Fashion Design and Tactile Perception: A Teaching/Learning Methodology to Enable Visually Handicapped People to Identify Textile Structures

Geraldo Coelho Lima Júnior(✉) and Rachel Zuanon

Sense Design Lab, Ph.D. and Master's Design Program,
Anhembi Morumbi University, São Paulo, Brazil
glimadesign58@gmail.com1, rzuanon@anhembi.br2,
rachel.z@zuannon.com.br2

Abstract. The question of how textile structures should be regarded is an essential part of the training of fashion design students. The problems encountered in this area have had a significant effect on the definition and application of the material used in the garments for fashion collections. This paper sets out a teaching/learning methodology that is concerned with determining and distinguishing between flat materials for visually handicapped people by heightening their sensitivity to tactile perception. As a result, it was found that there was a significant value in extending the scale and two-dimensional and three-dimensional representations of the textile links to this perception and hence being able to consolidate memories. The purpose of this was to enable students to broaden their horizons as fashion designers.

Keywords: Fashion design · Textile design · Tactile perception · Visually impaired people · Teaching & learning

1 Introduction

People are continually being stimulated by their surrounding environment. Visual, auditory, olfactory, tactile and gustatory images are apprehended by the feelings and are appropriately linked and merged in a system of human perception. An experience is undergone that is able to forge close ties between the body and the environment [1, 2]. This allows each person to learn several activities and retain them in their memory without the need to learn them again. These links are established by connecting what has been learnt to what is shown to each person [3]. They prove to be important when addressing matters concerned with teaching & learning that are related to any particular issue. The activities or stimuli arising from the body itself or the surrounding environment, can affect how learning takes place.

This research study is concerned with the teaching of textile design in fashion design courses in Brazil, in particular with regard to the building of textiles and the different factors that emerge from weaving fabric. As a result of successive attempts made by the authors to follow the guidance provided by research studies in fashion

N. Streitz and P. Markopoulos (Eds.): DAPI 2016, LNCS 9749, pp. 233–244, 2016.
DOI: 10.1007/978-3-319-39862-4_22

design (and on the basis of this to allow students to carry out tasks in this area), it was found that in a general way, students had difficulty in identifying textile structures [4–6], and to distinguish between flat fabrics. This has attracted a good deal of attention because the definition of materials in a collection has a decisive effect on the final result. The suitability of the material to an item of clothing proves to be important when it is taken into account that a mistaken use of raw materials can have an adverse effect on features such as the form-fitting, modelling, functionality and wearability of the garment or in other words, if it fails to make the wearer feel comfortable [7, 8].

Several components are taken into account in the textile structures of clothing and fashion products and each has distinct features. It is worth drawing attention to the following: the type of fibre or strand used – which can be subdivided into natural, such as cotton, silk and linen; artificial, such as viscose (synthetic material made from cellulose) or acetate (transparent plastic); or synthetic such as polyamide or polyester. Another feature is grammage, which affects the weight and frame of the fabrics. These are important aspects of weaving as they affect the form fitting, flexibility and degree of stiffness among other factors [4, 5, 9].

The flat material or flat canvas is the most basic and traditional substance that has been developed so far; the yarns are interwoven in this way in both the lengthwise (warp) and transverse (weft) directions and the threads of the warp cross over and beneath those of the weft. From this initial pattern, other means of interweaving the warp and weft have been adopted and resulted in distinct textile appearances to serve particular uses. [4, 5, 9]. It should be stressed that the weft is always a regular spun fibre and the differences are caused by the warp.

Other points that should be taken into account are the technical processes and finishings. For example, dyeing and washing can lead to greater softness. The design of the surface, also known as the industrial printing design, which is applied over flat surfaces, results in visual and tactile surfaces. This may or may not display protuberances and in visual terms alters the way this kind of woven fabric [10] is identified, without necessarily affecting the tactile perception of the structures.

