Mediators in Visual Interaction: An Analysis of the “Poietic Generator” and “Open Studio”

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Abstract
The Poietic Generator and Open Studio are examples of interactive art. They are based on distributed applications for visual interaction enabling to collaborate on the creation of visual images and narratives. This paper reports the analysis of the visual activity generated by their users. Such an analysis is founded on the phenomenological hypothesis that the visual activity generated by the participants in the Poietic Generator and Open Studio allows the study of the interaction process in terms of a co-determining relationship between perception and action, that is, at the level of the participants’ cognitive embodiment in visual interaction. The results of this analysis indicate five classes of mediators capable of tuning the development of the interaction process according to the context and the emotional state of the users. These classes are based on: (1) spatial relationships, (2) chromatic relationships, (3) figurative elements, (4) textual elements, and (5) temporal events. They can be supported by such mechanisms as emotional seeding and agency patterning.

By sustaining the intersubjective processing of information, mediators sustain the socially intelligent ability of constructing and sharing meaningful activities (i.e., co-creation). In this sense, they are particularly important in the design of social interactive systems that have purposes but not explicit goals (as in the case of art and creative activities in general).

Keywords: interactive art, visual interaction, distributed applications, collaborative systems, Poietic Generator, Open Studio, phenomenology, intersubjectivity, embodied interaction, co-creation, mediator.

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1. Introduction
Interactive art is a form of art that is already critically acknowledged and documented [1][2][3][4]; therefore, this paper is not intended to argue about artistic judgment, authorship, and interactivity from an aesthetical and historical standpoint (for the author’s contribution to these arguments, see [5]). For the aim of this paper, what is important is that collaborative systems for interactive art (such as those examined here) are particularly interesting as social interactive systems because they have purposes but not explicit goals [6][7]. This characteristic makes them suitable for studying how users socially construct and share “meaningful activities” in a mediated environment [8], according to the context and their emotional states. To this end, the study of the visual interaction occurring among the participants in collaborative systems for interactive art is enlightening in understanding the intersubjective manner in which information is processed and translated into meaningful activities. In these systems, digital images are not fixed, but computationally created, transformed, and manipulated by participants. They characterize an artificial universe on which formal structures mark not boundaries, but rather states in the continuous process of alteration of the image [9]. In these collaborative systems, computing produces a strong isomorphism between image and language [10], and an even stronger isomorphism between perception and action, to the extent that visual interaction can be seen as a form of embodiment or, more precisely, “embodied cognition” [11]. This embodiment takes place by means of the visual language performed by the users to express themselves and communicate with each other. In these systems, virtual images occupy a sort of “middle space”, blurring the distinction between subject and object; they comprise a continuum of visual experiences that are generated by the users, the results of which cannot be attributed either to images or to participants [12].

2. Visual Interaction as Creative Experience
This paper reports the analysis of the visual activity generated by the participants in the Poietic Generator and Open Studio, which are collaborative systems for interactive art based on distributed applications for visual interaction. The results of this analysis are part of a larger study aimed at understanding the nature of creative experience and design in the space engendered by information technologies [13]. This study reveals a relationship, according to the perception of participants, between “collaborating” and “creating equally and collectively”. By collaborating, participants experience a creativity in the evolution of the work that goes beyond their interaction with the computer; they feel a chance to be creative “in ways that they had not previously been”, according to one participant. During this kind of creative process, they find “wide latitude,” as expressed by another participant, in defining the meaning of the visual interaction.

The author’s study offers two complementary points of view on the origin of this form of creative experience, referred to as co-creation in Section 6.2. One view is that of the individual, the single participant; the other concerns the overall result of the myriad interactions occurring among the individual participants. When considering the point of view of the individual, the author’s study indicates different ways in which a single participant can explore and experience visual interaction as a form of creative experience. Participants can interact according to three different motivational paths (quotes here are from participants): (1) to enter into mutual relationships with each other
3. Research Approach

As usual for case studies in the social sciences [14], the research strategy is based on a mix of data relying on multiple sources of evidence (triangulation). In the present work, this mix of data is triangulated by integrating first-, third- and second-person methodologies, that is, combining subjective, objective, and “empathic” descriptions [15], respectively. First-person descriptions provide an account of phenomena that are relevant and manifest to an individual “subject”: they have a “subjective” character. Third-person descriptions provide an account of phenomena that are not clearly or immediately linked to the individuals who provide and produce such descriptions: they have an “objective” character. Finally, second-person descriptions can mediate first- and third-person descriptions: they ground on an “empathic” understanding and provide an intersubjective validation to the combination of the other two descriptions. This methodology of triangulation (for details, see [13]) is applied to the analysis of the visual activity generated by the participants in the Poietic Generator and Open Studio, and based on data concerning the collective interaction among participants. According to the methodology, these data derive from a combination of: (1) descriptive, objective data about participants’ visual interaction (collected by the author through direct observation); (2) in-depth, subjective understanding of participants’ activity (from participants’ answers to questionnaires and unstructured interviews); and (3) validating, empathic data about how participants feel when being emotionally and socially “situated” (provided by the author through immersive experience). The interpretation of the descriptive data is based on studies of visual perception and communication in both artistic and scientific disciplines [16][17][18][19][20][21][22][23][24], and is supported by the experience of the author as a participant as well as remarks and feedback to the questionnaires and interviews that participants provided (some of the participants’ answers are cited in the paper).

