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Towards 'Cinematic' Hypertext

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ABSTRACT
This paper proposes the paradigm of 'Cinematic' Hypertext (CH), in which discourse form is represented following principles that underpin the expression of narrative patterns in cinema. Primarily tackling hypertext discourse coherence in the non-linear medium, CH is conceived as a way of thinking the hypertext medium that is consistent with its characteristics. CH envisages the consistent and concurrent use of the medium's formal features, grounded in structuring principles, in order to allow the emergence of a local language. Relational primitives based on Cognitive Coherence Relations are proposed as a structuring principle to define hypertext links, while the use the medium's graphic features is proposed to render these relational primitives as patterns that will take shape during navigation. Taking scholarly hypertext as a domain, this paper articulates the theoretical basis for cinematic hypertext, presents the elements of a prototype visual language to express a sub-set of CCR, provides experimental evidence of its significance, and finally envisages the realisation of a cinematic hypertext environment.

Categories and Subject Descriptors
H.5.1 [**Information Interfaces and Presentation**]: Multimedia Information Systems – *Animations;* H.5.4 : Hyprtext/Hypermedia – *Architectures, Navigation, Theory*.

General Terms
Theory, Languages, Design, Experimentation.

Keywords
Cinematic Language, Hypertext Languages, Hypertext Discourse Coherence, Cognitive Coherence Relations, Discourse Patterns, Dynamic Visual Patterns, Visual Languages.

1. INTRODUCTION
The problem of discourse coherence has drawn a lot of attention within hypertext research in general [31], and a number of proposals address the issue of discourse structure in the non-linear medium [1,20,17]. In particular, some theoreticians have expressed reservations on the compatibility between the technical characteristics of the medium and the formal characteristics of argumentative discourse [12]. Hypertext's non-linearity has been seen to threaten authors' control over discourse order and, consequently, the effectiveness and ultimately the coherence of their argument. On the other hand, theoreticians acknowledge the fact that the non-linear medium allows one to express the sometime complex articulations of an argument better than linear text [11], and approaches to shaping hypertext discourse that mediate between the open explorative network and the closed argumentative line have been proposed [11,6]. In fact, this dialectic between linear and non-linear is reflected in different ways by the main paradigms adopted in hypertext research: *page-based hypertext*, *semantic hypertext* and *spatial hypertext*. Each of these present advantages and disadvantages as far as discourse structure and coherence representation are concerned.

The page-by-page presentation typical of the Web, is heavily characterised by discourse linearity, although the medium fully supports Associative Writing, with no semantic constraints [23]. And, although some categories of links may be graphically characterised, hypertext associations do not express much about discourse structure. However, this is the friendliest and closest paradigm to traditional argumentative writing, while allowing the expression of connective thinking typical of scholarly work.

Semantic hypertext implies a decisive commitment to semantics and structure. The expression of both discourse structure and semantics are fully supported, and so is an intelligible non-linearity. The ontological definition of nodes and links as objects and relations allows the representation of discourse structure as a network, where all components can be visualized in isomorphic configurations [19,4]. However, committing to semantics and structure may be constraining and undesirable for scholars.

In spatial hypertext [31] the expression of implicit connections and emerging structure are supported through the graphical connotation of hypertext nodes and their spatial distribution. Its paradigm emphasizes the use of features characterizing hypertext as a visual and spatial medium, while minimizing the need for semantic or structural commitment. However, a non-regulated use of visual features risks being inconsistent, i.e. unintelligible, and the static connotation of the nodes does not account for the variation of their contextual role in different navigation paths.

In fact, even a strong advocate of implicit and emergent structure as Rosenberg acknowledges the need for some kind of conditional rules in spatial hypertext [26,27]. Clearly, when applying representational conventions, one commits to some formality, but such conventions may become the 'raw material' with which one works in creative design. They do not imply commitment to any final form, rather they support the emergence of complex and intelligible shape, even if and when they were made to be broken.

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Based on this assumption, we propose 'Cinematic' Hypertext (CH) [17] as a fourth paradigm, which integrates features from the hypertext paradigms described above in its own specific approach, to enable the implicit and consistent expression of discourse structure. In CH, the problem of representing discourse coherence is reformulated as the problem of dynamically communicating discourse shape. To this purpose, discourse representational rules could express fundamental principles of discourse organisation. Once defined, the relations holding between the nodes could be shaped through the use of graphical features, connoting the nodes' relations to other nodes rather than their content. Consequently, the appearance of each node displayed on screen would dynamically adapt to express the node's role within a space-temporal pattern of nodes. In fact, with the use of representational rules, and consequently the dynamic representation of objects, hypertext *interface time* [15]) would become another dimension of implicit signification, increasing the visual expressive capabilities of the medium (as in cinema the *enunciation time* constitutes an important dimension of implicit signification [7,20]).

Below, we elaborate a proposal for 'Cinematic' Hypertext. We describe the cognitive principles on which discourse-structuring rules could be based in hypertext. We show how in cinema discourse patterns are expressed through the principled use of visual features and how this could be done in hypertext. We present the perception principles and design parameters based on which discourse relations could be visually expressed in hypertext. We describe the design process of few examples of relational renderings and discuss the results of a first experiment that was carried out to test the renderings. Finally we draw our conclusions.

2. CH'S THEORETICAL FOUNDATIONS

2.1 Hypertext Coherence as Text Coherence

Theoretical ground - Discourse coherence has been long studied in linear text, but among the many approaches the work proposed by certain psycholinguistic research on text coherence is especially appealing from the point of view of cinematic hypertext. This work suggests that coherence is a cognitive phenomenon, a characteristic of the mental representation that the reader constructs during the process of text interpretation. Text comprehension, therefore, depends on the reader's ability to construct a coherent representation of what (he thinks that) the text is conveying, and to do so the reader needs to be able to identify the conceptual relations (he thinks to be) holding between the set of discourse elements (whether these are clauses, sentences, paragraphs or entire text sections).

