THEMATIC ISSUE

Tactile Picture,
Cognition,
Education

Issue edited by Dannyelle Valente & Philippe Claudet

September 2014
Terra Haptica
International Journal of Visual Disability and Inclusive Practices

The international journal Terra Haptica, created by Les Doigts Qui Rêvent (Dreaming Fingers) in 2010, associated since 2012 with the ACTE Institute (CNRS 8218 - University of Paris 1 - Sorbonne), focuses on the socio-cultural, communicational and cognitive aspects of the visual impairment.

Supported by a scientific committee, each thematic issue is composed of two sections: a section devoted to Research, in which articles are submitted to a reading committee; and a section devoted to “Reports of experience”, providing a voice for practitioners and users.

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© Terra Haptica - #4 September 2014
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EDITORIAL

Tactile pictures, cognition and education,
Dannyelle Valente¹

In its report, “The State of the World’s Children 2013: Children with Disabilities”, UNICEF presents the principles of inclusive society and underscores its major difference from the model of social integration popular during the second half of the 20th century. In practical terms, social integration of a person with disabilities simply meant finding a place for him or her in an environment within a system of norms, featuring fixed principles and rules. Integrated, but not really included, the person with disabilities is supposed to “make do”, adapting herself through sometimes near heroic personal efforts to a society conceived by and for able-bodied people.

The inclusive system, derived from a social rather than a medical model, seeks to reverse the logic of “who adapts to whom” by addressing the root of the problem, namely, the society: on one hand, its maladjusted services, products, and practices, and on the other hand, its false beliefs and misperceptions concerning the skills of persons with disabilities. The child with a disability does not adapt herself to the school, rather it is the school that becomes inclusive.

The inclusive approach is anchored in respect for individual differences and the right of each to learn and live in a society with whatever sensory, physical and cognitive features she possesses. An inclusive society is a pluralist society, with all shapes and colors. It is a society that invests in and plans for the future in order to improve the shared life of all its members, questioning itself, constantly changing and working to remove all barriers, cultural, educational, and behavioral that hinder social participation of its citizens.

An inclusive society innovates, builds, and develops its services and devices based on the principles of Design for All, an approach to design and research born in the USA during the 80’s, connected to the movement for the rights of people with disabilities (Disabled People’s International established in 1981). Let us recall three crucial points that guide the design process in this approach:

- The crucial importance given to the experience of the user in the design process through implementing innovative methods of research and design that involve active participation of users (especially the methods of Participatory Design).
- The identification and elimination of exclusion and stigmatization in products that are designed on the basis of able-bodied standards and habits.
- Abandonment of a “medical”, “specialized” approach to design aimed only at a small group of people and for use in a specific context.

These principles can be summarized as follows: no service should remain out of reach but shall be designed, from the outset, FOR and BY disabled people. This idea is strongly defended in three recently published important documents: the “Convention on the Rights of Persons with Disabilities” (United Nations, 2006), the “World Report on Disability” (World Health Organization, 2011) and “The State of the World’s Children 2013: Children with Disabilities” (Unicef, 2013).

The new approaches to design (Design for All, Participatory Design) are in keeping with the change in standards advocated by current theoretical and scientific trends as evidenced in the field of Disability Studies. They evolve from and alongside this new way of thinking about disability from a socio-cultural rather than a medical perspective. The challenge is to replace notions of lack, deficiency, dysfunction

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and illness with notions of social responsibility, law, citizenship, accessibility and social participation. These new notions are contained in the term “differently abled”, proposed nowadays as an alternative to “disable” and “impaired.” Everyone is a priori “capable of” and we have only to find the adaptive means to reveal these capacities.

Issues in visual impairment: Evaluation of new tools and practice

We are immersed in a highly visual culture; pictures are everywhere and a great quantity of information is transmitted to us visually, every day. Despite the increasing availability of tactile, multimedia, and multisensory interfaces and devices, reduced access to documents in libraries, schools and cultural places is still the greatest barrier that confronts blind people.

There is no doubt that tactile documents, such as diagrams, graphics in mathematics or maps in geography are important tools for mediating and obtaining knowledge in school for blind and students with visual impairments. In the course of adapting the visual content of these for tactile reading, questions arise concerning what type of relief technique to use and overall how to adapt the content in order to be easily understood by individuals with visual disability. It also seems crucial to provide, in school and from an early age, a training program to support tactual discrimination and interpretation of these documents, including aspects of the visual conventions they contain.

The study by Valerie Morash and Amanda McKerracher, which begins this issue, is about this question: the interpretation of tactile graphics in relation to the learning of mathematics by blind students. A certain number of studies in psychology and semiotics over the past several decades have shown that visual contents produced in relief may be difficult for blind individuals to interpret (Valente & Darras, 2013; Thompson, Chronicle & Collins, 2003; Lederman, Klatzky, Chataway & Summers, 1990; Heller, 2006; Millar, 1991, 1975). The issue of understanding diagrams and graphics is even more complex because they are systems of representation that follow conventions that have very little concrete relationship to perceived reality. The ability to understand these tactile interfaces is all the more important because they are not only used daily in schools but also included in grade level standardized tests and college entrance exams, such as the Scholastic Aptitude Test (SAT), an exam that contributes to college admission decisions in the United States and elsewhere. After 20 years of specific pedagogic programs in schools (Expanded Core Curriculum and Braille Mathematics Standards in the USA) that aim to teach students how to use these types of documents, Valerie Morash and Amanda McKerracher attempt to evaluate whether students could indeed effectively use them or if, instead, the difficulty in decoding these documents adversely affected the performance of the students.

Understanding of tactile graphic contents by blind people and the improvement of interfaces made for them is also the area of study of the Chilean researcher, Maria Del Pilar Correa Silva. She conducted an extensive project supported by the National Commission of Scientific and Technological Research of Chile, analyzing 80 tactile pictures that appear in textbooks. Her principal research question is the following: What variables of the tactile image allow for a better communication of visuospatial information to blind children? In the paper provided here she summarizes the main results of this broad research program whose detailed results are published in her book *Imagènes que podemos tocar* (Correa, 2011)².