In concert with the adopted methodology, the collected data consist not of physical measurements, but of phenomenological data. Phenomenological data are essentially relational [25]. In spite of the variety of terms being used, a sort of consensus seems to have emerged around the idea that “a phenomenon, in the most original sense of the
word, is an appearance, and consequently something relational. It is what something is for something else” [15, p. 3]. The focus of this work on phenomenological data is based on the correlation between visual experience, which is fundamentally relational [26], and the visual modalities of participants’ interactions, which are essentially relational as well. In fact, visual modalities must be conceived as both perceptual and subjective [12][27][28]. For example, color can be considered either on its own terms (color appearance) [29][30] or as one of many attributes of our perceived world (color-perceived attribute) [31][32][33]. The way in which we organize color in linguistic and cultural categories according to different societies [34][35][36] proves that color is the product of the mutual specification of the world and an individual [26]. From this perspective—echoing statements in the art literature [16][17][18]—motion and other visual modalities also can be seen as relational, referring to structures in our perceptual interactions in which we trace out relations among various elements [37]. The phenomenological hypothesis on which this work is founded is that the visual activity generated in collaborative systems for interactive art allows the study of the mediation and development of the interaction process in terms of a co-determining relationship between perception and action [11], that is, in terms of the participants’ cognitive embodiment in visual interaction. Many current approaches to vision rest on the idea that when we see, the brain produces an internal representation of the world. According to these approaches, the brain basically mirrors the external world, and in doing so it gives rise to the experience of seeing. According to the phenomenological approach, instead, “seeing is a way of acting” [38, p. 939]; it is a particular way of exploring and interacting with the environment. On the basis of this assumption, this analysis has considered visual events in terms of shared and mutually influential subjective experiences, or better, “intersubjective experiences” [12][39]. The hypothesis of this work, therefore, is that the phenomenological analysis of the visual activity generated by the participants in the Poietic Generator and Open Studio allows an understanding of how users generate images and activities, whilst being modulated by the visual events resulting from their interaction with the environment. It means that, according to the hypothesis, we can study participants’ visual interaction as an intersubjective activity of “embodied cognition” [11], that is, as the result of interactions with an environment whose visual structures dynamically embody and convey other participants’ actions, perceptions, and emotions.

4. The Case Studies
The Poietic Generator and Open Studio are distributed applications for visual interaction that enable users to collaborate on the creation of visual images and narratives. Both pertain to the field of the interactive arts [40][41] and are to be considered as “art systems” [42]. In fact, they are not meant to represent or create a material “artwork”; on the contrary, they compose an interactive system that embraces all the participants in the interaction process (from the software to the users) [43], and allows them to establish mutual exchanges in the process of creation [2]. This difference corresponds to the different kind of creative relationship that the viewer establishes with a “finite” artwork versus an “intelligent system” [44], because only in the second case can the viewer mutually interact with the artwork, and eventually with the artist or other viewers.

The choice of these two case studies is based not on the technical capabilities that characterize them as digitally based tools per se, but on the features that distinguish
them as art systems. Their main similarity—relevant to this analysis—consists of the unique attention paid to visual interaction, to the detriment of verbal communication and established personal acquaintances (for more details on anonymity and patterns of participation, see [13]). Another interesting similarity is the critical investigation of the spatial and temporal aspects of visual interaction (see Section 6); in contrast, an important difference concerns their unique constraints and styles of interaction (for a description on the role of the Java applets developed by the artists that is more detailed than the one provided in the following two sections, again, see [13]). Lastly, a further reason for choosing these two case studies is that both have been popular for several years, and consequently they offer a rich collection of visual data available from both public and private archives.

4.1. Poietic Generator

The Poietic Generator (http://poietic-generator.net) was originally developed by Olivier Auber for the French Minitel in 1986, transferred to the experimental Multicast Backbone of the Internet in 1995, and moved to the Web as a Java applet in 1997. The Poietic Generator is a distributed application that enables a large number of people across the world to participate in real time in the emergence of an ephemeral and ever-changing image. This virtual image is the result of many local images, which are adjoining and do not overlap. Participants can join or leave the collective drawing process at any time; each new connection or disconnection causes the automatic rescaling of all the local images contained in the resulting global one. The number of participants can reach up to several hundred in the Web version, depending on server capacity; in the Multicast version, this number can reach up to several thousand. So far, the largest documented number of participants connected at the same time is 16.

Once launched, the program continuously offers a double view of the drawing process. The first view shows the current state of the global image, and it is the same for each participant. The second view shows each participant an enlargement of the local image associated with him or her (Figure 1 shows these different local views and how they compose the resulting global image). Local images can be modified at will by means of a palette that constrains participants to draw pixel by pixel. This palette is composed of 20 colors (10 light and 10 dark) and 4 buttons (permitting participants to define the size of the pixel, to undo, and to erase). Any modification to the local image is immediately propagated to all the global images displayed at that moment to the other participants, so that the collective image always changes in the same way for all participants.

The evolution of the resulting global image is saved event by event (i.e., pixel by pixel). It is not possible to rewind, erase, or modify a sign that has already been memorized. Initially, the individual sign of the first participant takes up the whole global image. Then, the part devoted to this sign decreases in size as long as other participants connect themselves to the current session. The program automatically determines the location of the new local images, either setting them side-by-side in a spiral-like shape or setting them in such a way that they will replace the image of a participant who has recently left the session (see, for example, the numbering of participants in Figure 1). By default, the system gives a place as central as possible to a new participant.
Figure 1. Poietic Generator: View of the local images that are associated with and controlled by each individual participant (on the right), and how they compose the resulting global image that is shared by all the participants (on the left).

As an art system, the Poietic Generator experiments the network capability of instantly assembling in one single time the attention and thoughts of a great number of people who are decentralized by the Internet and are communicating in real time. In doing so, the Poietic Generator allows one to experience a virtual space of extraordinary complexity in a rather simple way. The abstract and minimalist character of individual signs (reduced to the scale of pixels), as well as the non-imposition of definite forms of expression or narrative, force participants’ subjective interpretation to high levels of dynamism. Collective interaction produces here an uninterrupted sequence of abstract or figurative shapes that can be observed and modified at will by any of the participants, but not globally controlled.