Conceptual relations hold between text spans based on their content or discourse role. However, in linear text, connectives such as relational and referential phrases function as indicators to facilitate the identification of relations [28]. These indicators would, in fact, be expression of underlying pre-linguistic cognitive primitives that would be at the base of our cognitive structures [10]. Cognitive Coherence Relations (CCR) are described through four relational parameters, whose values determine the characteristics of the particular relations derived from their combination [29,30].

Basic operation describes whether two discourse segments are related by *additiveness*, if they are weakly connected, or by *causality*, if they are strongly connected. In "*I drove to the city this morning* and *I walked to the park this afternoon* " the two discourse segments are related by additiveness. In "*This morning it was raining very heavily* so *I had to take my rain coat to go out*" the segments are related by causality.

Source of coherence describes whether a discourse relation is *semantic*, if the two segments are related on the basis of their content, or *pragmatic*, if they are related on the basis of their rhetorical function. In "*It rained all day* therefore *the streets were flooded*" a cause-effect relation is observed (semantic relation). In "*The neighbours must be out* because *their lights are off*" a cause is inferred from its supposed consequence (pragmatic relation).

Order of segments describes whether two discourse segments are related in a *basic* order, corresponding to the order in which events are meant to verify in the described reality, or in a *non-basic* order, not corresponding to the order of events. In "*I missed the bus* so *I was late for the meeting*" the order of presentation of events is basic. In "*I was late for the meeting* as *I missed the bus*" the order of presentation is non-basic.

Polarity describes whether the relation between two discourse segments is *positive*, when the two segments are consistent with the basic operation, or *negative*, when one of the segments is inconsistent with the basic operation. In "*She had not slept* so *she looked rather shattered*" the polarity of the relation between the two discourse segments is positive. In "*She looked fresh,* despite *not having slept*" the polarity of the relation is negative.

Table 1 – CCR descriptive parameters (except directionality).

S.C. = source of coherence (semantic or pragmatic); B.O. = basic operation (additive or causal); P. = polarity (positive or negative); H. = hypotheticality (hypothetical or actual); C. = comparativeness (comparative or conjunctive).

S.C.	B.O.	P.	H.	C.	RELATIONS
sem	add	pos	-	conj	conjunctiveness
			-	comp	similarity
		neg	-	conj	disjunctiveness
			-	comp	contrast
	temp	pos	-	-	sequentiality
		neg	-	-	contrastive sequentiality
	caus	pos	act	-	causality
			hyp	-	conditionality
		neg	act	-	contrastive cause
			hyp	-	contrastive condition
prag	add	pos	act	-	elaboration
	caus	pos	act	-	argument
		neg	act	-	contrastive argument
		pos	hyp	-	background

In more comprehensive parametrizations [14] (reported in Table 1), among the relation *types* (basic operation), *temporal* relations, like *sequentiality*, are accounted for, in which the two discourse segments are not as strongly related as they are in causality, but still are more strongly related than they are in additiveness. In turn, additive relations include *conjunctive* relations, in which the two discourse segments are simply related as parts playing a role in a whole ("*Yesterday I bought 10 shares of the Company X,* and *I sold 50 shares of the Company Y*"), and *comparative* relations, in which the two discourse segments are related by some sort of *similarity* ("*The strikers were taken away by the regime's police,*

just like *cattle is taken to the slaughter house*") [24]. As for causal relations, they include *actual*, that is, properly causal, and *hypothetical*, that is, *conditional* relations [29]. Finally, as far as relation *directionality* (order of segments) is concerned, both temporal and additive relations can be *bi-directional* as well as *forward* (basic order) or *backward* (non-basic order).

Hypertext analysis - As a form of verification for its usability in hypertext, we used this parametrization of cognitive relations to analyze a few hypertext link taxonomies, such as TEXTNET's [33] and ScholOnto's [18,3]. From these studies, it did emerge that CCR can account for the link types included in these taxonomies, which suggests that they could be used to assess the exhaustiveness of link taxonomies in general [17]. A further form of verification was also carried out by using the same parametrization to analyze the links of an existing example of scholarly hypertext: *Hypertext and Suburbs*, from Kolb's last hypertext and paper-based work *Sprawling Places* (http://abacus.bates.edu/~dkolb/dkht/index.html).

We separately analyzed the discourse relations holding between nodes, between paragraphs within nodes, and between text spans within paragraphs containing links. The fact that the argument develops around a comparison explains the recurrence of the several similarity and contrast relations within nodes. The fact that this hypertext is an argument explains the so many pragmatic relations [30]. The fact that relations like *elaboration* (a pragmatic form of additive relation) and *background* (a pragmatic form of conditional relation) are very frequent between nodes reflects a specific approach to hypertext argumentation [11,17,6]. In fact, structurally speaking, these relations do not play the same role that, say, semantic causal relations play. Therefore those relations more frequently hold as links between nodes, while causal relations are kept within the node's discourse unit. This is also consistent with the findings of certain studies on Associative Writing [23]. These analyses do suggest that CCR could be used to define hypertext relations.

As mentioned above, in linear text connectives are used to indicate cognitive relations and they constitute an important element of discourse cohesion, giving formal expression to its relational structure. Likewise, if cognitive primitives could account for node connections in hypertext, these would need to be indicated by some sort of cohesive element formally expressing discourse structure. In this paper we propose that this cohesive function could be held by the medium's graphic features, which could be used to express discourse relations and so shape discourse structure. This proposal is grounded in the cohesive function that visual features have in another spatial medium sharing fundamental similarities to hypertext: cinema.

2.2 HT Coherence as Cinematic Coherence

Theoretical ground - The parallel between cinema and hypertext has been previously drawn and amply demonstrated [21,22,16,18], based on the equivalence between cinematic shots and edits, on the one hand, and hypertext nodes and links on the other, and on the fact that, from the cognitive point of view, cinematic discourse is the least linear of all linear media. As in the cinematic edit, the hypertext link is a moment of *transition* between what is known and what is unknown, a 'risky promise' to get somewhere further along a coherent path [22]. As the cinematic edit, the hypertext link produces a *juxtaposition* between two complex discourse units out of which the reader will try to make sense [16].

