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Towards an Inclusive Approach to Discovering Artworks

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ABSTRACT

Artworks in museums are presented to visitors generally through the sense of sight, it is forbidden to touch them because these objects are considered fragile or their size does not allow them to be touched. An inclusive approach becomes a priority so that these works of art are accessible to all. Some figures are not easy to describe in words but can be depicted tactilely, while colors and shadows can't be understood by touch but these details and the emotions induced can be evoked with audio description. By using our F2T force feedback tablet, the audio description of an element in a painting can be reinforced and supplemented. We propose a new inclusive approach to the discovery of works of art combining inclusive audio description with the movements of the user's finger on the F2T tablet, while giving the possibility of free and interactive tactile exploration.

1. INTRODUCTION

How to provide mediation devices to create an inclusive artistic environment and especially for visually impaired people (VIP)? Museums all around the world are faced with the difficulty of offering some means to access paintings, and artworks in another way than by sight. Artworks cannot be touched either because of their fragility, their size or hygiene concerns. The usual solution is to offer a guided tour but the lecturers must be trained to apprehend different types of visual impairment [1] and other disabilities. Transpositions into 3D objects or relief drawings are provided sometimes to visitors to have a tactile perception of some works like the multisensory case of "The Sweeper" painted by Pieter Janssens Elinga, in *Petit Palais*, Paris, France. More rarely, museums present tactile reproductions of artworks that can be touched beside the real work [2] and they propose audio guides [3].

The inadequacy of these devices can be presented in six points identified by Romeo et al. [4]: The guided presentations are organized usually on weekdays when VIP can work, so they do not guarantee equal access [5]. The skills of the speakers, with non-mandatory "visual impairment" training [6], influences the quality of the descriptions. These descriptions are always interwoven with contextual and historical elements, depriving VIP of access to the purely sensitive experience of the work [7]. Voluminous and expensive tactile representations are often too few for a justification of a trip to the museums where they are exhibited [8]. Several people cannot explore the same artwork at the same time, even if the museum offers some rare tactile transpositions. But with the sense of sight, one can share the experience [9] which is lacking in this case. Lots of frustration is generated with the majority of mediation devices because their goal is identifying pictorial elements and transmitting the artistic and historical context of the artwork, and not at eliciting an aesthetic experience [6, 7].

This article presents the importance of a multisensory approach based on the combination of audio and touch in the aesthetic 2D artwork accessibility in Section II. Then we introduce the approach of inclusive audio description (Section III) followed by the tactile approach using virtual images with force feedback (Section IV). Section V concludes this communication and provides some perspectives.

2. MULTISENSORY APPROACH

To break with the shortcomings of existing devices, we propose a multisensory approach to "aesthetic accessibility" [8], more specifically to the accessibility of two-dimensional works of art (paintings, embroidery and tapestries). For the following two reasons, our research does not focus on three-dimensional works. 1) These works, such as sculptures, are by nature accessible to the so-called visually impaired, at least partially. Their accessibility only raises practical questions: risk of degradation of the works in case of tactile exploration (which is why the use of gloves is sometimes mandatory), problems of cost and space required by their facsimile. 2) Consequently, these works can be accessible to VIP, and, in fact, many museums (Louvre Museum, Rodin Museum, Fabre Museum ...) now offer access, although limited in number, to three-dimensional works by means of touch. On the contrary, what the two-dimensional works represent is tactilely almost totally insensitive (some paintings, tapestries and embroideries make it possible to distinguish some textures and some shapes). Their accessibility to VIP is therefore a real challenge. However, such accessibility is not impossible, including for people who are totally blind. Indeed, if two-

dimensional works, for the most part, are not tangible, they are not reduced to the field of visuality:

1) Everything that, according to the history of art [9], traditionally belongs to "drawing" (painted, woven or embroidered forms), can be made tangible by a process of embossing, well described and imagined tactilely.

