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# HAPTIC BOOKS FOR BLIND CHILDREN: A DESIGN FOR ALL APPROACH

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## ABSTRACT

*Tactile books are devices that combine Braille texts and tactile pictures to promote access to books and reading for blind children.*

*In this paper we shall present our recent Research and Development projects conducted in a publishing house for the blind called Les Doigts Qui Rêvent (Dreaming fingers).*

*We will first discuss the cultural and semiotics aspects involved in the creation of tactile pictures and the possibilities of using these resources as mediators between the visual and non-visual world. We will then analyze more closely two types of illustrations created for the blind: one most common model "raised visual illustrations", and an alternative model "haptic illustrations" exploring sensorial experiences shared by blind and sighted. We shall use examples of books to show why this model, which works with a type of iconicity based rather on actions performed on an object than on its sole visual properties, is most appropriated in terms of inclusion and Design for all.*

*We shall finally introduce a new project to create an educative device for the blind using the method of Participatory design. We promote this method to value the voice of blind people but also, and above all, to change the standard practice of "projection" common in this field: sighted designers who are trying to put themselves in the place of blind people.*

*Keywords: blind children, tactile pictures, haptic illustrations, Design for all, Participatory design*

## 1 INTRODUCTION

Inclusive design or Design for all is a R&D approach created in the United States in the 1980's in line with the movements for the rights of persons with disabilities (such as Disabled People's International established in 1981). In the "Convention on the Rights of persons with disabilities" (United Nations, 2006), inclusive design is defined as "the design of products, environments, programs and services to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design" (Article 2).

In the field of disability, this approach advocates giving up the medical approach. The products designed for all must be as soon as possible easily usable by disable people as well, without any further necessary adaptation. It also implies an in-depth change in the way disability issues are viewed: from a deficiency or a dysfunction, disability can now be seen as the very source of innovation. (Houriez et al, 2013:25 ; Pullin, 2009).

Illustrated tactile books are devices associating Braille texts and pictures to be touched by blind children. The tactile illustrations which can be found in those

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books are made out of various techniques, such as textures collage or embossing.

As part of our R&D activities in the field of illustrated tactile books, we are exploring ways to develop a design model of tactile illustrations rooted in the principles of inclusive design. Through this new model of "haptic" iconicity, in which touched material refers rather to motor patterns and memorized actions than to the visual proprieties of objects, our purpose is to achieve new books and educative tools which can be immediately shared by both sighted and non-sighted.

Our previous research on semiotics had involved the study of strategies in tactile images design and the possibilities for blind people to grasp these contents (Valente & Darras, 2013; Valente, 2012). What we found was that most of these images were visual contents (the drawing of a house, a tree or the profile of a dog) reproduced on a tactile device. Though these images can be felt by manually touching them, they convey a visible reality and a system of rules within a two-dimensional representation that are far remote from what the children are experiencing in their daily life (conventional points of view, objects that are shrouded or superimposed in a scene). Touched material (the representamen in pragmatic semiotics) doesn't relate to its reference object due to a lack of interpretants coming from a visible reality and also because these subjects don't belong to a community of production and interpretation of figurative signs. Relying on a visual type of iconicity that is remote from the way children discover the real world, these images make the pleasure of discovery into a real brainteaser, while they strengthen disability issues and cultural exclusion.

Given this observation, we are inclined to further investigate the possibility of creating illustrations based on haptic iconicity rather than on a visual one. The term "haptic", introduced in psychology by Révész (1950), stands for the entire range of kinesthetic, tactile and motor sensations of the body interacting with objects and environment (Heller & Gentaz, 2014, Hatwell, 2003). In this paper, we will be introducing the semiotic basics of this illustrative model. We shall then refer to some examples of editorial projects of the kind, while underlining their benefits in terms of inclusive design.

## **2 RAISED VISUAL ILLUSTRATIONS VERSUS HAPTIC ILLUSTRATIONS : TWO TYPES OF ICONICITY**

To create tactile devices, the sighted designer is juggling between two different semiotic and perceptive contexts : on the one hand, a visual world filled with pictures of all sorts to which he is "spontaneously" used to and on the other hand, a blind world he is striving to imagine or experience by closing his eyes. However, as his culture is inevitably centred on visual representations, he finds it hard to get rid of some of his automatic reflexes. Most of these tactile images are in fact visual images, replicated in relief or simply "recoloured " and mixed with various textures such as foam, baize or textured papers. As it has been pointed out in our previous work (Valente, 2015; Darras & Valente, 2010), the visual images made tactile are based on the fairly narrow presupposition of a blind person's perceptive process, a clearly "visu-centric" approach; that is, the assumption that the fingers are the eyes of the blind and that the "eyes at the

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fingertips” are the most natural medium to be able to understand images and drawings.