By juxtaposition, cinematic shots generate the film discourse before the viewer's eyes: a series of related shots constitutes the sequence, a series of related sequences constitutes the macro-sequence, and a series of related macro-sequences constitutes the film. Relations between shots, sequences and macro-sequences are to be established at different levels and in multiple ways. The practice of reading cinematic text consists of establishing cognitive connections between shots, and the ability to read consists of being able to establish coherent connections. This 'cinematic literacy' is acquired through exposure, and consists of becoming acquainted with the representational conventions and patterns that regulate the cognitive connection of shots.

These rhetorical conventions and patterns progressively developed through a process of 'cultural selection' over decades of linguistic evolution since the birth of the medium [20]. All along they have been guiding the viewer's interpretation of the shot chain, allowing him to construct a coherent cognitive representation of the film's discourse. In the cinematic practice, representational patterns are shaped through a number of formal codes used to express discourse cohesion, so that coherent shot connections can be easily established [7]. Among others, from the perspective of 'Cinematic' Hypertext, the most relevant role is played by the *syntactic* codes (Table 2), which regulate the shot editing. They envisage: *association by* ***identity*** (an element of the image is present in both the connected shots), *by* ***analogy*** *or* ***contrast*** (the content of one shot is similar, or contrasting, to the content of the other shot) *by* ***proximity*** (between the elements presented in the shots there is spatial contiguity), *by* ***transitiveness*** (between the situations presented in the shots there is continuity of time or action), *by* ***combination*** (two shots are simply juxtaposed without presenting any connecting element). The *syntactic* articulation is in turn based on the shots' internal composition, which is defined, at a lower level of articulation, by *visual codes* (as well as other codes), responsible for shaping the syntactic minimal units. Here, we focus on the relations holding between the shots within the sequence, rather than between the shots' internal components.

Table 2 - Cinematic syntactic codes (montage codes). Criteria of association between two shots A and B.

FEATURE	formal elements in the connected shots
identity	B has same visual element/s as A
analogy	B's content is similar or equivalent to A's content
contrast	B's content contrasts with A's content
proximity	What B shows is contiguous to what A shows
transitiveness	What B shows continues what A shows
combination	B is just juxtaposed to A

Now, due to the iconic and indexical nature of the cinematic signifier, no visual cohesive feature in itself indicates any specific relational concept [18]. It is only the concurrent and consistent use of different visual elements that, contextually, makes any cinematic pattern recognisable as a whole. This aspect of cinematic *syntagmas* has informed the concept of *hypertext syntagmas* [21], as it informs the concept of hypertext *visual syntagmas* [17].

Cinematic analysis - Now, if cognitive coherence relations can be productively used to analyse hypertext connections, then it

must be possible to use them to account for cinematic pattern connections, given the similarity between the semiotic characteristics of the two media. To verify this, we analysed Metz's classical set of cinematic patterns [20] in terms of CCR, which produced interesting results [18,17]. As additional form of verification, we also analysed a few examples of cinematic sequences taken from films of different periods and authors.

One sequence, for instance, was taken from *2001: A Space Odyssey*, by Stanley Kubrick (1968). Immediately after a parallelepiped megalith has appeared on the apes' land, one of the apes, while looking for food among carcase remains, discovers that bones can be used as weapons to kill other animals and eat their meat. In Metzian terms, this is a *scene properly called* [20]. The sequence presents few shots showing the ape engaged in her search and relating by *sequentiality*. An initial *dislocated insert* showing the megalith suggests a *causality* relation with what follows: in the next shot, the ape finds a long bone and starts to bang it on other bones. A *shot/counter-shot* construction shows her arm going up, and down on the bones, while two *dislocated inserts* [20] showing a falling animal express *pragmatic causal* relations, suggesting that from now on the ape will use her weapon to kill. This is substantiated by the first shot of a new sequence, *sequentially* related to the previous one, in which the ape enters the field with a big piece of meat.

The causal connection between the presence of the megalith and what the ape discovers is expressed as follow. The *dislocated insert* with the alien object is a symmetric *contre-plongée*, the profile of the dark stone against the sky occupies the lower half of the visual field, as a geometric skyline (very different from the shapeless skyline of the apes' wasted land: *association by contrast*); from behind it, in the centre, the sun shows up, the moon perfectly aligned above it: "the light of intelligent and technological progress" is rising. And in fact, an edit cut takes us straight into the series of shots representing the ape's new discovery (*ass. by transitiveness*). This series' duration exactly corresponds to *Zarathustra*'s overture, the famous commentary music that 'encloses' the coming scene (whose shots are *ass. by transitiveness* and *proximity*). The series starts with a *medium-shot*: squatting in the centre of the visual field, the ape has spotted the long bone and starts to look at it. The overture attacks. She picks up the bone and bangs it around. The bangs become blows. Crescendo. She rises. Cut. *Detail*: her arm, against the sky, rises across the visual field along a right-left diagonal and comes down along a left-right diagonal. Cut. *Medium-shot*, slight *contre-plongée*: she stands up, her tall dark figure recalling the figure of the megalith (cognitive, non-linear, ass. by *analogy*). The motion of her arm continues down onto the bones. She strikes four blows. The fourth comes down onto a skull. Cut. *Close-up*: an animal's body drops on the ground, face down (*ass. by transitiveness* and *analogy*). This dislocated insert reifies a *pragmatic causal relation*: by analogy, the animal substitutes the skull on which the blow has fallen, visualising the inference that we can make from what we see happening on the scene. The shots are presented as *shot/counter-shot* (although that cannot 'realistically' be), the continuity between the two being formally expressed by the motion of the blow and the animal fall, plus by the fact that the skull is in the right low corner of the first shot and the head of the animal ends up in the left low corner of the second shot.

The cinematic syntagmas described above can be identified through the visual (and formal in general) elements that define the composition within the shots, in turn shaping the editing between them according to syntactic codes. The fact that the resulting patterns can be analysed in terms of CCR suggests that, likewise visual elements could also be used in hypertext to shape discourse patterns in order to reflect and visually express the text's discourse structure. In this perspective, the following section provides the theoretical ground for the parallel between text discourse and visual discourse cognitive processing.