2) Everything that traditionally comes under "colour" in the broad sense (which includes light and shadow) is a vector of non-visual perceptions, which blind people can access in imagination in the same way as any other person. Diderot in his time had already established it. He shows in a passage from the Salon of 1763, concerning Chardin's painting "The Jar of Olives" (1760) [10] that painting is the art which, through the medium of sight, gives access to non-visual sensations and perceptions - in this case, tactile sensitivities (the shape and texture of the orange from which the juice is extracted, fruits that we grasp), auditory (the sound of cookies breaking), olfactory (the scent of all these dishes), and of course gustatory.

However, these non-visual sensations and perceptions can be aroused by a medium other than sight, whether tactile (touching a relief drawing representing an orange) or auditory (hearing the word "orange"). Such a possibility of non-visual access to so-called visual art, is essential to our project to open two-dimensional art to, and with the VIP. It contributes to "de-visualizing culture" [11] (with multisensory representations) and thus to fighting against oculocentrism [12].

We excluded achieving accessibility by means of 3D transpositions of works in 2D because such an approach transforms into sculpture the original work and thus distorts it. We have also excluded the method of 2.5D transposition of the original work, (used for example in the project "Touch the Prado" in Madrid) which consists of a simple highlighting/embossing of the figures represented on the canvas. Based on not remembering that sight and touch are very different senses [13], this method results in incomprehensible tactile realizations [14].

Our approach is quite different: it does not consist in a transposition, but in a tactile translation of the original work that allows it to be apprehended by touch (elimination of details that hinder tactile exploration, production of tangible details, etc.) [15], and, in the co-writing of audio descriptions that accompany this translation. Finally, if we are not satisfied with touch alone or audio alone, it is, as we have already indicated [4], that these two modalities are in our opinion complementary.

First, audio description alone is insufficient to access both the "drawing" and the "colour" of the work. This is the meaning of an anecdote by Diderot in the Encyclopaedia [16] where he showed that a description is powerless to arouse in the mind the exact picture of what is described. As we have pointed out in the study [4], this is due to at least two reasons: 1) The generality of words in a language, which, apart from proper nouns, do not refer to single entities, but to categories. For example, the word "circle" does not refer to this circle that a person who sees perceives on such a painting, but applies to all circles. The only way, therefore, to signify this circle, or any other singular figure, whether regular or irregular, is to give its dimensions and/or mathematical function. But, this is the second reason for the impotence of language to produce, in the imagination, representations perfectly in accordance with the visible referent: 2) The human imagination is powerless to represent figures that are a little bit complex or irregular. This is what Descartes had already understood [17] with the representation of a thousand-sided polygon (chiliogone). In this way, the description of a painting can be understood, but it will not be imagined. However, the relationship to art is not simply intellectual one. Audio description will therefore never be able to arouse in the mind an image exactly in accordance with the vision of the painting. In other words, audio description does not restore sight to the blind – and this is not our goal, which is, rather, to arouse in everyone an analogue of the effects produced by the work on the sense of sight. On the contrary, by highlighting/embossing the figures, it is possible to touch the exact shapes, or at least the exact proportions of those of the original work.

Second, touch alone, too, is not enough to access a two-dimensional work of art via its tactile translation. On the one hand, it does not always make it possible to identify what is touched – and this, because a tactile form, simplified so that it can be comprehensible by touch, loses its unequivocal ability to signify. Indeed, the same shape can then denote a multiplicity of objects. It is therefore necessary that this information be given auditorily. On the other hand, touch does not allow access to the "colour" of the work - to the colours, shadows and light, but also to the complexion, the expression of looks, faces, etc. This is what the philosopher Geneviève Brykman called, in the context of Berkeley's philosophy, the "heterogeneity of sensitive series" [18]: The visible is not touched, the tangible is not seen, the gustatory is not heard, the auditory does not smell, and thus reciprocally of all the senses – and this, because each sensory organ has its physiological singularity. We should not conclude that painting is inaccessible to blind people (or that music is inaccessible to deaf people), we have seen why.

