A semiotic approach to blind wayfinding:
some primary conceptual standpoints

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Researchers from a wide variety of disciplines, such as philosophy, art, education or psychology, have over the years sustained the idea that blind persons are incapable or nearly incapable of formulating complex mental diagrammatic representations, which are schema based on the similarities found within internal logical relations between sign and object.

Contrary to this widely accepted opinion, we will present an alternative approach in this paper: Our main idea is that blind and visually impaired people relying upon tact as a main knowledge source are capable of diagrammatic reasoning very well, but use a different method for this purpose, namely the method of inductive reasoning. Such method can effectively provide the mind with the data necessary to the elaboration of mental maps. Therefore, wayfinding as a semiotic process in which a route is planned and executed from marks or navigation indexes, is also enabled by tact.

Keywords: blindness, touch, Peircean semiotics, induction, diagrammatic reasoning, wayfinding

1. Introductory note

In this paper, a few advances will be made on the research and development of cognitive-semiotic features of visual and haptic systems, furthering the ideas presented elsewhere. The main objective is to develop primary conceptual standpoints for the semiotic understanding of blind wayfinding, especially of blind individuals, when compared to clear-sighted individuals.

2. A quick definition of diagram according to peircean semiotics

Peirce\(^1\) defines sign as mediation (CP 1.328) between the finite universe of possibilities and singular facts, effectively embodied, existent, through which intelligibility or language (cognitive processes) is developed. Through the representation of something which lies outside of it – its dynamic object – the sign reports itself to a mind in which it will produce another sign, an operation in which a meaning is understood by being translated into logical terms.

A diagram, special case among all signs, and synonym of mental scheme (CP 2.778), in bound to the semiotic processes that operate, predominantly, by analogy construction between the represented object’s internal relations and the sign’s internal relations (CP 2.277; 2.279) representation is, in this case, elaborated “through a skeleton-like sketch of relations” (Stjernfelt, 2000, p. 358). Examples are graphs and maps (CP 3.419, 4.419), or schemes in general (CP 2.778).

\(^1\) Since all references on Peirce in this text have been investigated in the eight-volumed *Collected Papers of Charles Sanders Peirce* (1931-1935;1958), the following common quotation style will be used subsequently. E.g.: CP 1.328 refers on page 328 in volume 1.
3. Diagram perception as a predominantly inductive process in blind persons

Many authors suggest that the perception of objects or groups of objects that are bigger than the person’s hand is either impossible or extremely difficult for the blind (Duarte, 2004; Dunlea, 1989; Sacks, 1995). Touch could only access that, which belongs to the universe of proximity (Plaza, 1987), leaving outside all that is located away from the body and can not be embraced or acknowledged by the body at once. According to Katz (1989), those who are blind are unable to build complex representations, and furthermore, in regards to the predominantly diagrammatic thought, are unable to comprehend the spatial configuration of a series of objects or of the many rooms within a house, for example.

The mental schemes of a blind person would be, therefore, less complex than those of a clear sighted person. Perfect vision includes the elaboration of maps, graphs and other kinds of signs that translate a visual perception that encompasses both near and distal objects. The eyes are capable of perceiving a myriad of inputs through colors, shapes, curves, textures, etc – the many qualities which present themselves instantaneously and effortlessly (Dondis, 1997) to the visual system and, therefore, to the mind. Our understanding goes against the statement that blind persons are incapable of elaborating complex diagrammatic cognitive processes, even for big objects or groups of objects. Kennedy (1993, 1997, 2003, 2008) states that many of the spatial properties of surfaces are equally accessible to vision and tact, because a hand can perceive edges and borders that the eye can see. Therefore, we believe that those who are not capable of seeing use a logic that is predominantly distinct from that used by clear-sighted individuals in the acknowledgment of objects or groups of objects: successive temporal experimentation (Gibson apud Kennedy, 1993, p. 4), that is: the inductive investigation method.