2.3 Textual and Visual Discourse processing

Beyond the parallel between cinema and hypertext, the consistent expression of discourse connections through visual features constitutes the lesson that cinema can offer to hypertext. In fact, although throughout different cinematic genres, schools, or films different conventions and linguistic forms are used, as far as connectivity is concerned certain basic patterns recur that are always consistently represented within a specific genre, school or film. The same could be in hypertext, where the use of cognitive coherence relations as a base for the definition of links would have the function of making sure that visual features are used consistently and according to basic, primitive, hence widely applicable, relational concepts that would be reflected in the consistency and clarity of the discourse's visual shape.

In order for this to be possible, the way in which visual patterns are cognitively processed needs to be compatible with the way text itself is cognitively processed. In fact, the parallel between textual and visual processing has been already demonstrated [5,25], based on the correspondence between fundamental principles of textual cognition [8], on the one hand, and fundamental principles of visual cognition derived from Gestalt Theory, on the other [34].

Namely, the textual principle of *relation* says that the reader expects the items in a discourse to be related. In "*My mother said that she would visit me*", the most immediate interpretation is that "she" refers to "my mother", rather than to another woman. This corresponds to the visual principle of *continuity*, saying that the viewer expects the elements of a configuration to extend along a continuous line. In a cross-like configuration, the most immediate interpretation is that it results from two lines crossing each other, rather than from four segments meeting in a point. *Relation* and *continuity* can be expressed at a more abstract level as the principle of *cohesion*, according to which the subject tends to interpret a stimulus in the way that requires the least effort [5,25].

The textual principle of *manner* says that the reader expects discourse to be unambiguous. In "*Jane hid the letter from Dan*" [25], one will either interpret that Jane does not want Dan to see the letter, or that Jane does not want the letter she received from Dan to be seen, but not both at the same time. This corresponds to the visual principle of *figure-ground*, which says that the viewer will impose a single interpretation on a configuration. Example of this is the famous vase/face figure [25]. *Manner* and *figure-ground* can be expressed as the more abstract principle of *clarity*, according to which a subject imposes a single interpretation on a single stimulus [5,25].

The textual principle of *quantity* says that the reader expects discourse to contain neither too much nor too little information. In "*John likes football more than Gloria does*" [25] there is enough

information to understand that a comparison is been drawn between John and Gloria's preferences, but "*John likes football more than Gloria*" could be interpreted as an expression of John's preference for the game over Gloria. This corresponds to the visual principle of *closure*, saying that the viewer will tend to interpret a spatial figure as a whole. Example of this is Kanisza's Triangle. *Quantity* and *closure* can be expressed as the more abstract principle of *completeness*, according to which a subjects interprets a stimulus as a whole whenever possible [5,25].

Finally, the textual principle of *quality* says that the reader expects discourse to be truthful and not misleading. In "*The horse raced past the barn fell*" [25] one may assume that "horse" is the agent of "raced", until one gets to the end of the clause and realizes that the clause has to be reinterpreted, since "horse" needs to be agent of "fell". This corresponds to the visual principle of *constancy*, which says that the viewer expects objects to remain stable across different contexts. Escher's figures constitute famous illustration of this principle. *Quality* and *constancy* can be expressed at a more abstract level as the principle of *correctness*, according to which a subject interprets a stimulus at face value [25].

So grounded in the correspondence between textual discourse organization and visual discourse organization, the notion of *visual meta-discourse* coined for document design [13] is highly relevant here, where the use of hypertext's visual features is proposed to visually express the text's discourse articulations. In particular, it is relevant as far as the principle of *cohesion* (that is, of *relation*, on the one hand, and of *continuity*, on the other) is concerned, as the idea is to use visual features as cohesive devices in hypertext.

In visual space-temporal configurations, cohesion is defined by a number of Gestalt principles [5]. The principles of *similarity* and *proximity* say that the more similar and closer the elements of a configuration, the more they will be perceived as a group or unit. These two principles can either work together to reinforce each other's effect, or in antithesis to contrast each other's effect. Also, the *intensity* with which similarity and proximity between the elements of a configuration appear has an impact on the sense of their unity or continuity. Finally, *size* and *symmetry* also play a role in perception, that is, the viewer tends to group the elements of a configuration in large and symmetrical units, rather than in small and asymmetrical ones. These principles - also observed in cinematic practice - could be applied in hypertext to produce a visual meta-visual discourse and generate a sense of cohesion within the configurations expressing discourse patterns. The next section discusses the visual design process of a subset of cognitive coherence relations, which we graphically rendered for experimental purposes.

3. DISCOURSE RELATIONS IN CH

3.1 Visual Languages for Textual Discourse

The first step in this design process is accounting for the medium's visual elements that could be used to render the experimental subset of cognitive relations. Here, certain research on graphics, originated within the Bauhaus experience [9] and subsequently developed by semiology of graphics [2], constitutes the main reference. Unlike graphic design, graphics language responds to universal laws and can therefore be used to rigorously process data sets through the properties of the visual image [2]. Within the Cartesian dimensions X, Y and Z, the use of graphic variables according to specific design criteria allows the extraction and non-subjective representation of the information potentially contained in the data, which is expressed in terms of relationships. These are relationships of *similarity* or *difference*, of *order* and *proportion*, which can be in turn expressed through visual relations of difference, similarity, order and proportion.

The range of graphic variables, originally theorised for cartography [2], consists of two groups, respectively called *variables of the image* and *differential variables*. The former include the *distribution* of objects in the visual field (the plane X and Y), the *size* and *value* of graphic objects. Size has the ability to show ratios, and in any combination of variables size and value define order prior to the other variables, which are perceived along the Cartesian spatial dimension Z (in depth). The variables of the image are said to be *dissociative*, as they signify different concepts and can be effectively used at the same time to establish relationships [2]. For instance, if two objects having the same shape, size and value find themselves on the plane, they suggest a relation of similarity and equivalence. If one of them has a lighter value, this difference of value suggests an order along the Cartesian dimension Z, which produces an effect of subordination of one object with respect to the other. If the two objects are distributed on the plane next to each other, whether they are related by similarity or by subordination, their relation is emphasized. If they are distributed far apart, their relation is less perceivable. If two objects have the same shape and value, but different size, the difference in size suggests a quantitative difference. If the two objects also have different values, the difference in value suggests a difference in depth, that is, an order along the dimension Z, emphasized by the difference in size.