The third article presented in this issue is devoted to the more specific problem of representation and spatial orientation of partially sighted and blind people. Researchers from different French teams (Bourmenir, Verine et al.) compared the mobility skills of congenitally blind, late blind and blindfolded sighted subjects in a complex urban environment using tactile maps and verbal information provided by a touchpad device. Results showed that congenitally blind subjects find their way more easily than either of the other groups. Indeed, they perform better in using tactile and

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verbal data. This interesting study supports the idea advanced by Cornoldi and Vecchi (2000) that lack of vision does not pose a problem in processing spatial information per se. The “generated images” drawn from other sources of information (for example, haptic or verbal information) can be as effective as spatial images derived directly from visual experience.

Samuel Lebaz and Delphine Picard from PsyCLE Research Center (Aix-Marseille University) present in this issue a study about the recognition and classification of tactile pictures showing facial expression of an emotion (surprise, happiness, sadness, etc.). In the midst of the current debate on the skill of blind people in understanding raised line drawings, these authors provide a positive answer.

The question of interaction between the examination of tactile images and reading the accompanying braille text seems to us very interesting to take into account, mainly because youth literature and most tactile documents frequently present both. Within this framework, Yvonne Eriksson and Kerstin Fellenius studied the differences and connections between these two types of “reading” activities. The objective was to evaluate whether Braille readers use the same or similar hand movement strategies for reading in Braille and for exploring and interpreting tactile pictures.

The two last articles belonging to the research section deal specifically with intervention and assessment tools as well as innovative educational practices for blind people. The article of Mazella et al. involves the design and evaluation of a 2D haptic test battery for use with children and adolescents with and without visual impairment. This test battery, detailed clearly in the article, offers a means of assessing the perceptual-motor and cognitive skills involved in the processing of 2D tactile materials. It has been tested with a group of blindfolded sighted children and a group of children with visual impairments. Among the results, it has been shown for instance, that children who are visually impaired perform better on haptic discrimination tasks than blindfolded sighted children.

Finally, the article “Tranversal Learning: a key to autonomy for visually impaired people - Investigation in a special school”, from Anne-Lise Mithout presents data from participative observation of a transdisciplinary workshop with children with visual impairments conducted by a French teacher and a mobility trainer.

Link between research and practice: Report of experience section

One of the major ambitions of the journal Terra Haptica is to be a space for exchange and scientific cooperation in the field of visual disability. The journal was created by Philippe Claudet in answer to the need to strengthen the dialog between research and practice and to be able, finally, to connect the voices of all of the actors and experts in the field of tactile perception, image, art, language and the science of education. Its priority is to create a synergy among different actors whose scientific work and field experiences contribute to improving inclusive practices involving books, culture, and education.

The section titled “Report of Experience” gives a voice not only to practitioners, educators, and users but also to cultural mediators, artists, and illustrators who work in designing new devices, services and practices intended for blind people.

As a first and innovative experience from India, Kahani Her Mahine Ki (translated from Hindi language as “The Same Story Every Month”), is a kit designed to address the subject of the menstrual cycle for blind young girls. This device, successful aesthetically and practically, contains several boards in relief with accompanying documents in Braille that describe female body parts, the reproductive tract, and the process of menstruation. The device has been tested with ten students with visual impairments, aged 8 to 20 years.

In the next article, Aksinja Kermouner presents a new project, “Book in a Box”, intended for young blind children. The device combines Braille text and tactile illustrations, some audio materials, and miniature models of objects depicted in the illustrations. It is an interesting tool for promoting a child’s first contact with written language writing by encouraging their entry into literacy in a playful
way. In the previous part of the presentation of this multisensory device, the author deals more generally with issues related to the dominance of vision in our culture and with perceptual features of blind individuals. The article also presents some possible uses for this device with children with other types of disabilities.

The third report of an experience from the field comes from Brazil. The authors work in a leading museum of biology, *Museu do Instituto Adolfo Lutz*, where they have developed tactile devices and games to enable blind visitors to discover and learn about biological elements and organisms housed in the museum, such as snakes and parasites. In 2006, they launched the program “Dr. Know It All – The Vehicle of Knowledge” in order to show tactile devices in schools, hospitals and associations. Professionals of these institutions were trained in the design and production of these tactile devices.

Returning to France, we discover the work of professionals from the Rhône Alpes Resource Center for Visual Impairment (CTRDV) and a “pre-reading / language / representations” program from the *Fédération des Aveugles de France*. The article presented an educational suitcase created to help develop reading, language and mental representations. The second part of the article focuses on the possible use of this suitcase around the topic of physical guidance.

The last article in this section provides a well-documented reflection on the diagnosis of autism disorder in children with visual impairments. Andrea Urqueta Alfaro presents her experience, obtained through her work as a specialist at the Blind Babies Foundation in California. Although her work on this topic began while pursuing a Ph.D. at the University of Berkeley, here it is offered in a more reflective vein. The article reviews studies and findings on three key behaviors often cited in diagnosis of autism disorders in blind children: stereotyped behaviors, difficulties with pre-linguistic social interaction and communication, and difficulties in joint attention. This very informative study cautions against a superficial interpretation of these behaviors as evidence of autism disorder when a child has a visual impairment.

From France, Brazil, Chile, India, Slovenia and United States of America, the authors of the articles selected for this issue responded to an international call for papers and their work has been submitted to peer review. *Terra Haptica* #4 presents both representative studies of high quality and reports of experience in the area of visual impairment. *Terra Haptica* #5, due soon, will be devoted to the theme of cultural and artistic accessibility for individuals with visual disability.

Finally, we hope that the works presented here contribute to broadening and enriching knowledge in the field of visual disability and promote the development of inclusive and accessible practices across cultural, social, and educational contexts.

We wish you a very rich and successful trip through *Terra Haptica*.

- References -


Construction of a 2D Haptic Tests Battery for Use with Children and Adolescents with and without Visual Impairment

Anaïs MAZELLA¹, Mélanie LABARDIN², Sandra MESNIERES³, Jean-Michel ALBARET⁴, Delphine PICARD⁵

In line with the work of Ballesteros et al. (2005), we designed a Haptic Tests Battery for children and adolescents with and without visual impairment. This tool aimed to assess the perceptual-motor and cognitive skills involved in the processing of 2D tactile materials. The Haptic Tests Battery comprises 11 tests organized in five categories assumed to measure (1) scanning skills, (2) haptic discrimination skills, (3) spatial understanding, (4) tactile short-term memory, and (5) tactile picture comprehension. Preliminary results were obtained with 13 blindfolded sighted children and 13 visually impaired children, aged 9-10 years. Results showed that the two groups of children did not differentiate in their total score. However, the visually impaired children scored significantly higher in haptic discrimination tasks (shape and texture). Finally, the visually impaired children were also significantly more efficient and quicker than their sighted peers in tactile picture comprehension tasks. In the end, the Haptic Tests Battery should guide and support professionals of visual impairment in their practice.