As we have suggested in previous works (Santos, 2009a, 2009b), we believe that visual perceptive processes are, semiotically, supported by deductive reasoning (CP 7.203): images that are captured by the eyes are soon converted into explanations for the objects perceived, with an interpretation rule guiding towards the interpretative result beforehand – general brings about particular. Tact, on its turn, brings about a predominantly inductive way (CP 7.206) of knowledge: through sequential experimentation, over time, the haptic system obtains fragmented data, that little by little can be unified and decoded by an interpretative rule – particular brings about general. While a computer is, for example, seen close to its entirety and almost immediately understood by a rule of interpretation, its examination by tact demands a series of experimentations, which are done over time: screen, keyboard, mouse, etc, all need to be explored separately in order to be unified at a single subsequent moment and framed under the interpretative rule “computer”.

“These would be tendencies of the visual and haptic systems, not meaning, evidently, that they can not shift positions – tact operating deductively and vision inductively – or even being a source of abduction, an “explanatory hypothesis” (CP 5.171), which is, “after all, nothing but guessing” (CP 7.219). One must only think of a puzzle. Visual and inductively, pieces are grouped almost without any order, through a succession of experimentations, until, finally, they are comprehended as constituents of a predetermined representation: “the figure is a table”. On yet another meaning, an experiment undertook by Klatzky, Lederman and Metzger (1985) revealed hat adults were capable of choosing from over 100 objects of common use by touch only, with a very little margin of error, in less than two seconds – here, predominantly and in the haptic system, deductive reasoning has taken place. In regards to abduction, at any moment and any place, someone can see or touch / be seen by something that presents itself as a discovery, a new color or material for example, a process in which one might find subsidies for reformulating theories of phenomenological interpretation which will become – deductive – rules afterwards, which will need to be validated by inductive testing.” (Santos, 2009a).
This logical division proposed between vision – deduction – and tact – induction – works, we believe, for all kinds of signs, including diagrams. Let us take as an example the elaboration of the mental map of a living room by a blind person and clear-sighted person. While the visual system is capable of capturing furniture and object disposition, quickly allowing for the construction of a diagram of the room, tact will need to investigate local elements separately, gathering elements that will only be unified a posteriori into a single scheme allowing for deliberate walking.

In this manner, both tact (inductively) and vision (deductively) can conduce blind and clear sighted persons to similar interpretations, even for diagrams that allow the elaboration of complex schemes, such as, for example, a common or similar mental map of the spatial distribution of a particular place, coming from the data of visual and haptic systems.

4. Blind wayfinding: navigating without seeing

Nöth (1998, p. 130) states that “maps are mostly indexical signs”, representations that do not operate by similarity with the object which is being represented, but that are directly affected by such object, with which they begin to share certain qualities. They point towards “something that exists ‘here and now’ ” (Walter-Bense, 2000, p. 16), because they involve a reaction, produced by the sign´s contact with its dynamic object. That is why “its characteristic function is to bring the interpreter´s attention to the object, exerting on the receptor a compulsive influence” when directing a regard “to turn towards the object, compelling the interpreter towards an experience”, since “the index is forcibly introduced upon the mind” (Peirce apud Santaella, 2004, p. 123).

Such indexical power of “pointing towards” is, precisely, the way of cartographical signs that are, by their very constitution, indexically affected by the space – dynamic object – which they represent, for a map must obey determined laws of spatial projection in order to function appropriately (Nöth, 1998).

According to the idea that tact and vision follow distinct kinds of logic, visual and tactile cartography indexes should be different not only in regards to the presence of specific visual and tactile qualities, but especially in regards to the quantity of signs used to build a map.

Every sign that is predominantly indexical is under the dominance of induction, but visual and tactile indexes, despite fulfilling the same function – pointing towards a direction – require distinct semiotic strategies for diagrammatic construction: for a clear sighted person, one should indicate a route “less inductively” than for a blind person. Representing a pathway with many indexes for the clear-sighted does not mean the impossibility of knowledge about such pathway; however when it comes to the blind, building a cartography with the same amount of indexes used in a visual map could make blind wayfinding impossible.
Locomotion for a blind person entails a series of specific conditions, different from those of a clear-sighted person. According to Harper (1998, p. 15):

1. Visually impaired people have preview trouble of coming objects or obstacles\(^2\) and therefore the use of some type of preview device is important;
2. consequently the stride length and therefore walking speed of a visually impaired person is less than that of a sighted person, as is the continuity of progress;
3. travel for visually impaired people can be taxing and experiments often show a rise in heart rate with any travel task (although this is less for a familiar route);
4. this may also explain why visually impaired people orient themselves to a waypoint about every 40 metres as opposed to 100 metres for sighted people.