The group of differential variables includes *texture*, *colour*, *orientation* and *shape*. These are said to be *associative* variables, as their use can be associated with the use of the other variables. They do not interfere with the action of the dissociative variables, as they merely have a differential function between elementary images, but they cannot be used themselves at the same time without generating inconsistencies and confusion [2]. For instance, if one uses shape to differentiate two objects (eg. icons of different trees on a topographic plan, to identify various kinds of vegetation in an area), the orientation of their shape should be the same (the trees should all be oriented in the same direction), to facilitate their recognition and comparison. Likewise, if texture is used to differentiate two objects, using colour may be superfluous and may end up being confusing. At times, the combination of the dissociative variables with the associative variables requires attention, as it may be problematic. For instance, value can be used to suggest order between two objects having the same shape and different size, but then the two objects need to have the same colour, because variations of value are difficult to perceive between different colours.

Theoreticians have subsequently extended the original range of cartographic variables for use in multimedia cartography [9]. The new range is constituted by *visual variables*, including 2D static (size, value, texture, colour, orientation, shape, arrangement), 2D dynamic (speed, viewpoint, distance), 3D dynamic (perspective, overlapping); *sound variables*, including location, loudness, itch, register, timbre, duration, change of rate, order, attack/decay; *tactile variables*, including volume, size, value, texture, form,

orientation, elevation. Such a large range of variables would result in complex and rich cartographic graphic representations. However, only a sub-range of the visual variables was selected to render cognitive coherence relations in hypertext. The criteria for the selection are explained in the next section, along with the criteria that determined the selection of the subset of cognitive relations to be graphically rendered.

3.2 Graphic Rendering of Discourse Relations

Let us start with the selection of the subset of coherence relations for experimental rendering and evaluation. We wanted it to include the relations that we had most frequently encountered in our analyses, as they seem more recurrent. We also wanted to restrict the size of the set, as this would make it easier to differentiate the respective renderings. Finally it seemed sensible to base the subset on those coherence relations that have high agreement amongst theoreticians, being more understood and solidly established in the study of discourse coherence. The resulting selection includes the following relations: **causality,** in its semantic form (A causes B); **conditionality**, hypothetical form of causality (if A, then B); **conjunctiveness** (A and B); **disjunctiveness**, negative form of conjunctiveness (A or B); **similarity**, comparative form of additive relations (A like B); **contrast**, negative form of similarity (A unlike B); **elaboration**, a pragmatic form of additiveness (B elaborates A); **background**, a pragmatic form of conditionality (B is understandable given A).

Table 3 – Parametrical description of the subset of CCR selected for graphical rendering, for experimental purposes.

S.C. = source of coherence (semantic or pragmatic); B.O. = basic operation (additive or causal); P. = polarity (positive or negative); H. = hypotheticality (hypothetical or actual); C. = comparativeness (comparative or conjunctive).

RELATIONS	S.C.	B.O.	P.	H.	C.
CONJUNCTIVENESS	sem	add	pos	act	cnj
SIMILARITY	sem	add	pos	act	com
DISJUNCTIVENESS	sem	add	neg	act	cnj
CONTRAST	sem	add	neg	act	com
CAUSALITY	sem	caus	pos	act	cnj
CONDITIONALITY	sem	caus	pos	hyp	cnj
ELABORATION	prag	add	pos	act	cnj
BACKGROUND	prag	caus	pos	hyp	cnj

The graphical renderings of these relations were made based on their parametrical description (see Table 3), that is, the different values of each cognitive parameter defining the relations were rendered through graphical features. As a result, each relation was visually defined by the sum of the graphical features rendering the cognitive values that define it (see Table 4).

To reify the relation renderings, examples of argumentative passages were taken from a history of science text, whose conceptual complexity and literary style were very accessible. To make sure that the interpretation of the text conceptual content would not present any difficulty. Out of all the material provided by the book, a particular subject (theories about the orbiting of planets in the solar system) was selected, so that all the relations would be reified in the text within the same conceptual context. From the relevant sections, short passages of text were then isolated, each passage consisting of a pair or a triple of sentences. The sentences of each pair or group held with each other one of the eight selected cognitive coherence relations, all signalled by appropriate textual connectives. Finally, each pair or triple of related sentences was represented on screen respectively within a pair or triple of related text windows, and those windows were attributed certain graphical properties expressing the relation holding between the content of one sentence and the content of the other. On screen, all connective were removed from the text within the windows, and the connective function between the text spans was entirely delegated to the windows' graphical properties.

Table 4 – Description of the features used to design the parametrical values defining: conjunctiveness, disjunctiveness and causality. B.O. = basic operation (additive or causal); P. = polarity (positive or negative).

Par.	Val.	Rendering of each parametrical value
B.O.	**add**	Windows aligned along horizontal axis. Same value throughout or at initial stage. Second window appearing next to the first or overlapped on one side.
	cau	Windows aligned along vertical axis. Gradual value intensification from one stage to the other. Second and third windows in turns slide down from behind respectively behind first and second.
P.	**pos**	Value intensification or stability, from appearance of one window to appearance of the other.
	neg	Value of the window appearing first in the visual field changes to contrast the value of the object appearing second.

In order to be as differentiated as possible, each representation had to be kept as minimalist as possible, making use of no more formal elements than strictly necessary. Out of all the graphical variables mentioned above, only two dissociative variables, *value* and *arrangement*, were used. *Size* was not used as a variable, but came as a consequence of the quantity of text making up each sentence, whose format was a constant. *Shape*, one of the associative variables, was only used in the representation of two relations, *elaboration* and *background*; for the other relations, the shape of the windows also came as a consequence of the quantity of text contained in each one. Only *overlapping* was among the 3D-dynamic associative variables. Finally, the appearance and placement of each text window on screen, what could be called *trajectory*, was used with discriminating value. Due to space limitations, it is not possible to describe here the full set of relational renderings, for which the reader is referred to the full study [16]. However, below is the detailed description of three examples: *conjunctiveness*, *disjunctiveness* and *causality*.