Keywords: Haptic, Raised-line picture, Visual impairement, Psychometric tests

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INTRODUCTION

The vast majority of psychometric tests rely on the visual modality. Therefore, their usability in persons with visual impairment (i.e., those who are totally or legally blind, and those who have low vision) is a matter of debate (see Reid, 1994, 1995). Several American surveys (Bauman & Kropf, 1979; Hannan, 2007; Miller & Skillman, 2003) have shown a considerable dissatisfaction among professionals with current assessment procedures of cognitive and abilities applied to visual impaired individuals. Haptics (i.e., the sense of active touch; Gibson, 1966; Revesz, 1950) represents an interesting alternative to vision that could be adapted specifically for assessing visually impaired individuals whose “perceptual experience is haptic rather than visual” (Ballesteros, Bardisa, Millar, & Reales, 2005, p. 11). This modality can be used to process various properties of three-dimensional (3D) objects (Gentaz, 2009; Hatwell, Streri, & Gentaz, 2003; Lederman & Klatzky, 2009), but it can also be used to process two-dimensional (2D) raised-line materials, such as tactile images (for recent reviews, see Heller, 2002; Picard & Lebaz, 2012). Overall, haptics plays a key role in the cognitive and perceptual development of visually impaired people (Hatwell, 2003; Withagen et al., 2010).

Psychometric tests involving the sense of active touch are not numerous, and often lack some of the necessary psychometric properties (sensitivity, reliability, and validity) (see Mazella, Albaret, & Picard, in press). In addition, most of the currently available tools are tests for adults and only a few are suited to assess children. A notable study using a developmental perspective was conducted in Spain by Ballesteros et al. (2005). These researchers developed a haptic tests battery to assess perceptual and cognitive abilities of blind and visually impaired children from 3 to 16 years. The battery consists of six categories of tests that are assumed to measure: spatial comprehension, short-term memory, object identification, raised-shape identification, sequential scanning, and texture and material discrimination. The authors reported a significant main effect of age on the scores obtained from 14 subtests of the battery. They also found that visual status was a significant factor for variation in performance, often with higher performance obtained by the blind children at several subtests. This developmental battery is a useful tool. However, one major limit of this battery is that it basically permits the study of children’s haptic perception of 3D materials.

While the use of 3D assessment materials appears both ecological and suited to the haptic modality (Lederman & Klatzky, 2009), we cannot ignore the fact that visually impaired children and adolescents are extensively exposed to 2D materials. Indeed, from an early age, in school learning situations, visually impaired children are working with 2D tactile materials, such as Braille or raised-line pictures (e.g., symbols, graphs, maps, drawings). However, despite the fact that 2D haptic skills play a leading role in perceptual-motor and cognitive development (Kirby & D’Angiulli, 2011), these specific haptic skills have not been the focus of assessment tools so far. It is therefore important to create novel tools that specifically assess 2D haptic functioning in visually impaired children, and to make them available to psychologists. Importantly, these tools should have all the properties expected for genuine psychometric tests.

In line with the work of Ballesteros et al. (2005), we conducted a research project in which we designed a 2D Haptic Tests Battery for use with children and adolescents, with and without visual impairment. Our tool aimed to assess the perceptual-motor and cognitive skills involved in the processing of 2D tactile materials. This new haptic test battery is currently under construction and experimentation with the targeted population. In the end, it should allow us to assess age-related changes in children’s haptic abilities as well as differences due to visual status. Our research therefore uses both a developmental and differential perspective. Below, we first present the overall structure and content of our 2D Haptic Tests Battery. Then we report some preliminary results obtained with a small sample of sighted and visually impaired children aged 9-10 years.
PRESENTATION OF THE 2D HAPTIC TESTS BATTERY

Overall structure of the battery

The main hypothesis underlying the structure of our battery is that tactile picture reading is a complex activity, involving different perceptual and cognitive mechanisms (see Lederman, Klatzky, Chataway, & Summers, 1990). These mechanisms range from information encoding to the mental representation of picture content, and access to its semantic meaning. In our view, tactile pictures reading skills develop in children concomitantly to the following capabilities:

1) identifying tactile elements that are present in a picture without missing any; following a tactile line without losing contact (perceptual and motor scanning skills);
2) discriminating tactile elements according to their shape, size and texture (tactile discrimination skills);
3) identifying the spatial location and orientation of tactile elements in a picture (spatial processing skills);
4) keeping a set of tactually perceived information in working memory (haptic short-term memory) (see, e.g., Picard, Albaret, & Mazella, 2013).

The battery includes a series of 2D haptic tests, involving low-level perceptual abilities (scanning skills and tactile discrimination skills), and higher-level perceptual and cognitive abilities (spatial comprehension, short-term memory and reading tactile pictures). Table 1 presents the overall structure of the battery. The battery consists of 11 tests, divided into five categories. All tests involve the processing of 2D raised-line materials, and consist of more or less complex raised elements (points, lines, geometric shapes, figurative images...), printed on Swell paper.

Description of the tests

In this section, we provide a short description of the materials and instructions used for each test of the battery. Figure 1 illustrates some of the test materials.