The “haptic illustrations” pattern, as an alternative to the classic and visu-centric “raised visual illustrations” pattern, is grounded in the bodily actions and experiences that are common to the sighted and the blind. Walking up the stairs, swimming in a pool, riding a bike, makes you use a both sensorial and motor perceptive system called haptic perception. Haptic perception is the cognitive rendering of the world explored through the body, the entire range of muscles and the skin. It integrates “the cutaneous information and the proprioceptive and motor information linked to exploratory movements” (Hatwell, 2003: 12).

To fully grasp the difference between the two models, let’s take the illustration of a house as an example. As can be seen in the table below, model 1 –“raised visual illustration”- depicts what looks like a house through the classic visual sketch made out of a triangle and a square.



	The house	
Type of illustration	1. Raised visual illustration	2. Haptic illustration
Medium Representamen		
Iconicity	<b>Visual iconicity:</b> Global appearance of a house.	<b>Haptic iconicity:</b> action of opening a door.
Interpretants	<b>Visual interpretants</b>	<b>Haptic interpretants:</b> Mediation through interpretants that are common to sighted and blind.

Table 1 - Raised visual illustration and haptic illustration, comparative model

The fact of considering the differences and equivalences in the interpretation of an image / sign by readers situated in different cognitive and socio-cultural contexts requires an appropriate methodological approach. Thus we have adopted the pragmatic semiotics of C. S. Peirce and its most recent applications in field of image and design (Darras, 2011; Darras, 2006). Unlike the structuralist school of semiotics, which focuses on the internal organization of the system of signs, disregarding the conditions of interpretation or considering that they can be generalized from the experience of the analyst, Peirce’s pragmatic semiotics is interested in the construction of signs by users in the context of their experience and according to the circumstances of production of meaning by the user. This approach, however, is only partly ‘subjectivist’ because it shows that the construction of meaning is undertaken within interpretative communities that regulate common sense and diverse experiences. The different results of these constructed meanings are more or less stabilized within the various internal and external memories available to individuals (Darras & Valente, 2010).

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For the sighted, the iconic relationship between the figurative sign illustrated in model 1 and the real object house depends on factors of which a large part is related to the visible aspects of objects and also derive from the subject's belonging to a production and figurative signs reading community (Valente & Darras, 2013; Darras, 2003, 1996). As for the blind, although they can correctly identify by touch the materiality and position of the lines on the page, they fail to unambiguously make the link between the touched materiality and the real object illustrated. The iconic relationship between the figurative sign explored by touch and what it refers to — its object of reference — remains very challenging in their interpretative context for two main reasons : 1) the iconic relationship is here referring to proprieties linked with the shape and global appearance of the object that are perceived in a visual experience, which is precisely inaccessible to these subjects. 2) The blind have basically very few prior contacts with figurative signs and lack the interpretants enabling them to create an iconic link between the touched figurative proprieties and the real object, i.e a triangle represents a roof and a square represents a house (Valente & Darras, 2013).

While they were submitted to different tests on tactile images recognition, blind children have shown difficulties understanding some visual rules of object representation in a two-dimensional space. (Valente, 2012 ; Heller, 2006 ; Millar, 1991, 1975). When asked about his opinion on a very similar drawing as our example house sketch, a blind adult confided to us his difficulties to decipher without any ambiguity the figurative components of the representation: " Those shapes over there, what are they? Windows, aren't they? About this one I don't know either! (...) Is it a door? I just can't figure it out. If you say so, well, this is a door, but to me it doesn't add up sensorially speaking. Here, for example, I see a rectangle, not a window. This could well be something totally different too, like a mosaic or tiles..."