Conjunctiveness - The presence or appearance of two entities or phenomena at the same time in the same space denotes a conjunctive relation. Conjunction says that the two entities or phenomena coexist in the same place at the same time, but it does not say anything about the reasons behind or the modalities of their co-presence. In the specific context of their occurrence they play an equivalent and complementary role in constituting a whole. In this case, the conjunctive relation was reified by the text spans:

A. *Part of Newton's astronomical theory derives from Galileo's kinematic laws of falling bodies and projectiles, and from the completion of his principle of inertia.*

B. *Part of Newton's astronomical theory derives from Kepler's descriptive laws of planetary motion, and from the completion of his conception of gravitation.*

The two respective text windows were given the same value and their vertical sides were given the same length; they appear on the screen next to each other, one at a time, the window containing the first text span appearing on the left and the window containing the second text span appearing on the right after 2 seconds. Firstly, the concept of *addition* was rendered by the windows appearing next to each other, with the order of appearance following the direction of reading that we are familiar with (in the Western culture). Secondly, the concept of *equivalence* was rendered by the value of the windows' areas, and reinforced by the fact that their sides were of identical length, and they appeared next to each other and not, say, one under the other. The way the windows positioned themselves was the simplest possible one, to render the fact that the two entities are simply related as complementary components of a whole (Figure1).

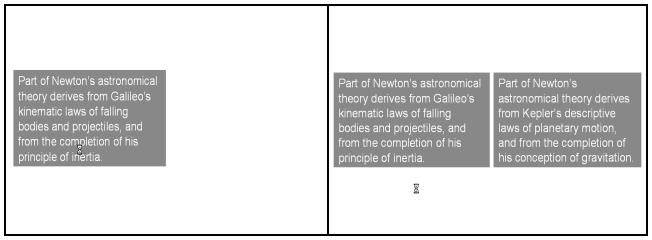

Figure 1 - Two screen shots from the animated graphic rendering of conjunctiveness.

Disjunctiveness - Two entities or phenomena do not coexist in a space-temporal interval, but are *alternative* to one another, that is, exclude each other. The relation obviously implies their actual existence, but it also implies that this can only be at different times, in different places, or in different circumstances. The text spans selected to reify the disjunctive relation were:

A. *In Galileo's times, one could have embraced the heliocentric theory incurring the consequence of being considered a heretic by the Catholic Church.*

B. *In Galileo's times, one could have rejected the heliocentric theory and still have the chance of being considered a good Catholic.*

The text windows were given the same appearance as those used to represent the additive relation, with the difference that as the second window appeared on the right 2 seconds after, the window on the left had the value of its background changed to a very light grey, which made it difficult to read the text. In other words, the concept of *alternative*, of reciprocal exclusion of the two situations, was rendered through the fact that, as the second span of text appeared, the first one would become unreadable (Figure2).

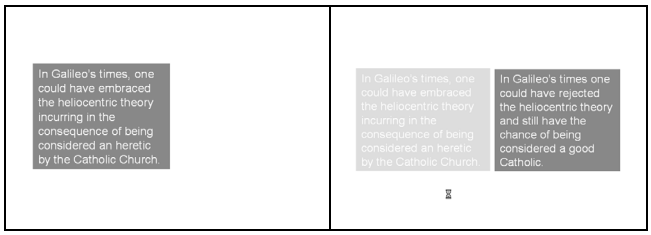

Figure 2 - Two screen shots from the animated graphic rendering of disjunctiveness.

Causality - On the other side of the spectrum with respect to additiveness, *causality* constitutes the strongest cognitive relation between two entities or phenomena. The causal relation implies conjunctiveness, in that the two entities or phenomena connected are part of the same picture, context, or situation. It implies sequentiality, that is, order, in that one entity or phenomenon necessarily follows the entity or phenomenon that has caused it. However, the bond is so strong, the connection so specific, that the first is directly producing the second. The text spans, three this time, selected to reify causality were:

A. *Galileo ignored Kepler's demonstration of the elliptical orbits of planets and continued to believe that planetary revolutions were a "natural" motion requiring no external mover.*

B. *Galileo failed to see that the actual geometry of the heavens contradicted any spherical model.*

C. *Galileo missed the problem of how planets were retained in their elliptical orbits.*

The three windows respectively containing the three text spans were arranged one under the other, the second sliding down from behind the first as soon as the first had appeared, and the third sliding down from behind the second as soon as it had reached its position. They all shared the same width, while the height of each was determined by the quantity of text contained in each window. The value of the windows' background became increasingly darker from the first to the third, and the ratio of increment was the same from the first to the second and from the second to the third, that is, they were equidistant, as far as the value was concerned. In this configuration, the *order* of the events was rendered by the arrangement of the text windows, while the fact that the second and the third windows appeared by sliding down from the previous one rendered the fact that the second and the third events *followed*, and were brought about, respectively by the first and the second event. At the same time, the darkening of the background rendered the idea of *progression* in the forging of a logical chain. Finally, the cohesion between the three events was reinforced by the fact that the three windows had the same width (Figure3).

Figure 3 - Two screen shots from the animated graphic rendering of causality.

The whole set of relations was rendered with the purpose of testing the renderings and their impact on users, in particular under four aspects: 1) The extent to which the concurrent and consistent use of visual features according to certain perceptual principles and design criteria would determine the expressiveness of the configurations designed to represent the selected sub-set of discourse relations. 2) The possibility that the relation representations that were easier to design would also be the ones that would be more easily recognised by other people. 3) The extent to which the contextual use of the relation representations would influence their perception, making each visual configuration recognisable as expressing a particular discourse relation. 4) People's ability to conceive abstract but specific concepts like cognitive relations in visual terms, and therefore to discriminate the relational expressiveness of different visual configurations.

