Touch and vision: some considerations for diagrammatical reasoning

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Abstract
Some of the spatial properties of surfaces can be translated by touch as well as vision. Both blind and clearsighted people can equally perceive corners and edges; their minds being equally capable of recognizing objects or arrangements of these. A fundamental difference, however, must be kept in mind: while most of the time the visual system readily homogenizes sensitive data through unity constructing, the haptic system usually «makes experiments» across time, which can be unified by a rule of interpretation only afterwards. Those are two different kinds of logic: visually knowing an object — or arrangement of objects — is to perceive it from general to particular, and tactilely knowing an object — or arrangement of objects — is to perceive it from particular to general. In this paper, with the theoretical background of peircean semiotics, we address the issue of how touch [predominantly inductive] and vision [predominantly deductive] are complementary perceptual/critical senses ecologically connected. Such senses can be intersemiotically translated, as outline drawings demonstrate. A map produced for clearsighted and blind persons will be examined in an attempt to show how diagrammatical reasoning can be developed from predominantly deductive or inductive cognitive processes, and possibly share common representations for haptic and visual systems.
Keywords: 1) peircean semiotics; 2) diagrammatical reasoning; 3) induction; 4) deduction; 5)t ouch; 6) vision

PEIRCE'S CONCEPTION OF DIAGRAM: A BRIEF INTRODUCTION

The American philosopher Charles S. Peirce (1839-1914) proposed a science to explain how everything that is perceived — which he named *phaneron* — could be understood as language or logic: semiotics. This abstract and general discipline is composed of a complex system made of sixty-six classes of signs (Borges, 2007), each one corresponding to a pattern of cognition. Before further exploring this field, we should briefly examine Peirce's phenomenology.

According to Peirce, there are three universal categories that can be found in every single phenomenon: firstness, secondness, and thirdness. Firstness concerns «the ideas of freshness, life, freedom» (CP 1.302), a *sui generis* monad (CP 1. 303); secondness, is related to the dyadic opposition of forces, the «element of struggle», «effort» (CP1.322, 8.330), which is inherent to existence; thirdness is defined as a triadic representation (CP 1. 339), the mediation (CP 1.328) between possibilities — first — and facts — second —. It might be said these categories are interrelated in the following way: «The category of first can be prescinded from second and third, and second can be prescinded from third. But second cannot be prescinded from first, nor third from second» (CP 1. 353).

Describing how each of those categories are renamed and reviewed in semiotics is not within the scope of this paper[1]. One must take into account, nevertheless, that the category of thirdness or mediation — which already includes secondness and firstness — is the one identified with the concept of genuine sign (CP 2.92), the bilateral action of guiding potentiality into individual facts (CP 1.328), in which the cognitive or intelligible world is circumscribed.

Since semiotics is the domain of logic, it is instrumental not only to describe the phenomenon but, also, to *analyze* it, revealing the hidden features that operate on everything that appears to the mind. A mind that, for Peirce, is not reduced to human mind, since is not necessarily connected to a brain, and includes, for example, «the work of bees, of crystals, and throughout the purely physical world» (CP 4.551; Santaella, 1994: 399).

From the sixty-six peircean sign classes, there is the mathematical possibility of 59.049 kinds of signs (CP 1.291; Santaella, 1989: 62). Amongst these, addressing only one specific sign class is sufficient for our purposes: the diagram, a hypoicon. Peirce (CP 2. 276) postulates that pure icons are «ideas» of their objects, tied up to the domain of firstness — the universe of possibilities, which have not yet been embodied as secondness and brought into existence. A sign may have, however, a predominant iconical aspect, «that is, may represent its object mainly by its similarity» (ibid.), which Peirce calls *hypoicons*; these can be

> …roughly divided according to the mode of Firstness of which they partake. Those which partake of simple qualities, or First Firstnesses, are images; those which represent the relations, mainly dyadic, or so regarded, of the parts of one thing by analogous relations in their own parts, are diagrams; those which represent the representative character of a representamen by representing a parallelism in something else, are metaphors (CP 2.277).

[1] For a detailed approach, see Santaella (2004).

Diagrams are not pure icons (CP 3.362), but representations that build — cognitive — relations between the internal connections of the sign and the internal connections of the represented object[2], such as graphs and maps (CP 3.419, 4.419), signs that mediate predominantly *schematic reasoning* [3] (CP 2.778, 2.782).