<table>
<thead>
<tr>
<th>Psychological function</th>
<th>Test</th>
<th>Measured ability</th>
<th>Items (nb)</th>
<th>Max score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scanning skills</td>
<td>1- Dot scanning</td>
<td>Ability to scan a raised dot display exhaustively</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>2- Line scanning</td>
<td>Ability to scan a raised line without losing contact</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Haptic discrimination skills</td>
<td>3- Texture discrimination</td>
<td>Ability to match raised-line elements on their material (texture) and geometrical properties (shape, size)</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>4- Shape discrimination</td>
<td></td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>5- Size discrimination</td>
<td></td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Spatial comprehension</td>
<td>6- Spatial orientation</td>
<td>Ability to recognize the spatial orientation of raised-line segments</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>7- Spatial location</td>
<td>Ability to recognize the spatial location of raised-line elements inside a configuration</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Short-term memory</td>
<td>8- Dot span</td>
<td>Short-term memory capacity for tactile numerals (raised dots)</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>9- Shape span</td>
<td>Short-term memory capacity for raised-line geometrical shapes</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Picture comprehension</td>
<td>10- Picture identification</td>
<td>Ability to identify raised-line pictures of common objects</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>11- Picture completion</td>
<td>Ability to detect missing elements in raised-line pictures of common objects</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td><strong>11 tests</strong></td>
<td><strong>132</strong></td>
</tr>
</tbody>
</table>

Table 1. Overall structure of the 2D haptic test battery
Scanning skills
1. Dot scanning. This test contains six items (adapted from Ballesteros et al., 2005). It requires that the child points to each dot with the index finger of his dominant hand so as not to omit any dot on a page or point to dots several times.

2. Line scanning. This test contains six items. It requires that the child follows a raised line on a page with the index finger of his dominant hand, without losing contact with the line.

Discrimination skills
3. Texture discrimination. This test contains six items. It requires that the child explores and memorizes the texture of a standard stimulus with his dominant hand, in order to recognize it amongst a series of four comparison stimuli.

4. Shape discrimination. This test contains six items. It requires that the child explores and memorizes the particular shape of a standard stimulus with his dominant hand, in order to recognize it amongst a series of four comparison stimuli.

5. Size discrimination. This test contains six items. It requires that the child explores and memorizes the specific size of a standard stimulus with his dominant hand, in order to recognize it amongst a series of four comparison stimuli.

Spatial comprehension
6. Spatial orientation. This test consists of six items (adapted from Ballesteros et al., 2005). It requires that the child explores and memorizes the orientation of a figure (which is made of one or more segments) with the index finger of his dominant hand in order to recognize it amongst a series of four stimuli comparison.

7. Spatial location. This test consists of six items. It requires that the child explores and memorizes the location of one or more elements within a circle with his dominant hand, in order to recognize it amongst a series of four stimuli comparison.

Short-term memory
8. Dot span. In this test (adapted from Ballesteros et al. 2005), the child is instructed to memorize and recall in the right order of exploration a list of raised dots. The figures are presented on dominoes and range from 1 to 6. The first series explored by the child includes a single domino, and the length of the sequence gradually increases to a maximum of six dominoes. There are two different trials for each length sequences. Testing is interrupted when the child fails to recall two sequences of the same length.

9. Shape span. This test is created by analogy with the Dot span test, numbers are replaced by geometric shapes.

Picture comprehension
10. Picture completion. This test consists of 8 drawings of familiar objects; it requires that the child freely explores (with one or two hands) each drawing, and identifies as quickly and accurately as possible what the picture represents. For each trial, the category name of the object is given to the child (e.g., fruit for the item of banana).

11. Picture identification. This test consists of 8 incomplete drawings (i.e. drawings with a missing element); it requires that the child freely explores a picture, and identifies as quickly and accurately as possible what the picture represents and what the missing element is. For each trial, the category name of the object is given to the child (e.g., clothes for the sweater).

A maximum score of 12 points can be obtained for each test, and a total maximum score of 132 points for the entire battery. For both tactile picture comprehension tasks, a measure of response time (in seconds) was considered in addition to identification accuracy.
Method for administrating the battery

The battery was designed so that it can be used with children and adolescents, and even young adults, with or without visual impairment sighted. Regardless of age and visual status, administration is individual. It can be performed at school, at home or in the centre in which the child is attended.

First, information about personal characteristics of the participants (age, sex, handedness, type of blindness, practice with haptic materials...) is collected. Second, the psychologist observed all participants individually and presented them with tests of the battery, ranked by category (the order of presentation of the five categories of tests was mixed from one subject to another, according to a Latin square technique; the order of presentation of the tests within a category was also varied across participants). Each test was presented in a booklet (A4 landscape format). A wooden cover was used to hide the equipment from the participants. Whatever their visual status, participants had to use their sense of active touch to complete each exercise of the battery. The tests were performed under the haptic modality only, and there were no visual feedback. Moreover, the conditions of administration were strictly identical for all participants. The administration of the battery lasted 1:30 hour per participant on the average, and it was generally cut in two sessions. A short break was also introduced between each category of test within a session.

PRELIMINARY RESULTS WITH 9-10 YEAR OLD CHILDREN

Characteristics of the participants

A total of 26 sighted and visually impaired children, aged 9 to 10 years, was observed. The sample consisted of 13 sighted children (7 boys, 6 girls; mean age = 122 months, SD = 6), and 13 visually impaired children (10 boys, 3 girls; mean age = 1221 months, SD = 7). Table 2 shows the characteristics of the visually impaired children. All these children had an early visual impairment (i.e., either congenital or acquired in infancy), and six had associated disorders. Seven had low vision (best corrected visual acuity below 4/10), five were legally blind (best corrected visual acuity below 1/10), and two were totally blind (light perception at best). The visually impaired children were from two French specialized care centers for the visually handicapped: Alfred Peyrelongue centre at Ambarès (near Bordeaux) and Cival-Lestrade centre at Ramonville Saint-Agne (near Toulouse). The sighted children attended normal schools and were matched for chronological age with the visually impaired children. We used the 10-item version of the Edinburgh questionnaire to assess participants’ manual preference. On this sample, 3 children (or 11.5%) had a left manual preference; the other had a right manual preference.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Visual Deficiency</th>
<th>Cause of the Deficiency</th>
<th>Associated disorder</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>legally blind</td>
<td>optic nerve hypoplasia</td>
<td>behavioral disorder</td>
</tr>
<tr>
<td>2</td>
<td>low vision</td>
<td>glaucoma + anisida</td>
<td>dysphasia</td>
</tr>
<tr>
<td>3</td>
<td>totally blind</td>
<td>microphthalmia</td>
<td>retinitis pigmentosa</td>
</tr>
<tr>
<td>4</td>
<td>low vision</td>
<td>hypermetropia</td>
<td>retinitis pigmentosa</td>
</tr>
<tr>
<td>5</td>
<td>low vision</td>
<td>anisidemia</td>
<td>retinitis pigmentosa</td>
</tr>
<tr>
<td>6</td>
<td>legally blind</td>
<td>retinitis pigmentosa</td>
<td>retinitis pigmentosa</td>
</tr>
<tr>
<td>7</td>
<td>low vision</td>
<td>albinism</td>
<td>retinitis pigmentosa</td>
</tr>
<tr>
<td>8</td>
<td>low vision</td>
<td>retinitis pigmentosa</td>
<td>retinitis pigmentosa</td>
</tr>
<tr>
<td>9</td>
<td>legally blind</td>
<td>optic nerve atrophy</td>
<td>retinitis pigmentosa</td>
</tr>
<tr>
<td>10</td>
<td>legally blind</td>
<td>neurofibromatosis type</td>
<td>retinitis pigmentosa</td>
</tr>
<tr>
<td>11</td>
<td>low vision</td>
<td>malformation</td>
<td>retinitis pigmentosa</td>
</tr>
<tr>
<td>12</td>
<td>low vision</td>
<td>retinitis pigmentosa</td>
<td>retinitis pigmentosa</td>
</tr>
<tr>
<td>13</td>
<td>totally blind</td>
<td>traumatic brain injury</td>
<td>neurological disorder</td>
</tr>
</tbody>
</table>