The tactile can certainly suggest the visual. For example, I touch an orange drawn in relief and I imagine its colour. However, such a suggestion remains extremely limited: the sense of touch suggests a colour only if this colour is previously associated with the touched element – in this case, the orange colour with the corresponding fruit. But if this association is not known, or if the colour of the touched object is not recognizable a priori (a snake, for example, can be of x different colours), the tactile element will not suggest it. Finally, even in cases where this association is known, it can be misleading – for example when the orange painted on the canvas is not orange ... but blue. One also thinks of Gauguin's "White Horse", which, on the canvas, appears green. For these two reasons, tactile translation must be associated with audio description, which will indicate everything that, in the work, falls within this field of "colour".

One objection may come to mind, however: such an association is futile for blind people, because they know nothing about visuality. We answer that in a sense, this is true of people who are blind from birth: as we have said, the visible is not accessible by any other sense than sight (this is the "heterogeneity of sensitive series"). However: 1) Not all people are blind from birth, and among them, some have retained the memory of everything that comes under the "colour". 2) Not all so-called visually impaired people are totally blind: as they themselves testify, many of them perceive colours. 3) People who have never seen or who have lost the memory of colours are not insensitive to the evocation of them. Indeed, colours can suggest to blind people other "sensitive series" (tactile, gustatory, etc.). If touch and audio are thus complementary to access painting without sight, it must nevertheless remain possible, to VIP as to any other person, to choose between one or the other of these mediums.

Our device thus gives the possibility to touch without listening and to listen without touching.

3. INCLUSIVE AUDIO DESCRIPTION APPROACH

To determine the main characteristics of the most relevant audio descriptions, the TETMOST consortium (CNRS AUTON challenge) organized, in 2018, a series of tests, based on semi-structured interviews associating qualitative and quantitative data, during which descriptions of paintings, were co-written by visually impaired and sighted people. These descriptions were proposed to 27 people with various visual abilities: 11 early blind persons, 7 late blind, 5 visually impaired persons and 4 blindfolded persons without visual disabilities. Each of them listened to two audio descriptions of the same contemporary Australian Aboriginal painting from the Museum Quai Branly in Paris, previously validated by the specialist Philippe Peltier: "The dream of the snake" by W. Tjapaltjarri (Figure 1A) or "Ord river, Bow river, Denham river" by R. Thomas (Figure 1B).

(A) (B)

Figure 1. The tests of audio description are with two Australian aboriginal paintings from the museum of the Quai Branly, Paris. A) «The dream of the snake», by W. Tjapaltjarri; B) « Ord river, Bow river, Denham river » by R. Thomas

The objectives of these tests can be reduced to three main ones.

1) Test the relevance of the project as a whole: make audio descriptions co-written by VIP and people who see, intended for all (including deaf people via their translation, which will be carried out later, in French sign language), and likely to cause a sharing of experience.

2) Test the ability of these audio descriptions to elicit a mental representation.

3) Test their ability to provide an aesthetic experience. A fourth objective, namely the determination of the type of audio description (with an "objective" aim, i.e. the most neutral possible, versus "sensitive", with a literary aim and assuming its subjectivity) most likely to fulfil these three objectives, was tested transversally at the level of objectives 2 and 3.

Objective 1

To the question "what do you think of the fact that what we propose are texts co-written by blind people and sighted people?", the support was almost unanimous (Table 1): whilst 2 people did not express an opinion, 25 considered that it was a good thing, or even a necessity, related to the fact, as some have indicated, that VIP do not have the same relationship to the world as those who see (different relationship to visuality - see above; increased attention to non-visual perceptions) and that only they can therefore judge whether an audio description suits them.