Usually, image evolution starts with different chaotic forms, something like moving “fruit salads”. Then, rather quickly, one person enters something interesting, a sign (for example a house), and—consciously or not—that person’s neighbors start to imitate that sign. Whether a vague imitation or a faithful copy, all of a sudden a relation of translation emerges, with one theme here and similar images there. As known, the human eye is quite adept at reading analogies throughout the chaos and organizing this information meaningfully through well-known collective mechanisms, such as
mimetism, symmetry, pattern recognition, and so on [45]. According to the artist Olivier Auber (personal communication): “It is almost like looking at clouds: one identifies a shape and quickly it is recognized by all”. However, contrary to cloud movement, which depends upon the wind, everyone here contributes to the shape or the background, to the clouds or the sky. Everyone can modify his or her own sign to confirm or contradict, for example, a horse shape. Everyone works on a subjective shape, which then becomes objective for all. The horse finds a life of its own: its head moves, it changes color, or it mutates into a Taurus or something else (Olivier Auber, personal communication). Little by little, signs mutate, and a collective narrative emerges from the continuum of the interaction, as an autonomous and erratic animated image.

4.2. Open Studio

Open Studio (http://draw.artcontext.net/) is a Java-based drawing system by Andy Deck that concurrently links users up to a single pictorial surface, and allows them to participate in the creation of a graphic animation. Once connected, participants can choose whether to start interacting from scratch, by drawing on the surface of Open Studio in its current state, or to retrace the older, archived drawings. The most recent drawings are automatically stored on the server. Their history can be redrawn on the participant’s applet any time the “Play” button is used, and stopped any time the “Stop” button is clicked. Once the full history of previous drawings has been shown, the participant sees the present state of Open Studio. The history has a finite length, which changes as people continue to draw. Participants also can save and store drawings on the server, and quickly play them back at any time in the same sequence of strokes and marks originally used. Anything a participant plays, draws, or edits on his or her applet surface is automatically shared by the other participants and added to the history of Open Studio.

These various opportunities of interaction produce multiple and overlapped spaces of real and recorded time; there are no guarantees that a participant sees exactly what other participants who are connected at the same time are seeing. Because it is impossible to identify one participant from another only on the basis of his or her drawing activity, when someone interacts with other participants while sketching on the recent Open Studio history, or while editing a drawing that is being played back, he or she does not know whether the strokes and marks appearing on the canvas are recorded or drawn in real time. Some participants will be “real” and some will be rather “phantoms”. However, regardless of when the action took place, drawing tools have been designed to be expressive and reactive to participants’ movements (speed, direction, curving, and so on). Lines, marks, and strokes convey a persistent visual and “bodily” quality that questions the nature of participants’ presence, and time linearity as well.

As in the Poietic Generator, the interface is very simple. It has been designed to be easy to use and intuitive: a set of drawing tools, a color picker, a size control, and the shared canvas (Figure 2).
As an art system, Open Studio draws its inspiration from graffiti as well as from jam sessions, in which musicians create music playing by improvisation. Says Deck, quoting a review of Open Studio from 1999: “You have to cope with being not the only creator. While you’re watching the image you just made, it’s starting to change; and yes, you suddenly notice that the program has got two users, and now three. … It’s no use to swear or protest. Somewhere in the cyberspace somebody else is sitting in this moment and painting over your creation, in his or her own fantastic or terrible way” (Andy Deck, personal communication).

Andy Deck began to produce software that combined drawing and time-based sequences of drawn images in 1990. His work is based on the idea of “malleable aesthetics”, the essence of which is a profound reconfigurability of the artwork in response to feedback from interested participants [46]. According to Deck, whereas the beauty of most existing multimedia is supposed to reside in the masterful interplay of the prospective narratives wired in by the author, the allure of malleable aesthetics is instead the potential to open up unanticipated paths. The paramount question is how to involve people in meaningful events, and orchestrate contributions to something that can last beyond the event itself, and turn into a shared history.

5. Results of the Analysis

This section reports the analysis of the visual activity generated by the participants in the Poietic Generator and Open Studio. This analysis illustrates how the intersubjective field of perception and action that is produced by the participants’ embodiment into the environment provides a social and dynamic context for the evolution of the interaction process. The analysis identifies five classes of environment excitations resulting from
this intersubjective processing and composing dynamic structures capable of tuning the development of the interaction process. Such emerging structures are called “mediators”.

5.1. A Definition of Mediator

Definition: A mediator is a situated and collective structure, which emerges from the socio-technical environment during the course of an interaction and is capable of tuning the development of the interaction process according to the context and emotional state of the participants.

For example, in distributed applications for visual interaction, such as the Poietic Generator and Open Studio, a mediator can be the pattern of lines and strokes, the combination of colors, the set of figurative elements, or other determinants generated and modified by the participants’ drawing activity as a specific configuration of pixels. The mediator is instantiated by the spatial, chromatic, or narrative relationships that these patterns compose on the canvas, and that participants collectively “interpret” as meaningful structures. Mediators are responsible for the emotions and modes of conduct that will emerge over the course of the interaction, as well as for the activation of collective mechanisms (such as, for instance, the pattern recognition that children employ while looking at clouds).

The capacity of mediators is to drive users from one state of the interaction process to another by conveying the “emotional tone” of the interaction, that is, the tonality of the affective trend that will induce actual emotions and behaviors to emerge and shift. Mediators do not convey the single and immediate emotions of an individual user; they convey the tenor of the interaction occurring among users. This trend is proper to a coherent set of visual events, and how these are “interpreted”. In this sense, mediators neither express nor provoke a particular emotion or conduct; rather, they communicate the nature (aggressive, peaceful, introverted, and so forth) of the course of the interaction.

By providing a social and dynamic context for interaction, mediators support the socially intelligent ability of constructing and sharing meaningful activities. They are particularly important in the design of systems that have purposes but not explicit goals (as in the case of art and creative activities in general). However, in this analysis, the concept of mediator is assumed and explored exclusively in the context of visual interaction; other considerations and a possible expansion of the concept are discussed in the final sections (see, in particular, Sections 6.2 and 6.3).