Table 2. Characteristics of the visually impaired children

Total scores

Figure 2 presents the mean total scores obtained by the participants at the haptic test battery. The results show that the mean total score obtained by the sighted children (Mean = 65.38, SD = 13.63) is lower than that obtained by the visually impaired children (Mean = 70.98, SD = 15.13). However, a non-parametric test for independent samples reveals no
significant (with an alpha level at 0.05) between-group difference in the total scores (Mann-Whitney U-test, p = 0.0871).

Scanning scores

Figure 3 presents the mean scores obtained at the scanning tests by the children at 9-10 years. The results show that, at the dot scanning test, the sighted children score slightly higher (Mean = 3.69, SD = 2.81) than the visually impaired children (Mean = 3.08, SD = 2.40), but the difference in score between the two groups is not significant (Mann-Whitney U-test, p = 0.6444). At the line scanning test, the sighted children also score slightly higher (Mean = 8.92, SD = 2.25) than the visually impaired children (Mean = 7.08, SD = 3.33). However, again, the difference in score observed between the two groups does not reach significance (Mann-Whitney U-test, p = 0.1438).

Spatial comprehension scores

Figure 5 presents the mean scores obtained at the spatial comprehension tests by the children at 9-10 years. The results show that both groups obtain rather similar scores at the spatial orientation test (sighted: Mean = 8.92, SD = 2.66; visually impaired: Mean = 8.46, SD = 2.18), with no significant between-group difference (Mann-Whitney U-test, p = 0.5383). It is also the case for the spatial location test: both groups obtain rather similar scores (sighted: Mean = 8.77, SD = 2.52; visually impaired: Mean = 8.62, SD = 2.36), with no significant between-group difference (Mann-Whitney U-test, p = 0.8777).

Haptic discrimination scores

Figure 4 presents the mean scores obtained at the haptic discrimination tests by the children at 9-10 years. The results show that the sighted children score lower at the texture discrimination test (Mean = 7.08, SD = 2.78) than the visually impaired children (Mean = 9.23, SD = 1.74), with a significant between-group difference (Mann-Whitney U-test, p = 0.0483). At the shape discrimination test, the sighted children score lower (Mean = 6.92, SD = 2.78) than the visually impaired children (Mean = 5.54, SD = 2.73), but the between-group difference is not significant (Mann-Whitney U-test, p = 0.2184).
Short-term memory scores

Figure 6 presents the mean scores obtained at the short-term memory tests by the children at 9-10 years. The results show that the sighted children score higher at the dot span test (Mean = 5.31, SD = 2.06) than the visually impaired children (Mean = 3.92, SD = 2.29). However, the observed difference is not significant (Mann-Whitney U-test, p = 0.1303). At the shape span test, both groups obtain rather similar scores (sighted: Mean = 5.85, SD = 2.03; visually impaired: Mean = 5.85, SD = 2.38), with no significant between-group difference (Mann-Whitney U-test, p = 0.8979).

Accuracy and speed in picture comprehension tests

Figure 7 presents the mean scores and mean response times obtained at the picture comprehension tests by the children at 9-10 years. In terms of accuracy, the results show that the sighted children score lower at the picture identification task (Mean = 4.50, SD = 2.29) than the visually impaired children (Mean = 6.23, SD = 3.05). However, the observed difference does not reach a significant level (Mann-Whitney U-test, p = 0.1007). At the picture completion test, the sighted children score lower (Mean = 3.58, SD = 2.31) than the visually impaired children (Mean = 6.06, SD = 2.90). The observed difference is significant (Mann-Whitney U-test, p = 0.0333). In terms of speed, the results indicate that the sighted children are slower than the visually impaired children to respond at the picture identification test (sighted: Mean = 40.52 s, SD = 23.04; visually impaired: Mean = 18.45 s, SD = 13.93) and at the picture completion test (sighted: Mean = 46.24 s, SD = 19.36; visually impaired: Mean = 26.96 s, SD = 14.66). The differences observed are significant for picture identification, (Mann-Whitney U-test, p = 0.0019), as well as for picture completion (Mann-Whitney U-test, p = 0.0089).
Summary of the results obtained at 9-10 years

To summarize, at age 9-10 years, we do not observe significant difference in total score obtained by the sighted and the visually impaired children at the haptic test battery. However, when the analyses are run test by test, notable differences emerge between sighted and visually impaired children in two categories of tests. On the one hand, in haptic discrimination tests, the visually impaired children score higher than their sighted peers in texture and shape discrimination tasks. On the other hand, in picture comprehension tests, the visually impaired children score higher than their sighted peers in the picture completion task; they are also quicker to respond to picture identification and picture completion tasks.

CONCLUSION AND PERSPECTIVE

In this article, we presented the content of a new haptic test battery for use with sighted and visually impaired children and adolescents, which is currently under construction and experimentation with the targeted population. We also reported preliminary results obtained with visually impaired children and their sighted peers aged 9-10 years.

The creation of a new haptic test battery aims to fill the lack of currently available psychometric tests that are suited to the assessment of the visually handicapped population. An originality of our battery refers to the exclusive use of 2D tactile materials that share similarities with the materials used in school learning situations, and to which visually impaired children are often faced with. Based on 11 test, divided in 5 categories, our battery covers a large range of perceptive-motor and cognitive abilities; in the end, it should allow us to gauge age-related changes in 2D haptic abilities, as well as differences due to visual status in 2D haptic functioning.