VISION AND TACT AS DIFFERENT AND COMPLEMENTARY DATA SOURCES FOR REASONING

Now that the conception of diagrammatical reasoning has been introduced, we move on to considering vision and tact. The aim is not to explore the way eye and touch are physiologically and/or biochemically constituted and integrated to the brain, but understanding how they work, respectively, as *schematic distinct and complementary data sources for predominantly deductive and inductive reasoning*, conceiving data as the set of phenomena perceived by the mind, or *phanerons*.

First, one must take into account that vision and tact have a lot in common. The…

> …spatial properties of surfaces are accessible by touch as well as by vision. The hand can feel corners and edges that the eye can see. If many properties are perceived by both touch and vision, then it is reasonable to conjecture that the tactile and visual perceptual systems share many of the same operating principles for perceiving the shape of our surroundings. (…) A table is both a visual table and a tactile table (Kennedy, 1993: 3).

Despite its seeming admissibility, the idea of a «symmetrical» mediated tactile and visual world finds several oppositions. The great mistake is to suppose «that touchers have trouble unifying a set of touches» (Dunlea apud Kennedy, 1993: 4), and that…

> …they cannot easily gain an overall impression of a complex shape, or the spatial layout of a set of objects, or the arrangement of rooms in a house (Katz, 1989, sect. 46). Touch needs guidance from vision, it is claimed. Touch is inadequate for organizing, and it provides a poor basis for attempts to remember spatial patterns. It is inherently less efficient than vision (Bailes and Lambert, 1986, criticize this view) (Kennedy, 1993:4).

Tact is often conceived as a «tool» for visual perception, or a less capable sense — even without any scientific evidence. This could be related to the fact that vision — the perception of light — is culturally identified with intelligence (Santos, 2008). In philosophy, since Greek

[2] Farias (2008), however, points out that diagrammatical problematization in Peirce's earlier works include pure icons. Sometimes, «the concepts of 'diagram' and 'icon' seems to overlap (CP 2282, 7467 [1893] 2279 [1895] 3429 [1896]), or diagrams are presented as examples of icon (EP2: 303 [1904] 4531 [1905]) and vice versa (W6: 258-259 [1889])» (ibid.). For this paper, only the hypoiconical dimension of diagrams is taken into account.

[3] A synonym of diagram.

Antique, names like Plotin establish direct links between eye and mind; in daily life, expressions such as «clarify», «illuminate» or «observe» also reinforce the biased connections visual-intelligible/ non visual-ignorant (ibid.). Scientific evidences, however, suggest a different scenario: «In one assessment of manual skill, Klatzky, Lederman, and Metzger (…) found that adult subjects could identify 100 common objects with very few errors in a mean response time less than two seconds» (Kennedy, 1993: 14).

Even the crystallized distinction that theorizes tact as «proximal» and vision as «distal» senses can be easily rejected. «Just as we can see through a transparent surface-looking (…) we can feel through a nearby surface to detect a more distant object» (ibid.: 12). It is the case, for example, of the «pressures generated by the wind of passage of a [distal] train» (ibid.). In fact, everything that rubs, presses and gets in contact with touch — the union of the cutaneous system and deeper regions of the body [kinesthetic system of joints, tendons and muscles], plus mobility (ibid.:11-12,15) —, or that is lifted, enclosed or held is able to be perceived by tactile senses. Touch includes equally passive and active, «proximal» and «distal» stimulation, just as vision does — the latter, since Gibson (1986), understood no more as a merely receptor, but exploratory active system: «eyes-in-the-head-on-the-body-resting-on-the-ground» (ibid.: 205).

> The body explores the surrounding environment by locomotion; the head explores the ambient array by turning; and the eyes explore the two samples of the array, the fields of view, by eye movements. (…) The observer needs to look around, to look at, to focus sharply, and to neglect among light. (…) The visual system *hunts* for comprehension and clarity. (ibid.: 219).

A crucial difference must be explained, nevertheless. Although touch «deals with the shapes of individual objects and the arrangement of objects in many of the same way vision does» (Kennedy, 1993:5), these senses use different kinds of logic. Plaza (1987: 57) helps us realizing why. He points out that vision is wide, and homogenizes through unity constructing; tact, on the other hand, is narrow, and «makes us perceive differences by contrast (…), the experience accentuated by the interval between the objects» (ibid.). In other words: visually knowing an object — or arrangement of objects — is to perceive it from general to particular, while tactually knowing an object — or arrangement of objects — is to perceive it from particular to general.