To the question "what do you think of the idea that a single audio-guide, for all, is offered in museums (or in the form of a smartphone application)?", 20 out of 27 people answered that it was a good idea or even a necessity, related to not segregating the VIP, but also to teach people who see to appreciate paintings differently (Table 1). The 7 people who were sceptical in this regard felt either that the audio descriptions would not interest the people who see, or that they could not be similar for these different audiences, which is refuted by the judgment and experience of the latter.

To the question "in your opinion, would these audio texts allow you to have a real exchange around a work of art with a person who sees / a blind person?", 24 people answered in the affirmative, which attests to the inclusive effects of our approach (Table 1). The 3 people (2 late blind people and 1 visually impaired person) who answered in the negative felt either that a tactile device was necessary, or that exchanges between the person who sees and the blind person without a mediation device had their preference. While these results deserve to be analysed more thoroughly, we can conclude that the principles and the first purpose of our approach, namely its inclusive aim, are approved not only by the people concerned but also by the people who see.

Table 1. On the overall relevance of the project, participants gave their preferences

Overall relevance of the project	Nb of persons	AD co-written by VIP and sighted people	Audio guide for everyone (universal design)	Experience sharing between VIP and sighted people
Early blind	11	11	11	11
Late Blind	7	6	3	5
Visually impaired	5	4	3	4
Sighted	4	4	3	4

Table 2. On the mental representation created by the audio description, participants gave their preferences

Mental representation	Nb of persons	The dream of the snake		Ord river, Bow river, Denham river	
		Objective AD	Sensorial AD	Objective AD	Sensorial AD
Early blind	11	Group of 5 2	3	Group of 6 5	1
Late blind	7	Group of 3 2	0	Group of 4 0	4
Visually impaired	5	Group of 2 2	0	Group of 3 1	2
Sighted blindfolded	4	Group of 2 1	1	Group of 2 1	1

Table 3. On the emotion aroused by the audio description, participants said which audio description gave them an aesthetic experience. Sometimes people had no aesthetic experience at all, sometimes they had one when listening to both types of audio descriptions

Aesthetic experience	Nb of persons	The dream of the snake		Ord river, Bow river, Denham river	
		Objective AD	Sensorial AD	Objective AD	Sensorial AD
Early blind	11	Group of 5 2	4	Group of 6 3	2
Late blind	7	Group of 3 1	1	Group of 4 1	4
Visually impaired	5	Group of 2 0	2	Group of 3 0	2
Sighted blindfolded	4	Group of 2 0	2	Group of 2 1	1

Objective 2

To the question of which audio description, "objective" or "sensorial", elicited in people the most satisfactory mental representation (coherence, precision, completeness), the tests produced contrasting results, especially due to the fact that the two paintings are very different from each other – the second having fewer details, and thus being easier to represent.

1) The preferences between the two types of audio description in relation to the quality of the mental representation aroused are distributed roughly equally (Table 2): out of 26 responses (1 person gave no response), 14 give preference to "objective" audio descriptions; 12 to "sensorial" audio descriptions. Two main lessons can be drawn from these results:

a) The "sensorial" nature of audio description is not in itself an obstacle to the development of a mental representation.

b) In this elaboration, the precision and clarity characteristic of the "objective" audio descriptions are nevertheless assets.

c) The preference between one or the other type of audio description does not relate to the visual ability of the persons.

2) With some exceptions (1 visually impaired person), the lack of sensitivity of "objective" audio descriptions is not what has been appreciated in them, and "sensorial" audio descriptions have never been criticized for their sensitivity. The shortcomings that have been pointed out are the insufficient clarity/precision of the description and the difficulty in distinguishing what is the story told and the painting itself. Our main lesson is that our future audio texts will have to combine precision and clarity in description with sensitivity – which the results of Objective 3 confirm.