The preliminary findings obtained with sighted and visually impaired children aged 9-10 years are encouraging: whereas the two groups do not differ significantly in their total score, significant differences emerge in favor of the visually impaired children in haptic discrimination tests (texture, shape), and in tactile picture comprehension tests. The latter observation is in line with the findings from a research study by D’Angiulli, Kennedy and Heller (1998) that show superior performance in tactile picture processing in blind children as compared to their sighted peers aged 8-13 years. This higher performance might be due to a higher familiarity (and thereby expertise) of blind children with 2D tactile materials, and to their more developed and efficient manual exploratory procedures (see also Vinter, Fernandes, Orlandi, & Morgan, 2012). The finding of a significant effect of visual status on both haptic discrimination of raised-line shapes and tactile picture comprehension is interesting as it makes it possible to envision that there is a link between these two skills. A recent study (Kalai & Sinha, 2011) suggests that the major difficulty in tactile picture reading is in acquiring the tactile shape of the graphically represented object. It will be worth examining, at the end of our project (i.e., with a sufficient sample size), the extent to which shape discrimination skills develop in parallel to, and sustain, tactile picture processing skills.

The next step of our research project consists in collecting data with a larger sample visually impaired children and adolescents. We decided to test our battery with ordinary visually impaired subjects, that is to say, without moving any subjects aside, like, for instance, those with associated disorders (who are quite numerous in the visually handicapped population). Our wish is that the 2D haptic test battery may be useful for assessing ordinary visually impaired subjects, and not solely blind children with any additional disability. If this option is interesting and very useful for practitioners, it is nevertheless difficult to set up from an experimental and methodological point of view. During the first data collection with 9-10 year old children, we quickly had to face up to the large diversity of the population, and it became clear that the visually impaired children differed greatly in their relationship with the haptic modality, and in their attentional and verbal abilities according to their personal characteristics. The consideration of individual factors, often neglected in previous research with the visually handicapped population (Thinus-Blanc & Gaunet, 1997), will be fundamental for our project. We will proceed to the systematic exploration of the relationships between individual factors and performance levels, so as to determine...
if it is necessary (or not) to distinguish between groups in our sample, and to proceed to separate standardizations in order to take the diversity inherent to the visually impaired people into account.

**ACKNOWLEDGMENTS**

This research is part of a PhD Thesis made by the first author, and received financial support from the PRES of Toulouse & Région Midi-Pyrénées (2012-2015). The authors are grateful to the sighted and visually impaired participants who took part in the study, and to the school team of Marssac sur Tarn (Marssac, 81). They also wish to thank the professionals of Cival-Lestrade center (Ramonville-Saint-Agne, 31), and Alfred-Peyrelongue center (Ambarès, 33) for their involvement in this project.
References


Brief history of Les Doigts Qui Rêvent

Les Doigts Qui Rêvent (Ldqr=Dreaming Fingers) was created as a nonprofit organization in 1994 by Philippe Claudet, a Teacher of Children with Visual Impairments (TVI), and four parents of blind children, with the aim of providing tactile illustrated books (TiB) for partially sighted and blind children and we wanted our TiB to the sharable between sighted and visually impaired, and to be as beautiful, and as well made as the ones for the sighted. In the 90s in France, there was no one producer and a blind child could arrive in 1st Grade without having had any books adapted to his/her sense modality.

In 1996, our social manufacturing workshop was opened, employing people with social disabilities. Our main activities are: design and production of TiB (early intervention, kindergarten, youth literature, teenager’s novel, artist TiB), workshops about “difference” for the sighted, research about tactile pictures, training (on design and production) and international projects.

In 2000, we created Tactus, the European competition of TiB, with Belgium, Italy, and United Kingdom. Our goal was to stimulate creation, production and use of TiB in Europe. In 2001 Finland joined. In 2005, Tactus became Typhlo & Tactus and Germany, Netherlands, Poland and Czech Republic joined. And in 2009, T&T became international (21 countries) and partner with ICEVI.

2000-2013:
- 622 entries (after national selection)
- 17 entries awarded by an international jury
- 7689 copies produced in 7 languages and distributed all over Europe at 15,25€ (with the financial support of the EU, the French Culture Minister and the Burgundy Region).
- 27 800 posters distributed all over the world.

Next competition in September 2015: www.tactus.org

In 2002, Ldqr settled the Amandine Center for research on tactile pictures. Today Ldqr has partnerships with 5 universities (France, Switzerland, Italy) and since 2013 we have a new department, Research & Development led by a researcher.

In 2004, we published our first artist’s TiB, "Ali ou Léo?" and since we have published 10 other titles in this collection. The same year we developed a new technique of depositing Braille on any support, which has since been used in all our TiB. A Braille according the official standards, durable and very comfortable.

In 2008, we offered a new collection for parents and professionals consisting of translation of essays from American, English, Danish, Dutch, German, Italian, Portuguese, Spanish, Swedish... There are few works in the field of visually impairment in each country, but gathering them as much as we can, we have now useful international resources for parents and professional. Today we have 30 titles on our catalog.

In 2010, we launched Terra Haptica with the idea to provide a way for researcher, professional and artist to meet, all working in the field of visual impairment and with an international dimension.

Since 2013, the articles are subject to a reading committee (double-blind evaluation) and Terra Haptica is attached to the ACTE Institute CNRS 8218, University of Paris 1 - Sorbonne.

In 2013, we were asked by several countries to produce TiB for them. Today, they include USA and Germany.

Since 1994, Ldqr created and adapted more than 200 titles of TiB that is around 40 000 copies of TiB. 45% of our TiB are distributed in schools (inclusive and specialized) and to families, 45% to public libraries (cultural inclusion) 10% to fans of beautiful books (because our TiB are considered as art books).

Our TiB:
= a long time of design and tests
= 2 to 8 hours of hand work
= texte in large print & Braille
= illustrations in material cut and pasted
= sharp contrast in textures et colors (low vision)
= an ergonomic binding (finger reading)
= as beautiful and well made as books for sighted

Les Doigts Qui Rêvent is a small team of 6 people

For any information contact
Philippe CLAUDET
philippe.claudet@wanadoo.fr
www.Ldqr.org
Summaries of the 3 first Terra Haptica issues

* original text in French
** original text in English
For # 4, the previous sections Research/Professional/Art have been replaced by Research/Reports of Experience.