The original meaning of the notions associated with the concept of mediator is defined in theoretical physics. These notions have been applied later to the description of complex phenomena, such as distributed computing and human interaction. However, a definition of mediator—as applied to human-computer interaction (HCI)—is still unresolved. Generally speaking, a consensus seems to have emerged around the idea that the origin of mediators is the environment, interpreted as “a collection of excitations”. The specificity of the present work is that the concept of mediator is here assumed and explored in the context of collaborative environments whose excitations are not independent from the interaction process, but are dynamically generated by (and embodied in) the participants’ actions, perceptions, and emotions.

In this context of analysis, a mediator is neither a construct nor an artifact (as is usually intended), but an emerging phenomenon. The contribution of this paper to the notion of mediators in HCI is grounded on this understanding. Because mediators
are not artifacts, they cannot be designed; their emergence can only be sustained (see Section 6.3). The emergence of mediators is the result of the interplay between affordances and externalizations, that is—according to the interpretation accepted by the author—between the opportunities for action provided by the information system and the external representations produced by the participants during the interaction process. The opportunities for action provided by the affordances of the information system (whether we want to conceive them as the properties of an ecological relationship \[53][54][55][56] or as the perceived properties of an object [57]) represent the physical constraints that impinge on participants’ externalizations. In turn, participants’ actions (and interactions) are stimulated by participants’ externalizations (conceived as external representations of the cognitive activities carried out by means of the system \[58][59][60] or, a step further, as an expression of thoughts and intentions in a form more accessible to reflective and creative efforts \[61][62][63]). In the specific instance presented in this paper, mediators emerge as the result of a collective “interpretation” (broadly defined) of the visual structures produced by the interplay between afforded drawing and actual drawing (Figure 3).

Figure 3. Mediators: An abstract representation of the emergence of mediators as a collective “interpretation” (emerging shapes) of the structures produced by the interplay between the opportunities for action provided by the information system (image field) and the external representations produced by the participants during the interaction process (actual lines).

At this point, some fundamental differences among affordances, externalizations, and mediators need to be pointed out. Table 1 provides a general and concise comparison.

Table 1. A Comparison among Affordances, Externalizations, and Mediators.

<table>
<thead>
<tr>
<th></th>
<th>Affordances</th>
<th>Externalizations</th>
<th>Mediators</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
<td>Opportunities for action provided by the environment</td>
<td>External representations enabled by the environment</td>
<td>Active structures situated into the environment</td>
</tr>
<tr>
<td><strong>Origin</strong></td>
<td>They are given with</td>
<td>They are incorporated</td>
<td>They emerge from</td>
</tr>
<tr>
<td></td>
<td>the physical environment</td>
<td>into the environment</td>
<td>the socio-technical environment</td>
</tr>
<tr>
<td>--------------------------</td>
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<td>---------------------------------------------------</td>
<td>-------------------------------------------------</td>
</tr>
<tr>
<td><strong>Nature</strong></td>
<td>They are independent from perception</td>
<td>They are dependent on the perception of an observer</td>
<td>They are dependent on the action-perception of participants</td>
</tr>
<tr>
<td><strong>Instantiation</strong></td>
<td>They are offered by the functional relationship with a specific object in the environment</td>
<td>They are produced by the externalization in the environment of users’ thoughts and intentions</td>
<td>They are generated by the collective “interpretation” of environment excitations</td>
</tr>
<tr>
<td><strong>Capacity</strong></td>
<td>They enable users to perform a task</td>
<td>They enable users to express a subjective perception</td>
<td>They drive users from one state of the interaction process to another</td>
</tr>
<tr>
<td><strong>Impact</strong></td>
<td>They affect users’ capabilities</td>
<td>They affect users’ understanding</td>
<td>They affect the global development of the interaction process</td>
</tr>
<tr>
<td><strong>Modifiability</strong></td>
<td>They change according to the complementarity of the acting individual and the acted-upon environment</td>
<td>They change according to further externalizations</td>
<td>They change according to the sequence of participants’ actions and perceptions</td>
</tr>
<tr>
<td><strong>Variation</strong></td>
<td>They may change over time, but it does not change the invariance (constant information) that specifies them</td>
<td>They may change over the course of the interaction</td>
<td>They constantly change during the development of the interaction process</td>
</tr>
</tbody>
</table>

Because mediators are the result of a collective “interpretation”, one could be induced to classify them as “boundary objects” [64][65]. However, mediators are conceptually different from boundary objects. A boundary object is “a means of translation” [65, p. 297], which enables different people to communicate and coordinate their different knowledge and perspectives; it is often conceptualized as an object (either concrete or abstract) aimed at facilitating the shared understanding and solution of a common problem [66]. Even when conceptualized as evolving “conversation pieces” [67][68], boundary objects always represent a means of coordination and alignment; in other words, they are a semantic concept. To some extent a mediator carrying users from one state of the interaction to another provides a common vector of “understanding”. Yet,
this vector is *transitory*: a situated and collective structure of “meaning”, or “sense”, that composes neither a construct nor an artifact. Mediators are not boundary objects meant to satisfy the informational requirements of different communities and maintain an intelligible coherence among them [65]; rather, they *mediate the interaction of non-fixed subjects around non-fixed objects*. They provide a ground (often pre-reflective) for engagement in open-ended and personally meaningful activities, rather than a means of classification (see Section 6.2 on co-creation). This distinction is important in order to understand when there is a need for mediators to be sustained and when the use of boundary objects is instead more convenient.

5.2. Classes of Mediators

The results of this analysis indicate five classes of mediators in visual interaction, based on: (1) spatial relationships, (2) chromatic relationships, (3) figurative elements, (4) textual elements, and (5) temporal events. Mediators usually operate jointly; this report, however, focuses primarily on their taxonomy.

The figures provided in this section support the presentation of these results. They represent snapshots extracted from video recordings that were archived by the artists, or they were documented directly by the author during sessions for which she was involved in the organization and in which she participated since 1999 (e.g., Golem Videofestival, Turin, Italy, November 1999; University of Montpellier III, Montpellier, France, June 2000; Fondazione Pistoletto, Cittadellarte, Biella, Italy, April 2001). Whereas the author’s direct observation of the video recordings examined the sequencing of large and small events over time, the snapshots provide accounts only for “meaningful events” that can be useful for the reader’s understanding and that were identified by the author as a participant (see Section 3 for the use of immersive experience in the triangulation of the research data). In the captions for these figures, PG and OS are used as abbreviations for Poietic Generator and Open Studio, respectively.