The problems of determining the ways the fabrics are distinguished becomes an even more arduous task when they entail the teaching & learning of visually-handicapped students. This is because within the range of the current methodologies being employed, the types of woven flat materials are identified by means of a magnifying glass that amplifies the crossing of the yarn.

In the light of the constraints imposed by the use of a visual apparatus, the task of identifying the fabrics is transferred to other feelings, among which touch proves to be the most reliable for this task. The forming of textile fabrics was originally carried out manually or with looms, which involved motor skills. Handicraft fabrics are still made by looms today. Tactile perception is essential for this task since it is in this manner that ways can be learnt of crossing the warp yarn to form textile structures.

Thus it should be realised that the employment of a methodology aimed at stimulating the tactile sense, as a counterpart to what is only supported by a visual stimulation, can, to a great extent, assist in the identification of textile patterns by textile design students, whether they have normal sight or not. With this in mind, this research study sought to conduct a formal experiment with four visually handicapped people who were all over the age of 18. This involved making use of accessible andragogical resources for teaching people with this impairment.

The main results show that tactile stimulation arising from the employment of different materials in different warp yarns, not only broadened the perception of the specific features of various fabrics for this public but also provided a better understanding of their application to the manufacture of garments, (in the light of the fact that these means of identification were now available). On this basis, it is clear that the widespread adoption of this methodology in the teaching & learning processes for flat materials can make a significant contribution to overcoming the obstacles faced by students in the field of textile design.

2 Textile Design and Tactile Perception

As mentioned earlier, the structures of fabrics can be recognised by means of both visual and tactile perceptions. Figure 1 shows a graphic representation of woven cloth made of canvas, twill and satin. It can be seen that the crossing of the threads between the warp and weft occurs in different ways. The alternating woven forms are a factor that defines the patterns of the cloth that depend on the fibres used; these alter their appearance and the tactile perception of the fabric. What can be detected through touch are the physical properties of the fabric that result from the following features: the nature of the fibre, fineness or delicacy, stretching, and moisture among other factors [6].

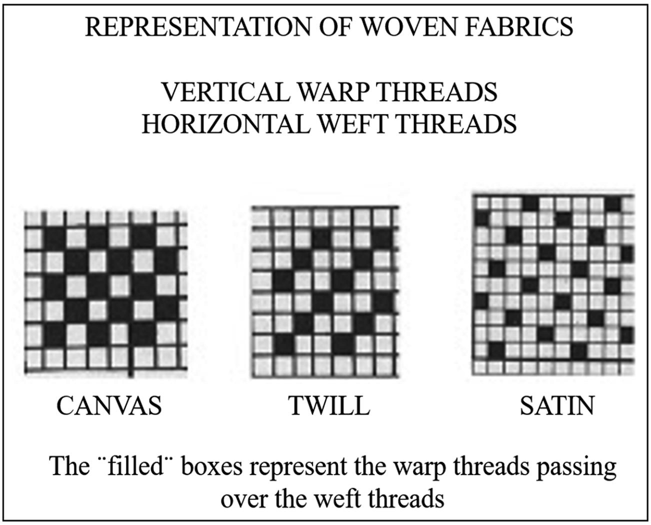

Fig. 1. Woven fabric – canvas, twill and satin. Source: author's property

In a research study, Kunzler [6] provides some descriptors for tactile perception by conducting tests in which the participants were asked to identify fabrics with the same textile samples in three different stages: (1) visual; (2) tactile; (3) visual and tactile together.

The author employed the following descriptors to describe the different visual and tactile forms of contact with the fabrics in the experiments: rough, a good fit, shiny, dainty, hard, slippery, fine, firm, flexible, flimsy, waterproof, light, smooth, soft, supple, limp, warm, resistant, simple, synthetic and threaded [6] and these corresponded to the first stage of the tests.