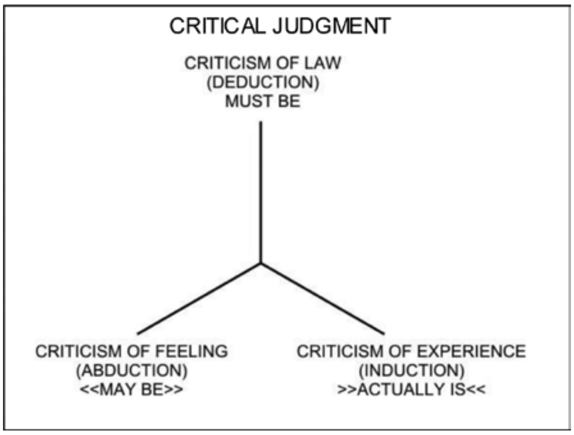
Imagine a huge cube plastic box inside a room. When an adult looks at it, an explanation arises immediately: «It is a glass or plastic cube», it might be thought. Through the visual channel, almost effortlessly, the mind is supplied with multiple data, such as color, shape, texture, size and deepness, which readily provide elements that are converted into knowledge — signs — and translated into an explanation or law — other signs — to categorize the phenomenon. If, otherwise, the same plastic box was investigated only by tact, the cognitive process would be different. The first impression concerns maybe the material of the object, its texture, hardness or temperature. As its size prevents it from being grasped, it must be touched piece by piece, several times, separately uncovering its faces, being opened and closed, in an effort to perceive a shape. Only after this process someone would be able to synthesize all the inputted data, which a short while ago seemed like particular disintegrated experiences, and make an affirmation: «It is a plastic box», a blind or blindfolded man could say.

When vision was used to analyze the box, a predominantly deductive reasoning (CP 7.203) operated: the image in front of the eyes did not take any long to become an explanation of the perceived object; a rule of interpretation — thirdness — guided the result beforehand. Tact, however, led the mind into a predominantly inductive knowledge process (CP 7.206), that is to say, provided fragmented data by successive experimentation across time (Duarte, 1995; 2001; 2004; Gibson apud Kennedy, 1993: 4; Sacks, 1995: 138), which only afterwards could be unified; the result — of the experimentation, facts, secondness — led to a rule of interpretation. Those are, certainly, tendencies of vision and tact as data sources, not meaning they cannot swap positions — vision becoming predominantly inductive and tact predominantly deductive — or even produce predominantly abduction, «an explanatory hypothesis» (CP 5.171), merely preparatory (CP 7.218), which is, «after all, nothing but guessing» (CP 7.219), the suggestion of a theory (CP 8.209).

Consider, for example, a child who is playing with a puzzle. He or she inductively seeks to associate the pieces, starting with merging them erratically by plugging and connecting two or three unities, after that organizing them as small groups, in an attempt to set fragments according to a predetermined visual representation. In addition, someone trained to read in Braille quickly fits each set of points perceived by the touch of the fingers as a different letter or symbol, because previously that person learned how to frame this kind of experience into interpretation rules; this is deduction. Abduction, moreover, entails that at any time and everywhere, someone can see or touch/be touched by something unexpected which then becomes a discovery — like a probable new color or texture —, providing data for the reformulation of the phenomenological theories (CP 5.145; 7.218) of interpretation that, afterwards, become — deductive — rules and will have to be validated by — inductive— tests (CP 5.171).

This semiotic process starts as a *perceptual judgment*, «the first judgment of a person as to what is before his senses» (CP 5.115), a «starting point or first premise of all critical and controlled thinking» (CP 5.181), «without [, however,] any controlled and criticized action of reasoning» (CP 5.157). Indeed, Perceptual judgments «are to be regarded as an extreme case of abductive inferences, from which they differ in being absolutely beyond criticism» (CP 5.181): «There are mental operations which are as completely beyond our control as the growth of our hair. To approve or disapprove of them would be idle» (CP 5.130); this is the universe of *belief*, which has no place in science (CP 5.60; Peirce apud Santaella, 2005: 353; Santaella, 2004: 47) or critical reasoning.