Such conditions do confirm our thesis that states that the haptic system – the union of the cutaneous system and deeper regions of the body [kinesthetic system of joints, tendons and muscles], plus mobility (Kennedy, 1993, pp. 11-12; 15) – operates inductively: blind persons follow a series of experiments, little by little when compared to clear sighted persons, and over time will ascertain that a specific route is being followed. We must also stress that blind persons

"... also use more temporal and egocentric terminology and less spatial and environmental terminology in defining points and make explicit statements on distance more often. Body rotation is also used to describe parts of a journey and route descriptions are more complex when given by a blind person. The route is broken into a greater and more complex number of stages than when sighted people describe it, confirming the importance of a large number of fixed points [indexical signs] to a visually impaired traveler. Obstacle information is also more specific and present in greater detail when a route is described by a visually impaired person (Harper, 1998: p. 16)."

That is why tactile maps produced for blind persons must entail a greater quantity of indexes – higher levels of induction – than those developed for clear sighted persons, in order to enable wayfinding, “the process of determining and following a path or route between a origin and a destination” (Golledge, 1999, p. 6)), and navigation, defined as “updating one’s position and orientation during travel with respect to the intended route or desired destination and, in the event of becoming lost, reorienting and reestablishing travel toward the destination” (Loomis et al., 1998, p. 193).

Considering this fact is fundamental, assuming that maps, be they mental or material, are the initial tool for planning a route, and can, therefore, help minimize “limitation in orientation and mobility (...) considered the most serious effect of blindness upon the individual” (Welser apud Felippe & Felippe, 1997: p. 107). Usually blind children are late in their spatial and movement development when compared to clear sighted children (Amiralian, 1997, p. 61; Bruno, 1993, p. 19; Felippe & Felippe, 1997; Heimers, 1970, p. 13). In fact,

“... lots of blind children are capable of walking, but do not walk for fear and insecurity of moving without being able to get orientation and control from the environment, so they will usually walk after a year and a half or more. They need someone to walk them, to give them a sense of security through physical touch and who will anticipate patterns using sound so they can pursue motor organization and achieve motor walking patterns by the experience with another.” (Bruno, 1993, p. 19)

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\(^2\) In the original, Harper (1998, p. 15) states that "visually impaired people have no preview of coming objects or obstacles". We disagree with this assumption, considering that touch works on the perception of nearby and distal objects, albeit with some limitations for the latter when compared to vision. As demonstrated by Kennedy (1993: p. 14), "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.).

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Furthermore, what a blind child or even a blind adult needs is to be embraced by the environment, to find positive cognitive conditions that are conducive to their mobility, such as the conditions offered to other individuals: “If directional cues are available for guidance during blind travel, a blind individual may be able to continuously adjust the traveling path until reaching the final destination with minimal worry of getting lost” (Tang & Beebe, 2006, p. 116). Among these direction cues, we believe that indexes prone to inductive cognition should be contemplated through a tactile logic of spatial investigation, so that the following of a desired route by blind persons is ensured.

5. Indexes for blind wayfinding

Harper (1998, p. 21) proposes five kinds of indexes for wayfinding:

1. Route planning: Plan a journey, and decide on a route before hand, based on maps and/or previous knowledge [mental maps] of the route or journey;
2. Obstacle detection and avoidance: While traveling, constantly detect and avoid any obstacles, either stationary (lampposts, walls, etc.) or moving (people, cars, etc.);
3. Orientation and waypoints: The journey will be sectioned into waypoints/wayedges. These allow some means of orientation, and travelers naturally divide a journey into Sections with a waypoint as the start and finish (road junctions, landmarks, etc);
4. Information points: Information points are points along a journey where information about the journey is available (timetables, next bus information, etc);
5. In-route guidance: In-route guidance is sometimes performed. This may be by asking for directions or by carrying a map.

We can see, therefore, that a route is constituted by its cartography and latter navigation monitoring of different stages of the journey. The objective is to ensure that the indexes defined by the map in order to ascertain the following of a route will be, afterwards, diagrammatically found at the “real world”, establishing a parallel between sign and object that allows for deliberate locomotion.