In the second stage, Kunzler [6] redefined her objectives by seeking to find descriptors that were particularly related to tactile perception and the results were as follows: "finishing/texture, friction, shininess, comfort, colour, size, toughness, human factors and ergonomics, style, familiarity, shape, hygiene, smell, weight, price, quality, resistance, application/usefulness, temperature, visual appeal" [6]. The descriptors used for Stage 2 include features that can be perceived in a tactile way. In the two stages, the author made use of three samples which had the following components: (a) 100 % Viscose; (b) 100 % Acetate; (c) 75 % Viscose, 20 % Polyamide, 5 % Spandex fibre. Descriptors such as finishing/texture, resistance or toughness indicate the form of the fabric since canvas material is what is responsible for defining the texture of the fabric [5].

A research study similar to that of Kunzler [6] was carried out by Carvalho [7], who made use of a wider range of materials including fibres with 100 % cotton and mixed fabrics. Her results were much broader and provided descriptors which showed the degree of intensity of each type.

In both research studies, the authors provided the results of tactile perceptions obtained from the sensory descriptors, which involved the participants touching the fabrics with their forefinger, with the sole purpose of recording their sensations.

Tactile perception is undertaken though different areas of the brain within the parietal lobe, which are also responsible for the perception of space, shapes and textures [11]. This lobe contains the superior and inferior parietal lobules where the somato-sensory information is processed. This is important for the way the body relates to its surrounding environment as well as for integrating information linked to "perception and language, mathematical reasoning and visual-spatial cognition" [12]. "The human brain maps any object that is outside it, any action that occurs outside it and all the relations that characterise objects and actions in space and time relative to others and also with regard to (…) the organism" [2]. This mapping does not only include visual patterns, but every kind of sensory pattern formed in the brain [2].

In a general way, the sensory stimuli enter the brain as a stream of electric pulses triggered by the firing rate of neurons that are present in a determined route. The question of what defines whether one stream can be turned into vision and another into touch, depends on what kind of neurons are stimulated [13]. It should be understood that human perception consists of an iterative process between various sensory channels. "Sensory signals presented simultaneously in more than one sensory channel tend to be detected more accurately and at lower thresholds than the same signals presented individually" [14]. On this basis, it is also possible to detect if the lack of one of the senses has an effect on the activities of the others. In other words, the lack of the sense of vision in someone who is visually handicapped (VH) (either partially or wholly) can interfere with the results for the perception descriptors related to the other senses.

In view of this, a methodology is required that in the first place can be employed to interpret the features that shape the warp yarn and hence allow the textile structures to be identified. In the second place, this knowledge can be used to extend the scope of the tactile descriptors of the fabrics and give a better prospect of learning about the textile features, as a counterpart to that which only gives precedence to the domain of the descriptors. “Everything woven by a conscious mind is created with the same thread: images produced by the capacity for mapping of the brain” [2]. It is up to the designer, to discover the purpose of the textile material by investigating its features and ensuring that they are changed in accordance with the aims of a particular project [5].

3 Materials and Methods

The experimental undertaking was carried out with a group of four students over the age of 18 who had visual impairments - one with poor vision and the others completely blind. The experiment made use of the basic principles of teaching textile design with regard to cloth patterns and their weaving associated with andragogical resources. These were made accessible for teaching visually handicapped people to stimulate sensory, tactile and motor portals [2], as well as the students′ perception, apprehension and registering of information taught through the teaching material produced in this activity.

Close attention was paid to the studies of the brain functions [15, 16], as a procedure that could significantly assist the planning and execution of the method. This was mainly aimed at the definition and application of several kinds of stimuli that are able to trigger the formation of mental images in the students based on the activities of the peripheral sensitive organs. “In the case of touch, there is a direct mechanical contact of an object with the skin which affects the activity of the nerve endings situated within the skin. The (mental) images, which we form from the shape and texture of an object, are the outcome of this process.” [17].