In the second model characterized as "haptic", the house is depicted through the relevant action of coming home, illustrated by the concept: a "door opening". Thanks to a system of opening and closing by handle, the child may indeed mimic the action of opening a door. On the far right side of the door, there's a specific texture which imitates the sound of a door opening. In this illustration, the iconic link between the touched/handled material and the real object is carried out through sensorimotor memory of an action and not on the semantic memory of the object's global appearance. It must be noted here, that the iconicity concept we are mentioning can be defined as a "similarity which is not associated with the object's appearance but to a recognizable important characteristic of it" (Gomes, 2005). This relationship of similarity is thus not exclusive to the visual field, since a sign-representamen can also refer to a reference object through touch, sound, taste, and so on.

In a study on the recognition of raised-line drawings by blind children (Valente & Darras, 2013), we found that haptic information and action patterns could also help blind children understand specific drawings. Indeed, the illustrative registers representing the trajectories of interaction with objects – climbing stairs and sliding down a slide for example – are more easily understood by the blind than drawings that simply represent the formal properties of the object itself (like the drawing of a house). The representations of the stairs and the slide have figurative components based on an haptic iconicity. Blind children were able to understand these drawings as they explored the lines with their fingertips and this exploration mimicked the movement of the feet on the stairs or that of the body sliding in an oblique line down the slide. This iconicity of "haptic" type is particularly developed in a number of books of the publishing

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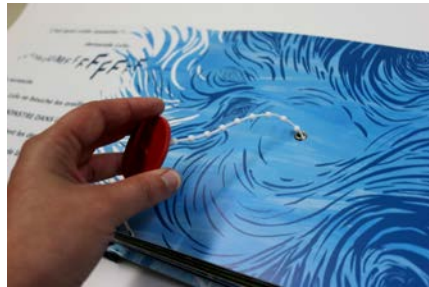
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house *Les Doigts Qui Rêvent* and more precisely in a new book project "Little Fingers", which we shall further analyse.

### 3 HAPTIC ILLUSTRATIONS AND THE "LITTLE FINGERS" PROJECT

Over the past few decades, the children's books sector has been impacted by new publications that have moved beyond the confines of the conventional album. The "pop-up" or "book-games" albums offer very original and interactive reading experiences (Boulaire, 2012; Fouquier, 2012). We see it as a wonderful breeding ground for alternative forms of illustration based on haptic experience. We strongly assume that the new illustrations created from the start for the specific context of the blind children, have a real innovation potential in the field (Valente, 2014).

Les Doigts Qui Rêvent publishing house is more and more exploring the handling and interactivity approach in some of its illustrations. It can be found in the recent books *Wa-Wa* and *Un Hiver Magique*. In *Wa-Wa* (2012) about toilets, children can flush the toilet thanks to an interactive system and a cord attached to the page. In *Un Hiver Magique*, published the same year, the child can walk on the snow, which is "illustrated" by a texture reproducing the sound and the sensation under the feet.



Figures 1 : to flush the toilets tanks in "Wa Wa" Figure 2: to walk on the snow in "Un Hiver Magique"

The sliding mechanism allowing the reader to move a character to the other end of the page is a device often used in the tactile books. An all pioneering experience based on the notion of path-following is also suggested to us in the new editorial project *La Chasse à l'Ours* (original title "We're going on a bear hunt"). On this book, the child may explore the illustrations using a pawn that moves from one side of a page to the other and finds himself completely engrossed in places like a forest, meadows or a stream.

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Haptic books for blind children: a Design for All approach

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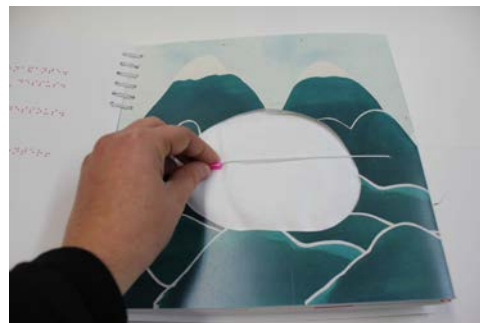


Figure 3 and 4: Adaptation of the book "We're going on a bear hunt": the child follows a path and finds himself engrossed in places like a forest or in the snow (Prototype)

The concept of body journey is even more deeply developed under a new project entitled « Little Fingers », but still in the prototype stage. A research project has been set in order to analyse the cognitive, perceptive and semiotic factors related to how blind children make this new type of illustration their own, with the participation of two laboratories in cognitive psychology (Laboratory for the Study of Learning and Development, UMR 5022, University of Dijon and Laboratory of sensorimotor, emotional and social development from birth to adolescence, University of Geneva) and the Semiotics of Arts and Design Team (ACTE Institute, UMR 8218, University of Paris 1 Sorbonne).