Objective 3

When asked whether the "objective" or "sensorial" audio descriptions elicited an aesthetic experience (of pleasure or another feeling) in listeners, the answers were much less contrasting (Table 3): 8 people had an aesthetic experience listening to the "objective" audio description and 18 people listening to the "sensorial" audio description that was offered to them. The conclusion here is clear, and hardly surprising: an audio description of a literary type (therefore subjective) is much more likely to achieve aesthetic accessibility than an audio description of a technical type, aimed (a text is never totally neutral) at objectivity.

However, we will notice a disparity, at this level, relating to visual ability: a small majority of people who are blind at an early age (6 against 5) have had more of an aesthetic experience listening to "objective" audio description than to that of "sensorial" audio description. We conclude that these people associate clarity and precision of description with aesthetic pleasure more than others because they enjoy accessing what they usually don't have access to.

Conversely, the more visual ability a person has, the less he appreciates "objective" audio descriptions - which could be explained by the fact that, sighted and partially blind people have access, or partially access to paintings by sight. They are thus not affected by a text explaining what the painting is or they think they are able to see. Finally, we note that sighted and VIP have nevertheless lived aesthetic experiences, to the point that a sighted person (out of the 4 sighted persons) did not wish to see the work after listening. This is a fundamental point, since confirmed by Alison Eardley and her team [19]: audio descriptions of works of art do not have to be reserved for the VIP, as they also enrich the relationship to art of sighted people.

The majority of visually impaired and blind participants had an aesthetic experience with sensorial audio descriptions. 71.2% of the late blind people who saw the colours confirmed for sensorial audio descriptions and 28.5%, for objective audio descriptions. 80% of visually impaired participants confirmed for sensorial audio descriptions; while early blind participants were divided in their feelings (45% for objective audio description, 55% for the one that was sensorial). We can observe that a painting's audio description can elicit an aesthetic experience even in people who have never seen one.

4. FORCE FEEDBACK TACTILE APPROACH

To create a tactile translation of the original artwork that can be easily apprehended by touch [15], we need to detect tactile elements from pictorial shapes. These can be represented as contours or textures. We can add to these representations motion sensitivity that can be created as a guided gesture following a shape or undulation. This tactile perception is not usual and even if very simple geometric shapes are recognised instinctively with movement [20], more complicated or slightly longer gestures can't be reproduced or memorised easily. They have to be accompanied with an audio description and expressed with words in order to facilitate their understanding. Some elements in artworks like the context and the colour can't be perceived with shapes and in addition, the number of available textures is sometimes limited. The contours should be segmented to be identified separately as the proximity of different objects in a painting would cause some confusion when touched with fingers. Museum curators can orientate the choice of some elements as more representative compared to others.

We developed a force-feedback tablet, F2T [21] based on a mobile flat thumbstick moved by two actuated orthogonal axis X and Y (Figure 2). The user's finger can push this servo-

controlled support in all directions and experience force feedback in-line with the movement or against the produced effort. The surface of F2T is 25 cm by 25 cm which is sufficiently small to feel the size of a virtual element in a painting by comparison with the size of a hand. The movement of the hand can be synchronised with an audio description while on top of a characteristic element.

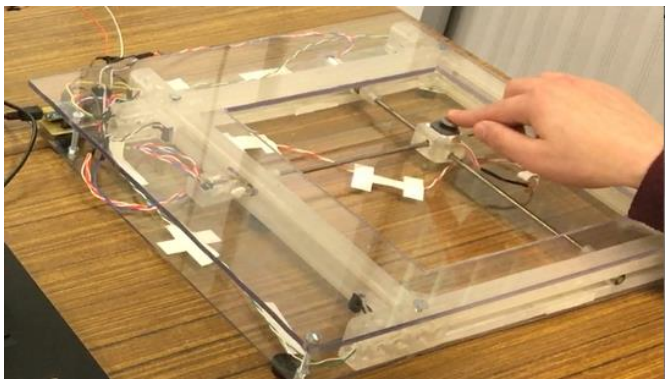


Figure 2. Force-Feedback Tablet, F2T

The easiest way to discover the tactile elements in a painting is the guided mode of exploration where the finger on the thumbstick is guided to discover the characteristic properties of this painting. The accompanying audio description can complement a first impression (gist) of the global setting of the objects on the painting. This is a part of the global description that VIP are always asking for when starting to explore an artwork.