As a result, the teaching material prepared while carrying out this research, was concerned with ways of recognising textile constructions by means of touch although not just with regard to the index finger of the students on the fabric; it was carried out in a way that could make them perceive (step by step) the warp and weft threads used in weaving. This was achieved by setting out five stages related to the types of weaving that are involved in creating any flat fabric and these followed a growing order of difficulty and complexity in identifying the warp yarns through tactile perception, namely: (a) open warp threads; (b) open yarn threads; (c) handloom – open thread; (d) handloom – closed thread; (e) industrial loom.

What is remembered from the encounter with the particular object transposes “the visual pattern mapped in the optical images of the retina” [2], in encompassing the sensitive-motor features linked to the following: (a) the view of the object; (b) touching and handling the object; (c) evoking previously acquired memories and relating them to the object; (d) triggering emotions and feelings associated with the object.

Thus it was ensured that the transition between the stages was carried out in a progressive way with regard to the display of samples. This was because those with more open structures (a, b, c) – and which allowed an accurate investigation of the spaces between the threads and the woven fabrics, even the most difficult (d, e) - became more difficult when employed for identifying the fabrics by touch.

It should be stressed that, unlike the recommendations of Kunzler [6] and Carvalho [7], in this experiment the aim was to point out the tactile descriptors. The materials employed in constructing the boards shown in stages (a) and (b), can be distinguished from each other. However, they are solely and exclusively aimed at providing a tactile reading of the woven patterns and thus have no similarity with the tests conducted by the authors cited above.

(a) **Open warp threads**

In this stage, several boards were prepared with the aim of showing visually handicapped students different woven fabrics. In this manufacturing process, threads like cotton, chenille and polyester soutache were used to help detect the warp and weft and distinguish them from each other. It was decided to keep a distance of 10 mm between the threads with a thickness of 1 mm (ratio of 100:1). It was noted that this distance between each part of the weaving was a means of allowing the student to run his fingers between the threads – from top to bottom - when he touched the material and thus be able to detect the differences of the crossings, as well as to make contact with the threads that had no alternations with the palm of his hand. Each board was shown separately to each student and the sequence of the display was designed to bring the similar patterns closer together and highlight the differences between them (Fig. 2).

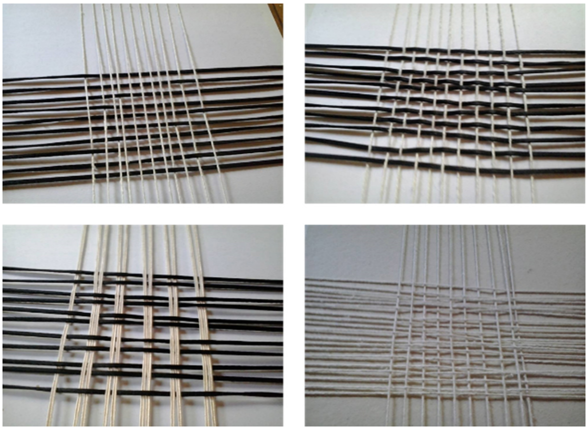

Fig. 2. Warps for woven fabrics. Source: author's property

(b) **Open yarn threads**

The boards with exposed yarn threads were manufactured with the aim of showing how the cloth appeared, although it remained possible to identify the woven fabric by touch. There was no handling of the underneath surface with these but only the upper surface. Grosgrain ribbons were used with a thickness of 20 mm, and without any separation between them (ratio of 200:1). As stiff material was used, it was feasible to locate the woven patterns and distinguish between them (Fig. 3).