5.2.1. Spatial mediators

Spatial mediators usually originate from lines and strokes and from the shapes and spatial relationships they identify on the canvas. Spatial mediators disclose, and simultaneously affect, participants’ emotions and intentions in a pre-reflective mode that is founded on participants’ *sensory-motor perceptions* of other users’ actions on the canvas. They originate from an environment in which space is perceived and experienced as a *proximal field* among participants, and in which lines and strokes embody the intentional movements of participants. For some, the experience of such a space is, according to one participant, “almost like touching”.

By means of the spatial orientation and configuration of the lines that are being drawn (PG), or according to the capacity exhibited by the strokes covering previous drawings or letting them show through (OS), spatial mediators can express either “openness” or “closure”.

Figure 4. “Openness” and “Closure” in PG: Spatial Orientation.

Figure 4 refers to the Poietic Generator. As described in Section 4.1, participants can draw only inside their own local images, that is, inside the sections of the canvas that have been specifically associated with them. In Figure 4(a), six participants were interacting (their sections can be identified by dividing the image into six even squares); in Figure 4(b), there were eight participants. In both figures, an open attitude and a disposition for dialogue are expressed by the use of lines connecting to each other across the different sections of the canvas. In Figure 4(a), for instance, the yellow horizontal line traced in the middle of the canvas is the result of a tacit accord between two participants, who connected their sections by joining their sign into a horizontal line, and making a little man walk on this imaginary path in the sky. In Figure 4(b), three participants filled portions of space with the same color and connected them to obtain a green field in the middle of the canvas, which expresses a similar disposition for dialogue. An opposite disposition is manifested, instead, by shapes stressing the borders of individual sections or spiraling on themselves in a centripetal movement. See, for instance, the brown borders in Figure 4(b), and the shapes at the right bottom in Figure 4(a) and Figure 4(b).

Figure 5. “Openness” and “Closure” in PG: Space Configuration.

Figure 5 presents other instances of “closure” and “openness” in the Poietic Generator by how space is configured by participants. Figure 5(a) expresses openness by a state of chaos that blurs and expands the limits of individual areas. This state of chaos, which will soon lead to the emergence of a shared image, is produced by drawing pixels in a fine-grained manner and quite rapidly. Figure 5(b) expresses closure by various types of
crosses and squares. This kind of space configuration stresses the limits of individual sections, prevents local images from expanding, and keeps imaginary elements constrained in the individual sections (like the potential little turtle trapped in the right square at the bottom).

Figure 6. Aggression and Dialogue in OS: Canvas Resetting.

Figure 6 refers to Open Studio. As described in Section 4.2, participants draw concurrently on the same canvas. The strokes that they trace on the canvas do not allow locating and associating them with sections of the canvas (like in the Poietic Generator). Strokes are the only way in which participants are represented on the canvas. Moreover, since recording does not allow tracing how many users participated in a session, it is impossible to derive this number from the observation of historical records. (The author was able to document no more than eight users participating simultaneously in Open Studio.) In Open Studio, aggression is usually expressed by thick and heavy marks meant to completely cover the previous drawings, whereas an open attitude and a disposition for dialogue are manifested by the use of lighter strokes, which allow previous drawings to show through. In Figure 6(a) and Figure 6(b), for instance, two different brushes are used to reset the canvas. In Figure 6(a), the black strokes express an aggressive behavior that will lead to a sudden and forceful resetting of the canvas; in Figure 6(b), the white strokes express a more dialogic behavior, which also will eventually lead to the resetting of the canvas, but in a slower and gentler manner. The arbitrary resetting of the canvas by participants is a cyclic event in Open Studio. However, even though in both cases the canvas is arbitrarily reset, the way in which this happens affects significantly the emotional tone of the participants and the development of the interaction process.
Figure 7. Aggression and Dialogue in OS: “Action Painting”.

Figure 7(a) and Figure 7(b) provide a close look at how the choice of different brushes in Open Studio—and the way in which they are used (such as a certain size and speed)—can express either aggression or a more dialogic attitude, according to the manner in which the strokes overcome the marks drawn by other participants or, on the contrary, let them show through. As in the Poietic Generator, the process of interaction goes through chaotic states, eventually leading to the emergence of shared images. As in canvas resetting, the nature of these chaotic states in Open Studio influences participants’ disposition toward the development of the interaction process, and is conditioned by the participants’ “action painting”, meant here as the expressive and physical quality of the strokes on the canvas.

5.2.2. Chromatic mediators

Chromatic mediators originate from colors and how they connect to each other. Just as spatial mediators do, they both disclose and affect participants’ disposition toward the interaction process. As explained in Section 3, colors neither express nor represent anything per se; they are “relational” in the sense that they are a product of the mutual specification of the physical world and an individual’s perceptual capabilities and categories. According to recent methodologies of pictorial analysis compatible with such a cognitive assumption [24], neighboring colors establish relationships that can be either “static” or “dynamic”. Any color has its own physical quality that makes it red, yellow, green, and so on. Expansion or contraction of such a quality allows a color to evolve and dissolve in another color, or encloses it in a “separate and silent world” [24]. Therefore, a relationship is dynamic when the quality of a color—as a force—passes to the adjacent color (e.g., red-orange-yellow); it is dynamic-static when the effect of movement is stopped (e.g., red-purple-yellow, in which purple connects to red but not to yellow); and it is static when the process does not take place (e.g., red-blue).

The analysis of these and other relational properties reveals that chromatic mediators can: (1) determine static or dynamic relationships among participants (and consequently affect the dynamism of the interaction itself); and (2) work as transitional states for the emergence of collective images and shared narratives.
Figure 8. Chromatic Configurations in OS: Dynamic and Static Relationships.