F2T allows free exploration of the virtual elements with non-crossable edges that can be explored with the finger on the thumbstick moving along the contour. Usually free exploration includes the time to find the relative location of items and their identification.

Guided mode can't replace the more precise perception of free exploration but it can shorten free exploration time by up to 50% if VIP get a general organisation of the picture already with a guided path (See test results in layout perception in [21]).

In guided and free exploration modes, short audio descriptions could be inserted to explain the details of the virtual elements over which one moves the thumbstick. Tactile illusions of slope and various velocities can enhance the relief feeling of the touched elements. The thumbstick can produce a flow effect on the finger with force feedback to create a resistance feeling when the exploration moves in a wrong direction. Also, if the finger moves in the right direction the force feedback can create an acceleration of the thumbstick along the path. Attractors located in inner contours can guide the finger for the exploration of these elements. Texture effects can be used to differentiate some parts of an artwork. These are created with force feedback as solid friction or liquid friction [21].

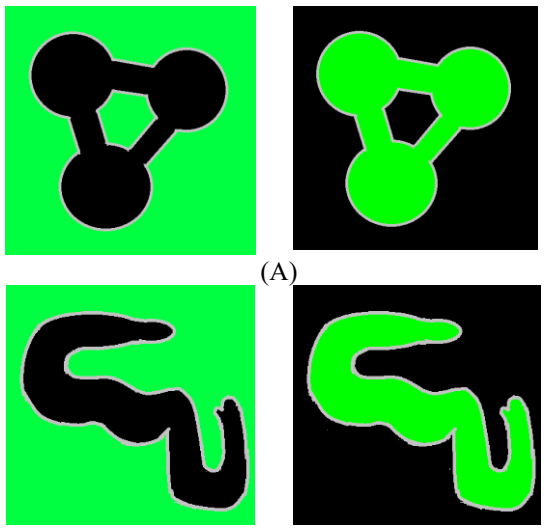
The emergence of perceptions provided by the movements of the thumbstick and accompanied by audio description stimulate the mental image formation. During our tests with VIP and blindfolded sighted persons, the participants reproduced correctly the simple elements they explored on the surface of F2T. They were willing to explore freely the virtual objects even after a guided contour [21] to check the mental image. For more complex figures, there is a need of articulation of listening and touch, taking in account that one cannot be concentrated on both at the same time. The nature of the explored element should be audio described briefly before the tactile exploration takes place.

To illustrate how hearing and touch are expressed, 2 examples of a tactile path are given in Figure 3. The tactile paths are shown with a green line. The guidance with audio description will alternate with the tactile equivalent on each simple curve or segment followed on the tactile path. Every path can be repeated if the user needs a thorough appropriation.

(A) (B)

Figure 3. Two examples of tactile paths from the painting "The dream of the snake". A) Concentric circles and their connections, B) Curved path showing the shape of the snake hidden in the painting

To fully understand an element of a painting, a user may wish to explore it by himself and at his own pace after listening to the audio description. The examples in Figure 4 show simplified tactile images of the contours of the elements in Figure 3: the circles connected with line segments (Figure 4A) and the contour of the snake (Figure 4B). These images can be explored freely. The outline of the elements is explored either from the inside or from the outside. The green colour represents the spaces that cannot be crossed as walls. The finger on the thumbstick is guided to the tactile exploration surface initially and then to the inner contours according to the user's choice. Thus, the user virtually "touches" the element.