4. TESTING CH'S VISUAL LANGUAGE

4.1 A First Empirical Evaluation

This experiment constituted a first verification on the design implications of this work's theoretical contributions: that cognitive coherence relations between textual nodes in an argument can be rendered 'cinematically' through graphical and animation cues whose consistent use can be perceived as meaningful by the viewers, helping them to recognise discourse structure. The specific question here was whether there are stereotypes held by viewers that can be exploited to communicate abstract conceptual relationships between textual nodes in visual ways. If so, these are prime candidates for rendering coherence relations.

As a first form of verification, an empirical study was designed and conducted with a group of **24** subjects. People were asked to choose from three different 'cinematic' representations the one that in their judgement best expressed each relational concept. That is, for each relation, three different representations were presented to the participants: the one that had been designed to represent that particular relation, plus two alternative representations originally designed to express different relations. For instance, (always using the same text spans selected to express that particular relation) causality was given the representation designed to render it and, as alternative options, the representations that had been respectively designed to render conjunction and disjunction. Likewise, (always using the same text spans selected to express that particular relation,) conjunction was given the representation especially designed to render it and, as associated options, the representations that had been respectively designed for contrast and disjunction. And so forth.

One at the time, the participants were given the original text that had been used to reify each relation, as well as an abstract definition of the relation in question, then were shown the three animations associated with it, from which they had to choose what they thought to be its most expressive representation. To allow the participants to become acquainted with the whole process and familiarise with the various choices, they were asked to go through a second round, in which they were allowed to modify, one way or the other, the choices made in the first round.

The results were very encouraging: for each given relation, the great majority of participants tended to converge on the same option, which in fact corresponded to the animated pattern that had been specifically designed to render that particular relation. The Chi squared tests carried out on the results largely confirmed their significance for **causality**, **conjunction**, **similarity**, **contrast**, **elaboration** and **background**, if not entirely for **conditionality** and **disjunction** (Table 5).

Table 5 – Results of an experiment conducted with 24 subjects.

R. = renderings designed to respectively express each relation. 1st and 2nd = votes obtained by each rendering respectively in the first and in the second round. χ^2 = *Chi square*. p. = probability that the result was obtained by chance.

R.	CAUS	COND	CONJ	DISJ	SIMI	CONT	BACK	ELAB
1st	19	10	18	12	16	20	21	20
2nd	**22**	**13**	**21**	**12**	**18**	**20**	**21**	**21**
χ^2	37	4.750	32.25	3.25	19.75	28	32.25	27.25
p.	<0.001	>0.05	<0.001	>0.05	<0.001	<0.001	<0.001	<0.001

4.2 Analysis of the Results

As shown above, the results of this first study seem to indicate that people did recognize a particular expressiveness in the options that had been specifically designed to render the subset of discourse coherence relations. In other words, there is positive evidence that the concurrent and consistent use of graphical elements, according to certain perceptual principles and design criteria, can support the visual - implicit - expression of specific relational concepts. Paradoxically, even the weaker results of this first study support the idea that there is a strong correlation between cognitive relations and visual relations. That is, the fact that the renderings of conditionality and disjunction did not obtain the same consensus obtained by the others can be related to the fact that both conditionality and disjunction are characterized by a greater degree of cognitive complexity.

Causality, conjunction, similarity, contrast, elaboration and background constitute 'linear' relations, that is, from the cognitive point of view they hold within a space-temporal continuity, or along one possible line of events. However, conditionality and disjunction hold 'across' two possible lines of events. That is, they implicate the cognitive projection into an alternative space-temporal dimension (or narrative axis), before the conditioned or disjuncted situations can be presented. Such an abstraction is easy to express in natural language, thanks to its symbolic nature, but it is not as easy to express in visual languages such as cinema, due to its iconic and indexical nature. In cinema, the representation of conditional and disjunctive relations requires some kind of expedient, like an actual back and forth narrative move, showing in turn different alternatives in the development of an action. For disjunction, this is regularly expressed through a construction like the *parallel* syntagma. For conditionality, a solution is illustrated in movies like *Smoking, No Smoking* and *Sliding Doors*, which - in an utterly hypertextual move - render the mechanism of conditionality on which their stories are based through the repetition, and variation, of the same situation at turning points.

It is not surprising that both the renderings of conditionality and disjunction did not score highest among the participants. In fact, they were also the most difficult to design, exactly because of the level of cognitive complexity expressed by the relations. A greater level of arbitrariness was implied in designing the visual

renderings for these two relations than it was in designing the renderings for the others. So, it is not surprising that the resulting representation was less recognizable. Further studies will target this aspect more specifically.

The results of the study also seem to show that the participants were able to 'tune' themselves in the task and get a grasp of the visual language used to render the relations as they were experiencing them going through the selection process. In fact, the data obtained from this study alone is not enough to evaluate this fact on a statistical basis, although the numbers seem to be supporting this interpretation rather than challenging it. Also this aspect could be targeted by other subsequent experiments.

Finally, the study shows that people are perfectly capable of reasoning on the visual representation of abstract relational concepts. That is, no matter whether they chose the expected options or not, whether they did it in the first or second round, the great majority of them was able to provide the rationale for making each of the choices that they made, and even for not making the choices that they did not make.

Although a number of potential technical and cultural limitations (such as the fact that most of the selected relations were cognitively simpler and therefore easier to render than other ones would have been; the fact that the sample of subjects was not very large, etc.) might have influenced its outcome, the significance of the results obtained in this study cannot be dismissed. This was only the first step into the empirical investigation of 'Cinematic' Hypertext. Whether subsequent, further elaborated, studies or applications will continue to give positive evidence is to be seen, but these results and enough theoretical ground, suggest that this investigation is well worth the effort.