Terra Haptica #1 (Sept 2010)

Research

-Images à toucher: réflexions sémiotiques sur les images tactiles destinées au public aveugle.*
  “Tactile Images: Semiotic Reflections of Tactile Images for the Blind”
  Dannylee Valente, Bernard Darras (ACTE Institute CNRS 8218, University of Paris 1 - Sorbonne, France) 

-Le dessin chez l’enfant malvoyant et chez l’enfant aveugle*
  Drawing in Blind and Visually Impaired Children
  Annie Vinter, Viviane Fernandes (LEAD-CNRS 5022, University of Bourgogne, France)

-Effets de la lecture conjointe sur l’appréhension d’un livre tactile illustré par de jeunes enfants aveugles précoces*
  The Effect of Joint Reading on Tactile Comprehension of a Tact-Illustrated Book by Early Blind Children
  Anne Theurel, Edouard Gentaz et al. (LPNC-CNRS 5105, University of Grenoble, France ; University of Padova, Italy; Robert Foundation of Padoue, Italy & Les Doigts Qui Rêvent, France)

Professional

-Guide à l’usage des psychologues qui s’interrogent sur leur pratique auprès d’enfants déficients visuels accueillis en institution
  Guide for Psychologists Who Asked Themselves About Their Practice with Visually Impaired Children in Special Institutions*
  Stéphanie Frileux (Psychologist, Rehabilitation Center of Ressource, Réunion Island, France)

-Un album tactile : du projet sur le terrain à l’édition
  A Tactile Book: from Designing in the Field to Publishing*
  Françoise Le Gal, Mireille Lafleur (Educators, Montéclair Institute, France)

-Mon projet de CAEGADV : un album... tactile
  My Project for my TVI Diploma: a Book... to Touch*
  Laura Souprayen-Ramaye (Teacher of Students with Visual Impairments (TVI), Rehabilitation Center of Ressource, Réunion Island)

-Créer une bibliothèque tactile en Suisse romande pour faire face au manque de moyens d’accès à la lecture
  To create a Tactile Library in French-speaking Switzerland to Counter the Lack of Reading Access*
  Dominique Vallat, Anne-Lise Schwab (TVI, Switzerland)

-oUkoU PATA, la première collection internationale d’albums tactiles en tissus
  Oukou Pata, First International Series of Tactile Fabric Books
  Lynette Rudman, Philippe Claudet & Pietro Vechiarelli (I Head With My Hands, South Africa; Les Doigts Qui Rêvent, France & National Federation of Blind, Italy)
Art

- La vue n’est que la peau du monde
The Eyes is Only the Skin of the World
Jenny Feray (Teacher and Photographer, University of Amiens, France)

- A deux visions
With Two Visions
Myriam Colin (Artist, France)

- Proposition d’adaptation tactile d’œuvres plastiques originales
Proposition of Adaptions of Original Tactile Art Work
Solène Négrerie (Tactile Designer, Les Doigts Qui Rêvent, France)

- Photographie et cécité
Photography and Blindness
Rose-Marie Loisy (Photographer and Designer, France)

- Expériences tactiles à l’école et dans l’édition
Tactile Experiences in School and in Publishing
Mauro L. Evangelista (Artist, Italy†)

Terra Haptica #2 (Sept 2011)

Research

The first five papers are originally published on the Journal The Educator (2011, volume XXII, issue 2)

- Que savons-nous et comment le savons-nous ?
What Do We Know and How Do We Know It?
Kay Alicyn Ferrel (University Northern Colorado, USA)

- La recherche est-elle nécessaire ?
Is Research Necessary
Michael Tobin (University of Birmingham, UK)

- Types de recherches: quantitative, qualitative, mixte et actions des enseignants
Types of Research : Quantitative, Qualitative, Mixed Methods and Teacher Action
Sunhi Bak (University of Soonchunhyang, South Korea)

- Ethique dans la recherche en éducation et protection des sujets
Ethics in Educational Research and the Protection of Human Subjects
Silvia Coreea-Torres (University of Northern Colorado, USA)

- Appel à l’action : contribuer à la recherche par l’expérience quotidienne et l’enseignement
Call to action : Contributing to Research Through Your Everyday Teaching Experiences
Kim T. Zebahazy (University of British Colombia, Canada)

- Analyse des stratégies exploratoires manuelles utilisées par de jeunes aveugles congénitaux lors de la reconnaissance de figures géométriques bidimensionnelles
Evaluation of Manual Exploratory Strategies Used by Congenitally Blind Adolescents During the Recognition of 2D Geometrical Shapes
Anne Theurel, Jérôme Létang et al. (LPNC-CNRS 5105, University of Grenoble, France; National Institut for Blind Youth, France; Rehabilitation Center of Ressource, Réunion Island)

- Le toucher, un ami qui nous veut du bien
Touch: a Friend Who Wants Good for You
Yvette Hatwell (LPNC CNRS 5105, University of Grenoble, France)

Professional

- Le Profil Tactile : développement d’une procédure d’évaluation du fonctionnement tactile d’un enfant aveugle
The Tactual Profile: Development of a procedure to assess the tactual functioning of children who are blind
Ans Withagen, Mathis P. J. Vervloed, et al. (Royal Visio and University of Radboud, Netherlands)

- Projet d’édition d’un livre tactile autour de l’exposition Images d’Alice au pays des merveilles initié par la Bibliothèque de Rennes Métropole
Alice in Wonderland in Tactile Version Narrated to Young Children: A Project by the Rennes library
Anne-Marie Meudal (Librarian, Library of Rennes, France)
L’accessibilité des expositions temporaires aux personnes aveugles et malvoyantes

*Accessibility of Partially Sighted and Blind People to Temporary Exhibitions*

Maria-José Anía & Mònica Surís. (Designers and Directors of Comm Access, Spain)

-Di che colore è il vento ? À la découverte du livre tactile illustré

*Di che colore è il vento ? Discovering tactile illustrated books*  

Pietro Vecchiarelli, Stefano Alfano (National Federation of Blind, Italy)

-La conscience de l’écrit tactile

*The Set : Toward Writting Awareness*  

Louise Comtois (TVI, Quebec)