Figure 8 shows two different states of chaos in Open Studio. In Figure 8(a), the relationships among colors establish a dynamic field (red-orange-yellow); in Figure 8(b), the relationship among colors establishes a more static field (red-blue). These chaotic states, here analyzed as chromatic configurations, seem to induce different degrees of receptivity and dynamism in the interaction process, and ultimately provoke a different disposition among participants. As evident from the snapshots, the nature of these chaotic states is sustained also by the style of the strokes and shapes that have been drawn (see Section 5.2.1).

Figure 9. Chromatic Configurations in PG: Chromatic Linking.

In the Poietic Generator—where the palette of colors is quite limited compared to that in Open Studio—the dynamicity of the configurations (and the consequent dynamism of the interaction) is usually a result of the spatial correlation among colors, rather than being due to the nature of the chromatic relationships. In Figure 9, for instance, the use of identical colors will generate over time a state of chaos expanding colors across the boundaries of individual sections, and connecting them in a dynamic configuration. This chromatic linking expresses the emergence of dynamic relationships among participants, and it can follow various mechanisms that range from symmetry in Figure 9(a) to mimesis in Figure 9(b).

As mentioned earlier, chromatic mediators can work also as transitional states. In this case, colors catalyze participants’ imagination. They act as elements through which participants negotiate the fictional world they are collectively creating and evolving, by triggering transitions from one recognizable “entity” to another. For example, in Figure
10, the same color suggests to participants different environments: in Figure 10(a), the light blue is a sky standing sunny over Paris, whereas in Figure 10(b), a slightly darker blue is a sea populated by octopuses, fish, and seaweed.

Figure 10. Color as Transitional Element in PG.

Instances of colors as transitional elements occur also in Open Studio. However, because Open Studio is based on concurrent drawing, color fields appear one upon the other (and thus also disappear), interweaving very easily and not lasting for long. To let a color field become a ground for the emergence of a figure, participants frequently use a black line. Upon the chaotic layering of colors, black seems to be very powerful in temporarily stabilizing a color field as a recognizable pattern. In Figure 11(a), for instance, the gray, blue, and black fields are fixed by means of a thin black line, suggesting, respectively, the nose, ears, eyes, and contours of a strange face. In Figure 11(b), instead, it is the color pink, rather than a pattern of colors, that evokes a rose. In this case, black is used like a pencil, to fix the suggestion given by the color.

Figure 11. Color as Transitional Element in OS.

5.2.3. Figurative mediators

Figurative mediators look archetypical in visual interaction, recurring as sort of variations of an original type. They usually represent faces, bodies, organs, animals, monsters (often an hybrid between a human and an animal), and natural or constructed elements (such as a tree, a building, or a road). Figurative mediators can (1) work as transitional states, triggering phenomena of pattern recognition and narrative
sequences; (2) express more explicit emotions, thoughts, or requests from participants; and (3) manifest participants’ presence and intentions through elements of auto-representation.

As transitional states, figurative mediators catalyze participants’ imaginations. In this case, figurative elements act as driving forces in the creation of the “entities” that populate and identify a recognizable world. In this sense, figurative mediators can be described as states that trigger transitions from one “world” to another (i.e., from one reference system to another). In Figure 12, for instance, the transition using the Poietic Generator is initially triggered by the figurative element of a large, single eye. First it was the Martian on the right of Figure 12(a), then it was the monster recalling the mythological Polyphemus, and finally it was the woman in Figure 12(b). According to the progression of figurative elements and colors (note the color pink, in combination with the figurative element, suggests the human skin), participants transform their frame of reference from an extra-terrestrial being to a mythological character, and lastly to a human being.

![Figure 12. Figurative Elements as Transitional Elements in GP.](image)

Figurative mediators can also more explicitly express emotions, thoughts, or requests from participants. In the Poietic Generator it is easy to recognize them, but in Open Studio this is more difficult to state. The difficulty is due to the concurrent nature of drawing and the complexity in inferring relations among visual elements that appear in a highly ephemeral way during the course of the interaction. However, it can be assumed that in Figure 13(a) the green human body, standing precisely on the horizontal plane of one of the squares, represents a reaction to the abstract and oppressive drawing of concentric squares on the canvas. Similarly, it can be assumed that in Figure 13(b) the eye, drawn with difficulty over the unceasing sequence of numbers produced by some other participant, represents a reaction to the current tenor of the interaction.
Figure 13. Figurative Elements as a Form of Expression in OS.

When manifesting participants’ presence and intentions through elements of auto-representation, figurative mediators can act either as a form of self-expression or as an action mode.

Figure 14. Facial Expression in PG and OS.

In the first case (self-expression), participants can be represented by means of different facial expressions, as in Figure 14. In the second case (action mode), they are represented by means of simulated senses and actions, as in Figure 15 and Figure 16. For example, in Figure 15(a), the arrow is connected to the eye and to the other arrow on the left, trying to simulate the action of looking at each other. In Figure 15(b), instead, participants simulate the action of hearing: the head on the right reacts to the sound waves produced by other participants (but ideally generated by the character on the left) with the movement of her eyes.
Figure 15. Simulated Movement in PG.

In Figure 16, the participants’ actual painting manifests the action mode of participants’ presence and intentions. It is important to recall that in Open Studio the drawing tools are reactive to the gestures of participants; they produce lines and strokes that are different in thickness and appearance according to the quality of users’ movements. Figure 17, for instance, contrasts a slow, heavy, and continuous movement in Figure 16(a), to a rapid and fragmented movement in Figure 16(b).

Figure 16. Pictorial Actions in OS.

5.2.4. Textual mediators

Textual mediators represent a form of linguistic embodiment. Their most simple form occurs when participants write their names in order to assert their presence. However, as a form of linguistic embodiment, textual mediators can also: (1) express emotions (Figure 17); (2) express opinions and comments on the development and outcomes of the interaction (Figure 18); (3) call for a shift in the current emotional tone of the interaction (Figure 19); and (4) allow verbal communications among participants (Figure 20). In Figure 17, a participant expresses his or her discomfort and uneasiness in interacting with the other participants by crying for help (“Aaah!”).
In Figure 18, a participant comments on the result of the interaction, ironically naming the woman in the picture: “Beautiful”.