Three types of fixed indexical signs would be necessary for the proper enacting of wayfinding: waypoints, orientation points and information points. According to Harper (1998, p. 19), these:

“... are all intended to represent some form of information giving object. A waypoint for instance may be just an arbitrary (implicit) point (say, where two roads/tracks meet) or it may be a specific (explicit) point intended to be a waypoint (a beeping sound marker, say). It is however intended that the information point will represent some form of device that gives complex information (for example a timetable, or street map ‘information point’).”

Another kind of fundamental fixed index is called way-edge. As previously mentioned, tact is as capable as vision to detect spatial frontiers which differentiate objects and sets of objects from one another. Therefore, a way-edge is an important resource for the blind, who

“... may also use a continuous or largescale object as a kind of waypoint. This could be called a 'way-edge', as it is possible that this object is followed until it ends or some other factor or object is met. For instance, an individual may walk along the edge of a wall using the entire structure as a reference point to where they are (a sequence of closely spaced waypoints if you will) (Harper, 1998, pp. 19-20).”
The problem is that, on our daily lives, waypoints, orientation points, information points and way-edges are, more often than not, signs which are built to be read by vision only, and not through hearing or tact, given that “touch has become not only restricted in its communicative potential but also repressed by the norms of societies” (Nöth, 1998, p. 407), what makes blind orientation particularly difficult.

At this point we must say that – although tact is the sense that, besides vision, enables spatial recognition, and object recognition – hearing has also proven to serve as an efficient aid to blind spatial navigation (Bennett, 2002; Holland et al., 2002). This happens because sound can function inductively as a non-visual cartographical index, according to a tactile logic of acknowledgment – experience/action-reaction – , when indicating previously established points in a map, activating waypoints, orientation points, information points and even way-edges. Moreover, hearing signs might be used as information points in case someone gets lost. One must bear in mind, however, that blind wayfinding might happen without hearing, but not without tact.

Regarding available tools for wayfinding, there is a need for the development of gadgets that, in addition to representing in space points that are given by a map, do also represent the occurrence of unforeseen obstacles, be they fixed or mobile. Among the common aids given to the blind, Almeida (2008, pp. 112-113) highlights the following:

1. **Sticks**: work as extensions of tact (Gibson, 1966, p. 100), perceiving vibrations from surfaces;
2. **Sighted guide**: clear sighted person who informs the blind about space, also guiding him/her;
3. **Dog**: trained dog. Stimulates speed, independence and provides company;
4. **Technology**: a variety of local and global positioning systems (e.g., GPS, LORAN, VOR-DME) in which the navigator determines current position using signals from transmitters at known locations (Loomis et al., 1998, pp. 194-195), informing about routes, obstacles and other data relevant for mobility.

All of these are semiotic mechanisms encompassed by cognitive processes which are predominantly inductive, through the creation of possible sequential access to a large amount of indexes. Even a clear sighted guide must be an intersemiotic translator of deductive visual knowledge into inductive verbal knowledge when describing a place for the blind; otherwise he or she will not accomplish their task.

### 6. Summary and future work

Sight impaired and blind persons are, via induction, capable of wayfinding and navigation over predetermined routes defined by cartography, either through mental or material maps. In order to achieve this, signs must be available to the traveler that can be read according to his/her own cognitive necessities and abilities, somehow distinct – and by no means inferior – from those of clear-sighted individuals. By adopting a predominantly indexical/inductive logic, a same diagram might be easily perceived and executed by someone who is visually impaired, as long as a greater amount of indexes is offered.

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3. Wayedge: the continuing and/or interruption of a given sound while a frontier is followed.

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We must also emphasize that the indexes used by clear-sighted persons in navigation also follow an inductive knowledge process, since they operate according to visual experiences. In fact, what we are suggesting is that when tact is the main source of knowledge, the amount of indexes must be greater than the amount required by vision, which is prone to deduction.

In future works, we intend to address two main questions: 1) How does hearing, by appropriation of inductive tactile logic, help on blind wayfinding through technologies that use sound as a primary language? What kinds of data are better transmitted via sound or tact, even when both follow the same tactile inductive logic of recognition/spatial localization? 2) Deepen research about tactile technologies for blind wayfinding, from wooden canes to laser and to the oral tactile interface for blind navigation, designed by Tang & Beebe (2006).

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9. References