A rapid prototype is created to convey the general concept of the book. The objective is to develop the prototype using participatory design and to test it with groups of blind children. This book explores a new approach centred on the representation of the actions of the body while it interacts with objects. Using two fingers, the child mimics the movement of the legs and engages in a journey that starts from the first page of the book. Using pop-up mechanisms, the real materiality of the scenery unfolds and the two fingers/legs perform various actions: they follow a zigzagging path, jump on a trampoline, climb and descend stairs, play on a swing, etc.



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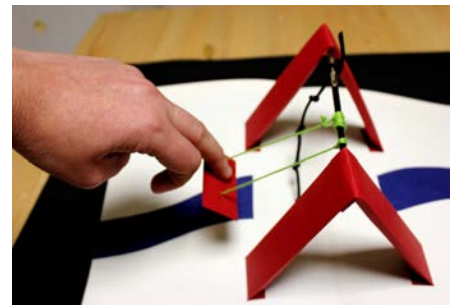
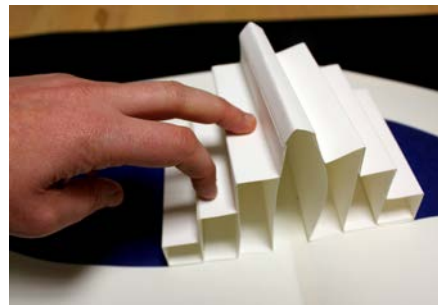
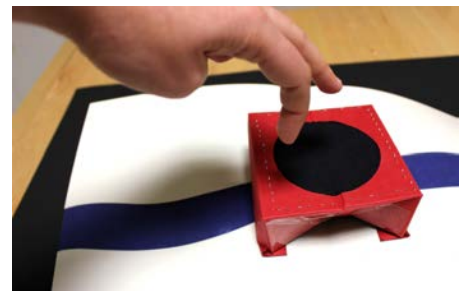
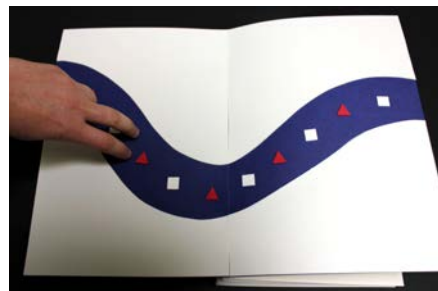
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Figures 5-8 - Prototype Little Fingers: zigzagging path, jump on a trampoline, climb and descend stairs, play on a swing, etc.

To fully analyze how blind children may grasp the various elements displayed in this book, it appears necessary to reframe and widen significantly the issue linked with their understanding of tactile illustrations. From research issues exclusively centered on the semantic approach and the capacity of touch to identify objects on two-dimensional illustrations, it is indeed necessary to shift and add the questions relating to the pragmatic approach dedicated to actions performed on objects and the iconic potential of this materiality (representamen) in memorized sensorimotor patterns.

Jeannerod's works in neurophysiology published in the 90's have put forward two systems of distinct treatment during perceptive activity: a semantic system and a pragmatic system (Jeannerod, 1997). The semantic system would be devoted to the identification of the object -its global appearance, shape, colour or texture-, while the pragmatic system would be specifically dedicated to the treatment of motor and functional proprieties linked with actions performed on objects (gesture of seizing an object or active exploration of the environment). The semantic function would be concerning the « What », whereas the pragmatic function would be responsible for everything relating to the « How ». (Rosetti, 1997).

Questioning the pragmatic approach of the perceptive activity is interestingly close to the notion of affordance introduced by Gibson (1979), as well as to the concept of *enaction* by Varela (1993). Consistent with an ecological view of perception, the notion of affordance describes the solicitations coming from the environment, which enable the immediate perception of an individual in the form of an action. To Gibson, the individual is engrossed in his environment and perceives objects starting from the possibilities of actions he may exercise on them. Derived from the English *to afford* (enabling to, allowing to), the term affordance deals with environmental solicitations of objects: a staircase is used to go upstairs, a hammer to hit, a path to be walked through and a door can be opened or closed...The affordances depend on the subject of the action'.