In Figure 19, for instance, a participant in Open Studio calls for a shift in the current emotional tone of the interaction, and asks for a change in the aggressive and violent behavior of other participants by writing: “No!”

The verbal communication among participants that is conveyed by textual mediators is usually “conative” [69]: rather than designating objects, it expresses an orientation toward the other participants (by means, for instance, of a vocative or an imperative).
This verbal communication rarely directs or coordinates the drawing activity toward a specific endpoint, and it typically takes the form of greetings, invitations, and questions (Figure 20).

![Image](image1.png)  ![Image](image2.png)

**Figure 20. Verbal Communications in PG and OS.**

Generally speaking, textual mediators do not convey a “referential” function. They usually express “emotional”, “conative”, and “phatic” functions [69]: rather than sustaining actual “conversations,” they focus on the personal attitude and emotional state of the speaker (emotional function); express an orientation toward the other participants (conative function); or aim at establishing, prolonging, and confirming or discontinuing the communication (phatic function).

5.2.5. **Temporal mediators**

Lines, strokes, colors, and all the figurative and textual elements occurring during the interaction process are in motion. They change over time, appearing and disappearing according to the actions of participants. *It is therefore time that ultimately engenders the context and emotional tone of the interaction process in the space of several and diverse intervals (from the immediate to the whole process)*. Time enables narrative sequences and a shared imaginary to emerge from the *nonlinear flow* of participants’ collective interaction. For example, in Figure 21 the interplay of the various classes of mediators over a particular interval of time finally leads to a major meaningful event, which can be described as a shared imaginary. This shared imaginary—representing a sort of decadent portrait—is the result of the interplay among spatial mediators (strokes that do not cover each other, but come together), chromatic mediators (a combination of black, blue, and white), figurative mediators (the suggestion of a pair of glasses, curly hair and mustache, and a cat), and textual mediators (the French words).
In Figure 22 as well, a narrative sequence—representing a funny history of seduction—takes place in the space of a particular interval of time, as the result of the interplay among the other classes of mediators.

Figure 22. A Narrative Sequence in PG.

Temporal mediators make time be perceived and experienced as “a network of intentionalities” [39][47], rather than as a linear measure of passing instants. Temporal mediators are neither synchronous nor asynchronous—borrowing the term from Merleau-Ponty, they are “duration”. In the space of this duration, outcomes (either images or narrative sequences) emerge from an initial state of chaos, become identifiable, and are recognized as meaningful events. Temporal mediators are dependent upon the other classes of mediators, and encompass them.

6. General Discussion

This section provides a final account of participants’ cognitive embodiment in visual interaction, offering an understanding of context and emotional states as a result of the intersubjective processing of information that is sustained by the emergence of mediators (Section 6.1). Co-creation—usually defined as a category of interactive art comprising works that generally exhibit a high degree of malleability, responsiveness, and transformability—is here described as the socially intelligent ability of constructing and sharing meaningful activities that results from such an intersubjective processing of information (Section 6.2). Finally, the discussion is open to the kind of mechanisms that can sustain co-creation in the design of social interactive systems (Section 6.3). These
mechanisms, however, still represent a quite unexplored topic, which the author frames in general terms in view of future work.

### 6.1. Visual Embodiment

The results of the analysis confirm that the visual interaction among participants in the Poietic Generator and Open Studio consists essentially of a mediated form of cognitive embodiment. As such, the visual interaction among participants can be defined as a form of “embodied interaction” [70], because it not only entails “possessing and acting through a physical manifestation in the world” [70, p. 100], but also implies a “participative” way of being [70, p. 125]. In other words, it reflects that “property of our engagement with the world that allows us to make it meaningful” [70, p. 126].

This visual embodiment of the participants in the socio-technical environment involves notions of: (a) affective bodies; (b) relational setting; and (c) intersubjective processing of information.

#### 6.1.1 Affective bodies

In the Poietic Generator and Open Studio, visual embodiment does not take place through the representation of a user’s body (for example, an emoticon or an anthropomorphic avatar), but as a visualization of participants’ spontaneous and impromptu activities. It is a fully cognitive embodiment that enables users to experience the socio-technical environment as both the world in which they can manifest and express themselves and a source of sensory-motor and emotional excitations. Visual embodiment takes the form of the visual language performed by the participants to express themselves and communicate with each other, so that a user’s body is defined by the way in which a subject manifests himself or herself through the use of marks, colors, and other different kinds of visual elements. For example, the local image in the Poietic Generator, or the individual painting in Open Studio, constitute the contours of a users’ body; however, it is only by acting and reacting, affecting the others and in turn being affected by them, that participants manifest themselves. Visual embodiment (as any mediated forms of cognitive embodiment) enables the manifestation of participants’ affective bodies [71][72] and their mutual interaction. These affective bodies are the result of a process of mediation rather than representation (affective bodies versus representational bodies).

#### 6.1.2 Relational setting

As a result, visual embodiment generates an environment whose structures dynamically express and convey other participants’ actions, perceptions, and emotions. Participants generate images and activities, while being modulated by visual events that can be described as interactions with an environment substantiated by other participants’ embodiments. This environment of embodied actions composes a relational setting, which is the origin of mediators. Such a relational setting provides a social and dynamic context for the evolution of the interaction process that allows participants to spontaneously negotiate their mutual understanding and common goals.