Reaching further than *perceptual judgment*, genuine *critical judgment* — thirdness that critically mediates what appears to the mind — contains invariably deducible universal propositions [*criticism of law*]: «under certain conditions certain phenomena ought to appear» (CP 2.775), in accord with inductive experience (CP 6.472) [*criticism of experience*], the necessary examination of a hypotheses originated from abduction [*criticism of feeling*], «an act of insight, although of extremely fallible insight» (CP 5.181). Schematically:



Whereas «Deduction proves that something **must** be [law]; Induction shows that something **actually is** operative [experience]; Abduction merely suggests that something **may be** [feeling]» (CP 5.171). And they all work omnipresently in tact and vision, not just perceptual, but also in critical senses: «Reasoning cannot possibly be divorced from logic» (CP 5.108), just as logic cannot be detached from perception (Rosenthal, 1990: 197). Senses are not simple front gates; they are critical explorative minds, endowed with different intelligences. «The elements of every concept enter into logical thought at the gate of perception and make their exit at the gate of purposive [critical] action; and whatever cannot show its passports at both those two gates is to be arrested as unauthorized by reason» (CP 5.212). These «purposive [critical] action» is directly connected to what Gibson (1986) named «exploratory active aspect» of the perceptive system: the critique has to be made on the phenomenon with both cognitive-sensuous skills.

It is important to say, nevertheless, especially assuming Gibson's (1986) ecological approach to perception, that there are no isolated perceptive organs, but integrated synaesthetic sensorial operations. Each sense would be responsible for a different type of data input; however, since they are interrelated, they could share the predominantly abductive, deductive and inductive inputted phanerons from each other, constituting an «extended complex mind», or an ecological perceptual system — to use Gibson's terminology. One same data or *phaneron,* in this way, could be read in its different meanings by all the senses working together simultaneously and interconnected to the nervous system, forming a single network of knowledge (Gibson, 1986: 4). Therefore, even if vision can operate inductively and touch deductively — two diagrammatical different kinds of data organization —, it is suggested that they do not usually follow this procedure because they — or the synaesthetic sensorial mind — can access the missing cognitive data from other senses.

It follows that, as deduction and induction are complementary kinds of reasoning, once the former traces out through a law of interpretation the necessary and probable experimental consequences of a hypothesis (CP 7.203), and the later validates this rule in the empirical world (CP 7.206), vision and touch are not trapped within antagonistic loci; they are, rather, interrelated and interdependent: What is seen and categorized by the visual system is tested and endorsed by haptics, and vice-versa. Thinking on the example of the box which was given previously, the person who saw the object and concluded it was a glass or plastic cube would have a chance, by touch, not just to confirm it was a cube but, as well, to be sure it was exclusively made of plastic — not glass — and, in addition, a box that could be opened — not an ordinary cube. The one who was touching, after aided by vision, would be able to confirm that the perceived object was a plastic box, and not an aquarium or something other.

Compared to vision, tact uses a predominantly or preferential different mode of data perception/organization: induction; and it is not the opposite or simplification of — visual — deduction, or even less it's instrumental to it; it is, unlikely, its complement, in the same way abduction is. Any critical judgment — synonymous of sign — has to be a law [3] of interpretation that mediates between *critical judgment of feeling* [1] and *critical judgment of experience* [2] — even when, many times, those borders are not well defined or, better, non-identified.

That means not only that tact and vision can and must work together as data sources — also connected to other senses —, but also translating visual into tactile data amounts to translating predominantly deductive reasoning into predominantly inductive reasoning, and translating tactile into visual data amounts to translating predominantly inductive reasoning into predominantly deductive reasoning. How is that possible? What is necessary to turn a phenomenon perceived through the eyes intelligible to the skin, or the other way around? The mediation of a semiosis or, precisely, an intersemiotical translation, is my argument.

Peirce (CP 5.283-5.284) argues that any sign is the translation of a thought into another thought, *ad infinitum*. When, however, this process involves different kinds of languages, such as the ones from visual and tactile systems, it is renamed as an intersemiosis (Plaza, 1987: 12). For the present case — touch [induction]/vision [deduction] —, outline drawings have been successfully used for a long time.