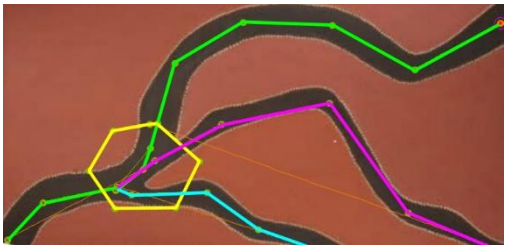


(A)

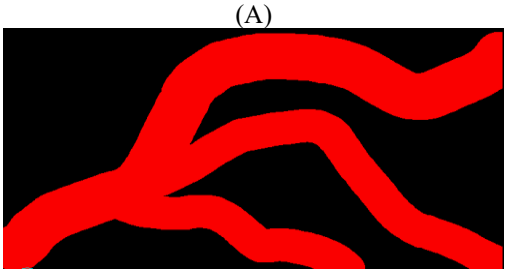
(B)

Figure 4. Free exploration of two elements of the painting "The dream of the snake". The green areas can't be crossed which makes it possible to explore the outline from the inside or from the outside according to the user's choice

Another example of a tactile path is given in Figure 5 for the painting “Ord River, Bow River, Denham River”. Several elements of the picture (the three rivers) can be explored in turn and the place where the rivers meet is indicated with a hexagon (Figure 5A). This hexagon can be located and compared to the size of the painting shown on the surface of the F2T tablet. Figure 5B is an example of texture map with fluid friction that can be associated to the tactile paths to give the feeling of the resistance of water.



(A)



(B)

Figure 5. A) The tactile path of the painting “River Ord, river Bow, river Denham”. B) The three rivers shown with the fluid friction (as if one is walking in water)

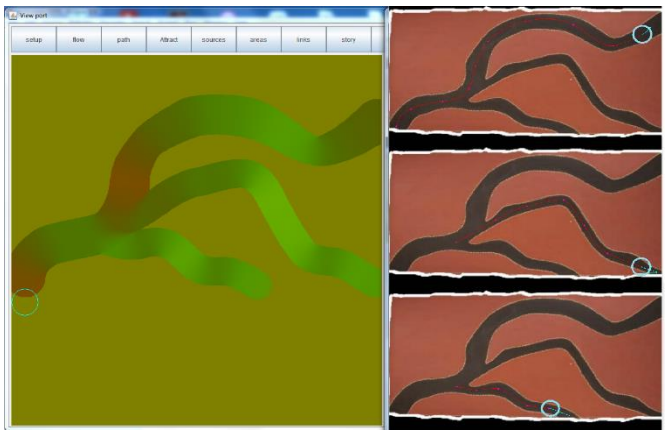


Figure 6. The flow image of the painting “River Ord, River Bow, River Denham” on the left. This image trains the finger on F2T along the river. The blue circle shows the start of the flow for each river along the water flowing direction (images on the right)

Finally, an example of the flow image of the painting “River Ord, River Bow, River Denham” is shown in Figure 6. The image of the flow follows the direction of the water. So, if the thumbstick is pushed on top of a river, the flow carries the finger in the direction of the confluence at the bottom left of the tactile image. The start of each river is shown in the three images on the right with a blue circle. This image creates interactivity of the flow movement with the finger and adds the flow effect to the exploration of the painting.

5. CONCLUSION

A novel approach to articulate virtual tactile exploration of paintings and their inclusive audio description is presented. We confirm that to understand the artwork tactilely, it is necessary to complement it with audio description which can also be used alone without touch nor vision. Nevertheless, the artwork perception would be more precise and closer to the original work if a tactile complement is used if desired.

This multisensory approach is inclusive, because it is not just for visually impaired people. Virtual elements’ discovery can be practiced at home or in the museum and creates opportunities for access to culture for all audiences. New emotions emerge in front of an artwork, allowing to exchange about the discoveries and this makes culture attractive.

We plan the adaptation of our approach to different types of artworks. The organization of the next tests will take in account the specificities of each kind of art and the articulation of tactile exploration with audio descriptions. We shall continue our research on the tapestries of Bayeux and of the Château of Angers as well as the paintings of the Museum of Quai Branly.

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