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sensorimotor faculties (perceptive system, field of action, height,...)., What may constitute an obstacle for a human being may not be so for an ant. The notion of affordance is relevant in the cognitive ergonomics and design sectors, inasmuch as it aims at giving the objects an appearance or a shape that suggest ways to utilize them (Richard, 2004). To our knowledge, very few studies have particularly examined the notion of affordance on how it may be applied in the perceptive context of blind persons. The few research pursued are devoted to the comparative analysis of the affordance of inclined surfaces by both haptic and visual perceptions (Fitzpatrick, Carello, Schmidt & Corey, 1994 ; Miossec, Darcheville, Luyat & Regia-Corte, 2004).

In "The Embodied Mind: Cognitive Science and Human Experience" (1993), Varela, Thompson and Rosch introduce a more systemic alternative to the notion of affordance through the notions of *enaction* and embodied cognition. A middle ground is explored between externalist/objectivist theories and internalist/subjectivist approaches of cognition, while the structural couple individual/environment is emphasized. Cognition does neither depend solely on the environment, nor on the simple knowledge of the subject. Environment and perceiving subject are determining each others. "Contrary to the concept of affordance, enaction results from two operations; on the one hand, an action guided by perception, on the other hand, cognitive devices emerging from sensorimotor schemes, which gives way for the action to be lead by perception." (Darras & Belkhamza, 2008).

In « Little Fingers », readers are invited to use their fingers to interact with miniature objects as they would do with their own body. For the discovery process to be effective, the objects presented must include sensory cues that are as close as possible to those found in real environment. To design this book and optimize its ergonomics, we may then question the way the affordances are acted and how *enactions* are processed in the specific perceptive and motor context of the blind. On a semiotic perspective, we also need to study the representative potential of the sensorimotor experiences of the body in action, and examine if illustrations such as walking up the stairs, the back-and-forth movement of the swing, jumping on a trampoline mimicked by fingers, are able to produce a type of haptic iconicity which could facilitate identification of objects for the non-sighted persons. The research program aiming to answer these questions consists in three key steps associating qualitative and quantitative research approaches: 1) Elaborating illustrations with users-readers in the making of a co-design project 2) 2D tactile illustrations recognizing test plus original haptic illustrations under the process we advocate 3) Testing the usability of prototypes and focus group. We are currently requesting for funding in order to carry out this research.

The confirmation of the hypothesis according to which data relating to sensorimotor experiences with objects and sensory experience can facilitate the comprehension of illustrative content could drive the development of new communication interfaces and devices that are directly understandable by a larger number of subjects, regardless of their sensory skills.

Illustrations based on haptic iconicity have the advantage of being based on experiences that are possibly the same for sighted and blind children. Unlike books with 2D tactile illustrations, which use visual content that are quite different from blind readers' experience, multisensory books create communication bridges between these two communities.

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## Future perspectives and ongoing participative design projects

In this framework of new R&D projects developed by Les Doigts qui Rêvent, we are also trying to set up a new design procedure in order to achieve innovating device in the field of books and reading. While seeking to avoid a practice of "projection" (when a sighted designer tries to put himself in the place of a blind person) we are testing a new participative method linking mediation and design. The aim here, is to associate the users with the designing of the devices.

Such an idea has been realized in the design of an educative tool revolving around a comic-strip album. Before the prototype stage, mediation workshops were organized with the children on a particular theme to collect data about their perceptive experience and assess their needs.

### 3.1 WORKSHOPS AND DESIGNING THE EDUCATIONAL KIT

In the comic album, each box illustrates a moment of the narration. Reading the boxes in sequence creates the characteristic motion of comic-strips. Visual signs like speed lines are commonly used to symbolize the trajectory of an object or to suggest an impression of movement (behind a car, for example). How to address such inherently visual notions with blind children? During the workshops, we took a big Velcro board with mobile boxes. Children could choose between different rail systems to animate the characters of the story and create their movements. One had to make up a comic-strip story with two characters using five boxes.

It proved so successful during the workshops, that we used this system again to introduce a tactile board from the comics « Ma Dalton» in Lucky Luke, included in an educational kit. This tactile board is composed of five boxes as well. To help familiarizing through touch and a correct handling in moving the pawns, the representation of two heroes in the story ("Lucky Luke" and "Ma Dalton") was simplified. The choice of fabrics depends on each tactile figure, also included in the kit.