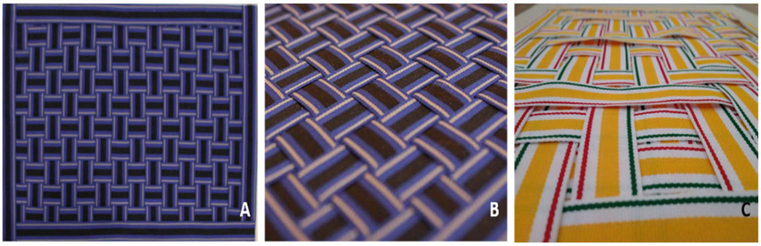

Fig. 3. Open yarn threads. The image (A) shows the board from above which makes it possible to view the weaving that forms the fabric in its entirety. In the images (B) and (C), with details of the boards, the woven fabric can be seen between the warp and the weft. Source: author's property.

After the boards with exposed yarn threads had been shown, the students began to handle the boards with exposed warp threads. At the same time, they paired up the different types of patterns with a view to perceiving the specific features of each formed fabric.

In the following stages, all the guidelines for the textile structures of the flat cloth were applied to the fabrics made in the loom, either by hand or industrially.

(c) **Handloom – open thread**

In this stage, the sample employed is made by a handloom with a more exposed warp enforced by the use of cotton fibres, viscose and polyester, which provide fabrics with a greater pliability so they have a better fit.

After the boards shown in stages (a) and (b), there follows a more complex reading for the identification of the woven fabrics, since now a ratio of 5:1 was adopted. However, the possibility of a tactile perception of the formation remained. The boards of stages (a) and (b) remained available for consultation and allowed action between the samples so that the reference-points obtained earlier would not be lost (Fig. 4).

Fig. 4. Handloom – exposed warp. Source: author's property

Fig. 5. Handloom – closed thread. The samples (A) and (C) show fabrics of cotton fibre made by a handloom. Sample (B) cloth with acrylic filaments made in a handloom. Source: author's property.

(d) Handloom – closed thread

In this stage, samples of fabric manufactured by a handloom with different cotton and acrylic fibres and filaments were selected. The purpose of this was to show that the raw material used had a direct effect on the texture when the cloth was touched. This also alters its density and grammage and as a result, the tactile perception. In the case of samples [A] and [C] a ratio of 5:1 was adopted, while for sample [B] the ratio was 3:1. The difference in scale between the samples was proportional to the degree of thickness of the threads.

As in the case of the earlier stages, the students were able to go back to the earlier samples and make comparisons and in this way identify the changes in the threads from the most open to the most closed.

Generally speaking, the industrialised fabrics are the most widely used for the manufacture of clothes products on a large scale. These are examined in the final stage of the experiment.

(e) Industrial looms

A number of samples of industrialised fabrics completed the experiment; these included smooth fabrics or those worked with dyed, striped and machine-made yarns. A ratio of 1:1 was adopted for all of them. In this stage, the tactile perception of the woven fabric is a highly complex matter. Visual perception can only assist in this identification by means of a magnifying glass – a condition that does not apply to the group of visually handicapped students. In this case, the tactile perception was transferred to the protuberances and textures that can be found in the fabrics in question. In other words, fabrics are perceived through the tactile qualities of the cloth such as softness which results in a larger number of threads per cm^2; porosity resulting from a lower number of threads per cm^2; and stretching, defined by the kind of intervals between the stitching of the warp and weft threads, among other factors (Fig. 6).

Fig. 6. Industrial loom. Source: author's property

4 Results and Discussion

(a) **The tactile perception of the way threads are arranged was heightened by broadening the range, the use of the outward appearance of threads and the three-dimensional representation of the woven fabric.**

This three-dimensional representation, which is heightened by the weaving, took place as a kind of tactile magnification. The optical means of broadening the range was shifted to the sense of touch. In this way, it was possible to stimulate the tactile perception of volume or, in other words, to form a three-dimensional space through different arrangements of the threads. In terms of growth, the different textures of the threads provided a distinct way of stimulating the perceptions and heightening the awareness of the students when making a cognitive record of this information. As well as forming perceptual images from several sensory domains, the brain must store the respective patterns of these images so that any attempt to reproduce them can be successful [2].