#### 6.1.3 Intersubjective processing of information

In the relational setting provided by visual embodiment, mediators sustain the intersubjective processing of information. This means that time, space, and physicality
are experienced in intersubjective rather than informational terms. Forms of visual empathy, for example, have been observed in some sessions of the Poietic Generator. These manifestations of visual empathy can be the seamless extension of a colored line beyond the borders of individual areas to create some sort of movement (like the movement of a snake), or the drawing of a boat that is deconstructed and reconstructed piece by piece across different local images and made to move from one side of the canvas to the other. In general, the results of this analysis advocate for a “relational concept of information” [73]. In this regard, the author’s study provides evidence of the fact that when participants more strongly perceive the physical constraints (or affordances) of the collaborative system rather than the emotional tone of interaction (that is, the presence of and the relationship with other participants), or when they are too focused on the construction of individual externalizations, the feeling of creating equally and collectively in a way that would not have been possible otherwise does not take place. Also, focusing on verbal chatting and previous acquaintances, rather than on the visual interaction, seems to distract the participants from experiencing an active and creative relationship with other participants.

6.2. Co-Creation as Socially Intelligent Ability

Co-creation is usually defined as a category of interactive art that comprises works generally exhibiting a high degree of malleability, responsiveness, and transformability [42], which would not exist without participants [74][75]. However, the results of this analysis allow a more extensive description of co-creation as the socially intelligent ability of constructing and sharing meaningful activities that is expressed by a socio-technical environment. As such, co-creation is engendered by the context and collection of interactions among participants that is moulded without any central guidance toward specific objectives or determined strategies. Whereas at an individual level we can understand co-creation in terms of the personal motivations leading to mutual interaction (see Section 2), at the level of the overall interaction of the socio-technical system, co-creation has to be understood and sustained in terms of dynamics of interaction (which has been called intersubjective processing of information). Participants enter into a relationship with each other and collaborate, revealing their individual motivations and strategies of interaction, on the basis of the embodied activities and intersubjective dialogues that occur among them. This is why the Poietic Generator and Open Studio produce not outcomes, but meta-outcomes; in other words, they are participative environments appropriate for open-ended and creative interactions [76].

6.3. The Design of Social Interactive System

As mentioned in Section 2, the main motivational paths to co-creation are emotionally driven. The analysis of visual interaction in the Poietic Generator and Open Studio, however, suggests that the appearance of co-creative activities is strongly connected to the conditions and dynamics for mutual interaction enabled by the system, meant here in the sense of how “closely” people interact with each other (intersubjective proximity), and how their intentions determine and recognize chains of actions and meaningful events over time (network of intentionalities). The analysis, therefore, seems to indicate that to manage and balance the effects of mediators, fundamental requirements are: (a) a relational understanding of space-time in terms of intersubjective proximity and network
of intentionalities, rather than the typical space-time matrix [77]; and (b) a purposely designed interplay between affordances and means of externalization so as to enable the formation of relational settings and affective bodies (see Section 6.1).

As stated earlier, mediators are emergent phenomena; therefore, they cannot be designed—theyir emergence can only be sustained. Two mechanisms have been identified that can manage and balance the effects of mediators, and thus enable and activate co-creative processes for the emergence of shared activities and meanings: (1) agency patterning, and (2) emotional seeding. These mechanisms are here only introduced (they do not represent indications immediately applicable), and are exemplified only on the basis of the cases presented in this paper. However, it is a belief of the author that these mechanisms, and the underlying relational principles, can be further explored and be particularly important for the design of social interactive systems that have purposes but not explicit goals (as in the case of art and creative activities in general). These mechanisms can be particularly relevant also for the advance of human-centered design approaches such as, for instance, metadesign [78][79], which is a novel approach aimed at defining and creating social and technical infrastructures in which new forms of collaborative design and creativity can take place.

**Emotional seeding** [13] is about “feeding” the emotional tone of the interaction. *It is based on enabling the users to experience the temporal and spatial features of the environment in terms of intentionality and proximity (or intimacy), rather than in informational terms.* It is usually nonverbal communication. In Open Studio, for example, the drawing tools have been designed to be expressive and reactive to the participants’ movements (speed, direction, curving, and so forth). The visual behavior expressed by the “bodily” quality of the strokes, marks, and colors drawn by the participants affects the users’ feelings and intentions, seeding the emotional tone of the interaction, and encouraging or discouraging the emergence of visual narratives.

**Agency patterning** [74] is about the setting of specific spatial and temporal parameters aimed at letting dynamic agencies emerge from the system. It defines the size, resolution, and character of the agency that is performing a global activity, that is, the nature of the collection of interactions among participants considered as individual agents. In the Poietic Generator, for example, it is the association of the participants with the local images (and their mutual interactions) that engender the collective agency responsible for the global image, whereas features and constraints of the interface determine the collective nature of such an agency. In fact, according to different features of the computational environment, agency patterning can give rise to different kinds of agency. Agency, for instance, can be dialogic (based on the close relationship between two subjects), collective (based on collective mechanisms, such as in the Poietic Generator and Open Studio), community-based, or even “machinic” (mainly based on non-human processes).

7. Conclusions

Moving from the analysis of two case studies in the field of the interactive arts, this paper analyzes the visual language and the kind of interaction occurring in the Poietic Generator and Open Studio not as tools for a user to interact with the computer and perform a task, but as forms of visual embodiment, that is, as a mediated form of cognitive embodiment or “embodied interaction”. This paper provides evidence of the emergence of mediators in users’ interaction processes, and it introduces notions for the development of support mechanisms, such as emotional seeding and agency patterning.
The paper argues that mediators—by sustaining the intersubjective processing of information—can support the design of social interactive systems, and be particularly important in the design of systems that have purposes but not explicit goals (as in the case of art and creative activities in general). This paper is neither about sensors and programming to allow a computerized system to determine the emotional state of its user and respond accordingly, nor about how to include emotional content in computer-moderated communications by means of better representations. The paper addresses co-creation as the socially intelligent ability to construct and share meaningful activities expressed by a socio-technical environment, and it argues that mediators and mechanisms for embodied interaction can provide human-centered design approaches with greater intersubjective capabilities. The notion of mediator can contribute to a new generation of methods for the design of systems, interfaces, and “creativity support tools” that better support the intersubjective and embodied dimension of human interaction.

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Abbreviations

PG: Poietic Generator
OS: Open Studio
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