"Lucky Luke" can be seen on the left with a small leather jacket and his cow-boy scarf. "Ma Dalton" is on the right wearing soft corduroy fabric:



Figure 9 - Tactile board « discover» (prototype)

The audio content is guiding the children during the discovery of the comics' notions and their testing the tactile device. As a first step, they listen to the audio story of Ma Dalton; then, they will be guided into the discovery of each

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tactile box, each telling a part of the story. This part is very interactive because it is up to the children to make the characters move along the rails while they listen to the sound samples. The extract below depicts the moment when the children have to switch to box 3 and make the corresponding figures move, as Lucky Luke and Ma Dalton are about to cross a street:

*Plin !* [acoustic signal]

Narrator's voice : *Once again, you can hear the little sound meaning you have to switch boxes. Remember how to read the comics : from left to right and from top to bottom. Now you can move to the box below.*

**Box 3**



Figure 10 – tactile comics – box 3

At this stage, you'll see that this box is way bigger than the previous ones .This one illustrates the scene when Lucky Luke and Ma Dalton are crossing the street. This sequence lasts longer than the other ones. It lasts 30 seconds. Let's imagine this box as a street to cross. When the time's right, in the next audio sample, you'll have to move our two heroes from the left to the right.

Are you ready?

Yes?

Let's go:

Audio story (30 seconds): An old lady shows him the other side of the street: "It's a pleasure young man. I'm going to the butcher's on the other side." Lucky Luke holds her by the shoulders and they begin to cross the street [Pacing sound].

**Box 3: crossing the street**

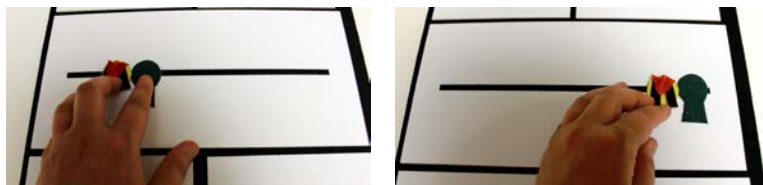


Figure 11 – tactile comics – box 3 (crossing the street)

Here you are?

Congratulations! They are now on the other side of the street!

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Other educative devices have been tested during the workshops and have been added to the kit such as a lottery of onomatopoeia and tactile images with ambient sounds helping understand the notion of framing.

Other ongoing participatory design projects are also aiming to involve not only the final users, but the professionals as well (teachers, educators, speech-language pathologists) in the making of new books and educational kits. From this starting point, our project is to organize design workshops ("Edu-Touch – Let's create together") with groups of professionals united to think about new practical tools or learning materials destined to the field. Several steps are planned in the workshop's schedule: defining the problematic, collecting ideas, creating a prototype, phase of testing, and field immersion.

#### 4 CONCLUSION

Every child, regardless of his/her disability, has the right to receive an education on an equal basis with other children (Convention on the Rights of persons with disabilities, 2006). Nowadays, blind children suffer from a 'book famine' (Unicef's State of the World's Children 2013: Children with Disabilities, 2013) and the very few illustrated books which do exist are often inadequate, as they are mainly based on a visual approach. During childhood, illustrated books are a great driver for social inclusion as they foster joint reading between the child and the adult or between the child and his/her peers. They thus constitute a major tool for sharing experiences.

Teachers and families are looking for reading support tools both accessible to everyone but also adapted to their children's needs. The projects presented in this article are directly in line with the three principles of inclusive design: 1) they are grounded on the sensorial experiences common to all children without any discrimination (vectors for exclusion are erased) 2) They are genuine tools for sharing, comprehensible for sighted and blind children without any necessary adaptation (abandonment of the "specialized approach") 3) Within designing projects like the one using the comics, the new device are built in collaboration with the user through the participative design method.

We are vividly assuming that the sensorimotor experiences with objects, as we have shown through the projects presented in this paper, is likeable to launch new interfaces and communication devices that can be fully understood by a great number of people, regardless their sensorial capacities.

We are also convinced that the participative design projects constitute a real innovation potential in this area. Involving the users in the designing process may deeply affect the designers's working method. Giving a voice to the individuals concerned seems to be the best solution to avoid mistakes and prejudices surrounding blind people capacities. As the first project involving the comic-strip was successful, new interesting dimensions are provided towards shaping new devices accessible to all and adapted to the needs of children with visual disabilities.

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