OUTLINE DRAWINGS AS INTERFACE FOR VISUAL AND TACTILE REASONING

For over three decades, Professor John M. Kennedy, from the University of Toronto, has been comparing drawings made by sighted and blind people. In a paper published in 1997, in *Scientific American*, titled *How the Blind Draw*, he presented some conclusions of this research, proposing similarities between the pictorial language used in sketching their surroundings by those who receive visual and tactile data:

> …for example, both groups use lines to represent the edges of surfaces. Both employ foreshortened shapes and converging lines to convey depth. Both typically portray scenes from a single vantage point. Both render extended or irregular lines to connote motion. And both use shapes that are symbolic, though not always visually correct, such as a heart or a star, to relay abstract messages. In sum, our work shows that even very basic pictures reflect far more than meets the eye (Kennedy, 1997: 77).

One special raised-line drawing kit[4] is used to allow blind persons to depict what they can fell with their senses, specially the haptics system. But the success of the procedure is

[4] «These kits are basically stiff boards covered with a layer of rubber and a thin plastic sheet. The pressure from any ballpoint pen produces a raised line on the plastic sheet» (Kennedy, 1997: 77).

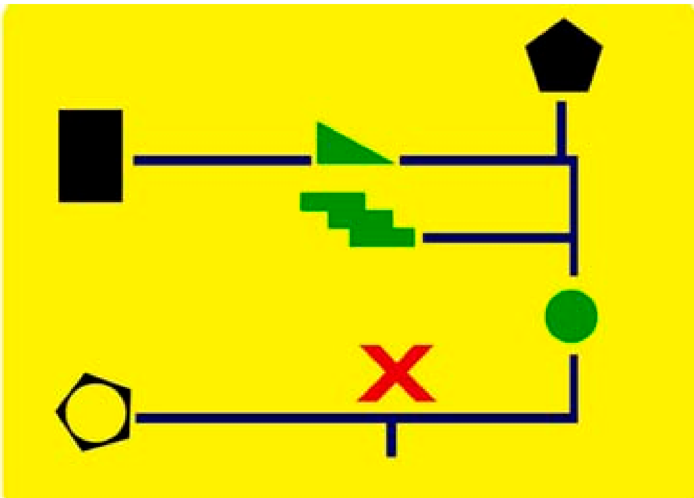
not entirely due to this technical apparatus — the predominantly indexical/material sphere —; here, the power of pictures to communicate is preponderant (Kennedy, 1974: 1-13), a language apprehensible for both sighted and sightless, specially on outline pictures, «useful for presenting essential details with a minimum of irrelevancy. In an outline drawing, key facts about the sizes, shapes, and locations of objects can be shown in a form of representation that requires less training than any code» (ibid.: 155).

Lines are full of information - differences (Ashby, 1970). They mark *abrupt changes* (Kennedy, 1974: 106-133), like surface discontinuities[5] of shape, deepness and texture, building frontiers equally accessible to touch and vision, and responsible for the perception of corners and edges. Therefore, raised contour makes it possible to tactile/visually depict the different objects or arrangement of objects of which the environment is composed, building representations readable inductively or deductively.

On one hand, a single glance reveals a set of lines that can be readily translated as a complete and unified picture, where it is possible to see the existence of individual elements as a unified and almost instantly intelligible representation — a predominantly deductively cognition. On another hand, lines are ready to show slowly and individually, across time, every detail that composes an object or arrangement of objects, which are later translated into a critical judgment — a predominantly inductively cognition.

OUTLINE MAP: DIAGRAM FOR BLIND AND SIGHTED PEOPLE

In the picture below, you can see a visual-tactile map, made for the use of blind and sighted people:



[5] Some discontinuities, like pigment, can be only perceived through vision, and others, like illumination —chiaroscuro — cannot be depicted with outlines (Kennedy, 1993: 32).

Diagrammatically, analogies are constructed in the map to represent the spatial layout of a bank first floor. Raised-lines that can be seen and touched inform customers about the location of services, indicated by graphic and written — braille plus ordinary western alphabet — captions. While sighted people are able to view this entire map in a very short time, blind persons have to perceive its components apart, inductively trying to organize what their fingers feel. Both processes, however, have potential to lead the mind into a same rule of interpretation or sign: the general layout of the bank first floor.

That happens because outlines used in the map depict where the corners and edges that composes the environment are. Although these outlines have nothing in common with the bank floor appearance, they are diagrammatically successful in representing how the space is organized. After knowing being the «X» on the map, someone would be able not just to self-localize, but also discover the position of the bank services and move to them. Eyes and hands, deduction and induction: they all work successfully for diagrammatical reasoning.

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