-L’album tactile aux Etats-Unis

*Tactile Books in the USA*  

Suzette Wright (American Printing House for the Blind, USA)

-Jeux et activités pour enseigner le langage précoce aux enfants déficients visuels

*Games and activities for early language teaching to blind and partially sighted children*  

(Institute for the Blind and Visually Impaired, Slovenia)

**Art**

-Tentative pour un recueil de livres haptiques

*Attempt to a Collection of Haptic Books*  

Sandrine Rebeyrat (ENSA Dijon, School of Art and Design, France)

-Aspects perceptifs (sensoriels) de l’art pour les aveugles

*Perceptual Aspects of Art for Blind People*  

Rudolf Arnheim (University of Harvard, USA)  

Paper originally published on Journal of Aesthetic Education (1990, issue 24)

-Métamorphose de la pierre: la touche de Pygmalion

*Metamorphosis of the Stone : the Touch of Pygmalion*  

Herman Parret (Institute of Philosophy, Catholic University of Leuven, Belgium)

-Une histoire sur un bout de papier

*A Story on a Piece of Paper*  

Annick Glauser (Artist, Switzerland)

-Alice au pays des merveilles

*Alice in Wonderland*  

Fanny Pageaud (Artist, France)

-Acajou. Danser sans voir

*Acajou : to Dance Without Sight*  

Delphine Demont (Dancer, Acajou Dance Compagny, France)

-Puisqu’ils ont si peu, il leur faut le meilleur

*Since they have so Little, they must have the Best*  

Colombine Depaire (Les Trois Ourses, France)

Terra Haptica #3

**Research**

-Comment, à travers l’étude de leur langage, peut-on approcher l’expérience sensorielle des enfants déficients visuels ?

*How Accross the Study of their Language, Can We Approach the Sensory Experience of Visually Impaired Children*  

Oriana Orlandi, Viviane Fernandes, Pascal Morgan & Annie Vinter (France, LEAD-CNRS 5022, University of Bourgogne, France)

-Langage, toucher et connaissances chez l’enfant aveugle

*Language, Touch and Knowledge in the Blind Child*  

Anna Rita Galiano (University of Lumière Lyon 2, France)

-Sélection de mots-clés (La Signification Individualisée centrée sur l’Approche du Lire et Ecrire en braille)

*Selecting Key Words for I-M-ABLE (The Individualised Meaning-centred Approach to Braille Literacy Education)*  

Diane P. Wormsley (North Carolina Central University, USA)

-La lecture d’un TIB comme contexte facilitant la production de questions de la part d’enfants déficients visuels : une recherche exploratoire

*The reading of a TIB to Facilitate the Emergence of Questions by Visually Impaired Children*  

Enrica Polato, Marina Santi and Roberta Caldin (University of Padoua and University of Bologna, Italy)
-Point de vue sur la prise en charge des enfants aveugles : état de la recherche et étude de cas
Point of View about Blind Children Caregiving: State of the Art and Case Study**
Michael Brambring (University of Heidelberg, Germany)

-Le braille en 8 points (Eurobraille)
8 Dots Braille at the Beginning of the Learning Process**
Markus Lang (University of Heidelberg, Germany)

-Recherche sur les stratégies de lecture observées au niveau de l’Eurobraille et de l’écriture abrégée et intégrale utilisée pour les aveugles en Allemagne
Studies about Strategies of Reading in Euro-Braille**
Sven Degenhardt, Dagmar Finn and Jan Schroder (University of Hamburg, Germany)

-La vue emblème du savoir; la cécité emblème de l’ignorance?
Sight as Emblem of Knowledge ; Blindness as Emblem of Ignorance?*
Solène Ledru (University of Bourgogne, France)

Professional

-Des albums tactiles pour la stimulation précoce des enfants aveugles
Tactile Books for Early Stimulation of Blind Children**
Markus Lang (University of Heidelberg, Germany)

-Revisiter le braille : créer avec le braille
Revisiting Braille : Designing with Braille**
Thierry Wijnberg (Total Italic Graphic Design, Germany)
Paper originally published on Proceeding of World Congress Braille 21 (September 2011)

Le côté invisible du braille
The Invisible Side of Braille**
Bruno Brites (Designer, University of Dundee, Scotland)
Paper originally published on Proceeding of World Congress Braille 21 (September 2011)

-Design pour tous ou conception universelle et braille: un inventaire des défis
Design for All or Universal Design and Braille: an Inventory of Challenges**
Gregor Strutz (Germany)
Paper originally published on Proceeding of World Congress Braille 21 (September 2011)

-Une approche multi-sensorielle des apprentissages en CP
A Multi-Sensory Approach of Learning in 1st Grade*
Hélène Leclair (Teacher, France)

-Géographie et déficience visuelle en milieu scolaire : inventer une véritable science de l’haptique
Geography and Visual Impairment in School : to Create a Real Science of Haptic*
Michael Bergman (France)

-La mobilité perçue : un nouveau paradigme pour faciliter la liberté de mouvement
Perceived Mobility: a New Paradigm to Facilitate Freedom of Movement**
Daniel Kish and Justin Louchard (World Access for the Blind, USA)

Art

-Pour une esthétique tactile : de l’adaptation d’œuvres d’arts plastiques aux personnes déficientes visuelles
Towards a Tactile Aesthetic: on the Adaptation of Works of Art for the Visually Disabled People**
Maria Clara de Almeida, Filipe Herkenhoff Carijó and Virginia Kastrup (Federal University of Rio de Janeiro, Brazil)

-Un workshop 2012 : livres tactiles à l’Ecole Nationale Supérieure des Arts et design de Dijon
A Workshop 2012 : Tactile Books in ENSA Dijon*
Martine Le Gac (ENSA Dijon, France), Virginie Delannoy (Artist, Switzerland)

-Lorsque des expositions à toucher créent des expositions touchantes
Touching Exhibitions**
Mario Schubert (Daetz Center, Germany)

-Découvrir le corps humain: matériel didactique en 3D pour enfants déficients visuels
Discover the Body : 3D Teaching Material for Blind and Visually Impaired Children**
Halla Sigriður Margrétardóttir Haugen (Iceland)
You can order Terra Haptica Issue #4

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Editorial
Dannyelle Valente

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ISSN : 1962-6576