009: 202), suggest that such integration is implemented by neural synchrony. Let me explain.

Neurons in different brain regions may exhibit rhythmic firing patterns. This is called neural oscillation, the frequency of which can be recorded by an electroencephalogram (EEG). When a group of neurons fire together with the same oscillation pattern, they are in *synchrony*. Neural synchrony is considered to be a central mechanism for many cognitive functions. In the case of visual perception, multifarious types of visual information are processed in different brain regions, which need to be combined to produce coherent percepts. The suggestion is that the transient synchronization in the visual system provides such a binding mechanism. In addition to vision, synchronization in the beta and gamma range has been found in the olfactory, auditory, and somatosensory systems, as well as other brain areas that interact with perception, such as the pre-frontal cortex, the motor cortex and the hippocampus (Singer, 2007).

Neural synchrony is considered as playing an important role in body representation as well. For example, Kanayama et al. (2009) used EEG to investigate the rubber hand illusion, and found high correlations between the visual-tactile integration process and the gamma band synchrony in the parietal cortex. They suggested that the illusion is caused by gamma band synchrony. Also, the studies of the out-of-body experience by Lenggenhager et al. (2011) found high correlations between alpha band oscillations in the sensorimotor cortex and the medial prefrontal cortex, on the one hand, and where the subjects feel themselves to be located in space, on the other. Therefore, as empirical researchers suggest, it is possible that the integration between perception and body representation is implemented by some sort of neural synchrony. More interdisciplinary research can and must be done to develop and test this integrative idea.

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視覺與客觀性之起始點

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摘要

本文探討 Tyler Burge 的一項主張：知覺 (perception) 劃定了表徵心智 (representational mind) 的下限，並展現出最初步的客觀性。根據這項主張，知覺是最初始的表徵類型，並且正確的知覺乃是將各種性質準確歸屬 給獨立於心智的物理世界。我將這主張稱之為「起始命題」(the Primitive Thesis)。本文的目標是要以視覺 (visual perception) 為範圍來攻擊「起始命題」。我將論證：視覺不是最初始的客觀表徵類型。這並不會完全駁倒「起始命題」，但會使它最顯著的適用範圍失效。我採取跨領域的進路，指出目前最佳並相關的經驗研究認為：個體如何表徵自己的身體狀況，在 實現知覺的生物性功能 (biological functions) 的事上，扮演了關鍵角色。我接著論證：劃定客觀表徵之下限的不是視覺，而是身體表徵 (body representation)。因此，視覺並不是客觀性的起始點。最後，我將根據本文的討論，對知覺提出一些綜合看法。

關鍵詞：視覺、生物性功能、身體表徵、客觀性