(b) **The tactile perception of the arrangement of the textile strands was heightened by the broadening of the scale and by the two-dimensional representation of the woven fabrics.**

The broadened or flat two-dimensional representation of the weaving stimulated the tactile perception of the surface, or in other words, created a two-dimensional space through different arrangements of the strands. "The brain records the various results of the interactions of the organism with the entity (i.e., the object)" [2], rather than only recording the structure of this object. The memory of an object "consists of the sensory and motor activities related to the interaction between the organism and the object during a given period of time" [2].

(c) **Tactile perception occurred in an open thread even when there was a reduction of the range.**

Tactile perception was made possible by the size of the warp, the differences in the outward form of each thread and the distinct kinds of weaving that can be traced on both sides of the fabric (front and back). The difference between this stage and those that preceded it "lies in the degree of complexity of the memorizing process. This complexity can be measured by the number and range of items remembered from a particular target or event, (…) the greater the degree of sensory/motor activity reconstituted (for a particular object), the greater the degree of complexity" [2].

(d) **Tactile perception of a closed warp thread occurred at the same or at a lower rate.**

The fact that tactile perception occurred in this situation can be attributed to the presence in the three samples of protuberances in the material. Moreover, since samples A and C (Fig. 5) had a greater density and thickness, as a result of the use of 100 % cotton fibre in their weaving, it was easier to carry out a tactile identification of the woven fabric. However, sample B (Fig. 5), woven in 100 % acrylic filaments made it difficult but not impracticable for a tactile reading to be carried out for the woven fabrics since the raw material had less density and thickness. The mind "is now full of a varied assortment of images, (…) and these enter and leave the awareness of a presentation that is too rich (i.e., complex) to occur rapidly or be entirely comprehensive" [18].

(e) **Tactile perception took place through a transfer of knowledge.**

"(Cerebral) maps are formed when we evoke objects which are databases of memory within the brain" [2]. In this sphere, textile recognition takes place through an association of the textile descriptors with features of the textile structures learnt in the previous stages. Making repeated comparisons between the boards proved to be an essential strategy for consolidating the mental images formed during the teaching & learning process. The mental image enables the images resulting from the current perception to be merged with those that arise from memory. This form of integration allows an extensive handling of images that are indispensable for creativity and for solving new problems [17].

5 Conclusion

The difficulties experienced in identifying textile structures and being able to distinguish between them when faced with flat fabrics, is a recurring problem when training fashion design students in the area of textile design. This situation becomes increasingly complex in the teaching & learning of visually handicapped students given their limited ability to make use of visual aids and the resulting transfer of this means of perception to the other senses.

In view of the key role that tactile perception plays in the recognition of textile structures, the recommendation of a new methodology aimed at stimulating the tactile sense, rather than that provided by visual stimulation, can bring significant benefits to students by enabling them to identify and distinguish between textile design fabrics, whether they have normal sight or not.

The formal experiment conducted for this research study set out different types of stimuli for tactile perception by students with visual impairments, including in particular: volume, surface, texture, density and grammage.

The principle results demonstrated the importance of broadening the range and making two and three-dimensional representations of the woven fabrics to heighten their awareness when identifying and distinguishing between textile structures. As it evolved, the presentation of teaching material in an ordered sequence enabled students to go back to experiences related to the preceding stages and thus consolidate these memories.

The main value of this study is that it draws attention to how the horizons of these students as fashion designers can be broadened, by endowing them with a capacity to carry out a tactile reading of the textile structures and as a result distinguish between them. This can enable them to make an appropriate definition of the fabrics in accordance with different items of clothing or garments in a collection.

The future ramifications of this research study will be aimed at the application and validation of this methodology to groups of students with normal sight, doing courses in fashion design.

References

1. Hidaka, S., Teramoto, W., Sugita, Y.: Spatiotemporal processing in crossmodal interactions for perception of the external world: a review. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4686600/
2. Damásio, A.R.: E o cérebro criou o homem [And the Brain Created Man]. Companhia das Letras, São Paulo (2011)
3. Estrela, J.B.C., Ribeiro, J.S.F.: Analysis of the Relationship between Memory and Learning in the Construction of Knowledge (2012). http://www.grupouninter.com.br/intersaberes/index.php/cadernointersaberes/issue/view/52
4. Hallet, C., Johnston, A.: Fabric for Fashion, a Complete Guide: Natural and Man-Made Fibers. Laurence King Publishing Ltd., London (2014)
5. Saltzman, A.: El cuerpo diseñado: sobre la forma em el proyecto de la vestimenta [The Designed Body: on the Question of Shape in a Clothes Project]. Paidós, Buenos Aires (2004)
6. Kunzler, L.S.Q.: Estudo das variáveis de rugosidade, dureza e condutividade térmica aplicado à percepção tátil em design de produto [A Study of the Variable Factors Involved in Creasing, Hardness and Thermal Conductivity Applied to Tactile Perception in the Design of Products] (2003). http://www.lume.ufrgs.br/handle/10183/4004
7. Carvalho, F.: Sensory Analysis of Textiles: Fabric Sorting Through Handle. http://www.coloquiomoda.com.br/anais/anais/11-Coloquio-de-Moda_2015/COMUNICACAO-ORAL/CO-EIXO2-ENSINO-E-EDUCACAO/CO-2-ANALISE-SENSORIAL-DE-TEXTEIS.pdf
8. Sorger, R., Udale, J.: Fundamentos do design de moda [The Fundamentals of Fashion Design]. Bookman, Porto Alegre (2009)
9. Chataignier, Gilda: Fio a fio: tecidos, moda e linguagem [Thread by Thread: Fabrics, Fashion and Language]. Estação das Letras e Cores Editora, São Paulo (2006)

10. Ruth Schilling, E.A.: Surface design: practice and learning mediated by digital technology (2002). http://www.lume.ufrgs.br/handle/10183/131159
11. Preusser, S., Thiel, S.D., Rook, C., Roggenhofer, E., Kosatschek, A., Draganski, B., Blankenburg, F., Driver, J., Villringer, A., Pleger, B.: The perception of touch and the ventral somato-sensory pathway (2014). http://brain.oxfordjournals.org/content/138/3/540.long
12. Martin, J.H.: Neuroanatomia: texto e atlas [Neuro-Anatomy: Text and Atlas]. AMGH, Porto Alegre (2013)
13. Carter, R.: O livro de ouro do cérebro [The Golden Book of the Brain]. Ediouro, Rio de Janeiro (2003)
14. Ferrè, E.R., Walther, L.E., Haggard, P.: Multisensory interactions between vestibular, visual and somatosensory signals (2015). http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4395320/
15. Masson, S., Foisy, L.-M.B.: Fundamental concepts bridging: education and the brain. McGill J. Educ. (Université du Québec à Montréal) **49**(2) (2014). http://mje.mcgill.ca/article/viewFile/9172/6972
16. Tokuhama-Espinosa, T.N.: The scientifically substantiated art of teaching: a study in the development of standards in the new academic field of neuroeducation (mind, brain and education science). Pesquisa de Doutorado, Capella University (2008). https://www.researchgate.net/publication/36710537_The_Scientifically_Substantiated_Art_of_Teaching_A_study_in_the_development_of_standards_in_the_new_academic_field_of_neuroeducation_mind_brain_and_education_science
17. Damásio, A.: Em busca de Espinosa: prazer e dor na ciência dos sentimentos [In Search of Espinosa: Pleasure and Pain in the Science of the Feelings]. Companhia das Letras, São Paulo (2004)
18. Damásio, A.: O erro de Descartes: emoção, razão e o cérebro humano [The Mistake of Descartes: Emotion, Reason and the Human Brain]. Companhia das Letras, São Paulo (2012)