5. CONCLUSION

This paper has presented the paradigm of 'Cinematic' Hypertext as a new way of thinking about the non-linear electronic medium. While the tendency in page-based hypertext is to use links in a non-differentiated way and the screen's real estate as a paper page, we suggest that links be differentiated through the visual connotation of nodes and the page be fragmented in a structured dynamic configuration reflecting the discourse's organization and motions. While the tendency in semantic hypertext is to differentiate relations to express the variety of possible link types, we seek to minimize this differentiation, in order to minimize the semantic commitment while maximizing the differentiation between the visual renderings of different relations. While the tendency in spatial hypertext is to make a non-conditioned use of graphic connotations, we propose the consistent and concurrent use of graphic features, at least within each particular hypertext, in order to support the emergence of visual patterns facilitating the cognitive process of discourse structure interpretation.

This approach is compatible with a fundamental aspect of argumentative discourse: the fact that part of its effectiveness is based on the gradualness in which the reader constructs his own representation of the author's vision. Therefore, the implicit definition of discourse structure through the use of visual features would let the reader decide what they want to read into those features. However, an overall shape perceivable in the form of local discourse patterns would become visible, which would support the reader's gradual process of a cognitive representation.

As in cinematic discourse patterns are primarily expressed through the principled use of visual features, likewise in cinematic hypertext the principled use of graphical features could express discourse structures as animated visual patterns, in which hypertext transitions take shape of dynamic configurations, as the reader clicks links and nodes appear on the screen. The principled use of graphical features could be based on cognitive primitives, which could be used to define the hypertext relations to be shaped. However, if CCR look like primary candidates to define hypertext connections and regulate the use of graphical features in 'Cinematic' Hypertext, any relational distinction relevant to a particular hypertext work could be used to shape its discourse.

Also, hypertext discourse patterns could be shaped at different levels of granularity and in different manners. One could shape the relations holding between the paragraphs of what could be a single large node in 'traditional' page-based hypertext. In this case, as that particular node was 'called' on screen, its paragraphs would appear and distribute one by one on the screen in a short animation. The resulting configuration would express the relations holding between those small discourse units. Or, one could shape the relations holding between nodes. In this case, as links were clicked, new nodes would appear and distribute, while older nodes would disappear, to continuously generate configurations that dynamically take shape and transform. These configurations would express the relations holding between the discourse units present on screen at a given time. And so on.

The further investigation into the theoretical, design and empirical aspects of 'Cinematic' Hypertext has the objective of implementing a hypertext authoring environment, for which a number of verified structuring and design guidelines already exist at this point. While providing structural and design support, such an environment should allow authors to freely specify relations and use graphical features, to give readers visibility on their specifications, and even to break their own rules. Ultimately, Cinematic Hypertext is based on the consistent and concurrent use of the medium's formal features with some structuring principle, to allow the emergence of regularities, hence of a hypertext implicit language. The concept of Cinematic Hypertext goes beyond argumentative discourse and the problem of discourse coherence, to take advantage of the technical characteristics of a powerfully visual medium, therefore to help hypertext authors and users to become designers and viewers in a medium that can fully support textual discourse through a rhetoric of vision.

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7. REFERENCES

1. Bernstein, M. (1998). Patterns of Hypertext. In *Proceedings of ACM Hypertext'98:* Pittsburgh, PA, ACM Press, pp.21-29
2. Bertin, J. (2000/2001). Matrix Theory of Graphics. *Information Design Journal*, 10(1), pp.5-19
3. Buckingham Shum, S., Uren, V., Li, G., Domingue, J., Motta, E., Mancini, C. (2002). *Designing Representational Coherence into an Infrastructure for Collective Sensemaking*.

2nd International Workshop on Infrastructures for Distributed Collective Practices, San Diego, 6-9 February

4. Buckingham Shum, S., Uren, V., Li, G., Domingue, J., Motta, E. (2003). Visualizing Argumentation. In Kirschner, P.A., Buckingham Shum, S., Carr, Ch.S. (Eds) *Software Tools for Collaborative and Educational Sense-Making.* Springer-Verlag
5. Campbell, K.S. (1995). *Coherence, Continuity, and Cohesion. Theoretical Foundations for Document Design*. Lawrence Erlbaum Associates Publishers
6. Carter, L.M. (2000). Arguments in Hypertext: A Rhetorical Approach. In *Proceedings of ACM Hypertext '00*, ACM Press, pp.87-91
7. Casetti, F., Di Chio, F., (1990). *Analisi del film*. Bompiani
8. Grice, H.P. (1975). Logic and Conversation. In Cole, P., Morgan, J. (Eds.), *Syntax and Semantics.* Academy Press of New York, Vol. 3, pp.41-58
9. Knoch, W.G. (2000/2001). Jaques Bertin's Theory of Graphics and Its Development and Influence on Multimedia Cartography. *Information Design Journal*, 10(1), pp.37-43
10. Knott, A., Dale, R. (1994). Using Linguistic Phenomena to Motivate a Set of Coherence Relations. *Discourse Processes*, 18(1), pp.35-62
11. Kolb D. (1997). Scholarly Hypertext: Self-Represented Complexity. In *Proceedings of ACM Hypertext '97*, ACM Press, pp.29-37
12. Kolb, D. (1995). *Socrates in the Labyrinth: Hypertext, Argument, Philosophy*. Eastgate Systems
13. Kumpf, E.P. (2000). Visual Metadiscourse: Designing the Considerate Text. *Technical Communication Quarterly*, 9(4), pp.401-24
14. Louwerse, M. (2001). An Analytic and Cognitive Parametrization of Coherence Relations. *Cognitive Linguistics*, 12 (3), pp. 291-315
15. Luesebrink, M. (1998). The Moment in Hypertext. In *Proceedings of ACM Hypertext '98*, ACM Press, pp.106-112
16. Mancini, C. (2000). From Cinematographic to Hypertext Narrative. In *Proceedings of ACM Hypertext '00*, ACM Press, pp. 236-237
17. Mancini, C. (2003). *Towards Cinematic Hypertext: a Theoretical and Empirical Investigation*. Ph.D. thesis. Knowledge media Institute, The Open University, Milton Keynes, UK.
18. Mancini, C., Buckingham Shum, S. (2001). Cognitive Coherence Relations and Hypertext: from Cinematic Patterns to Scholarly Discourse. In *Proceedings of ACM Hypertext '01*, ACM Press, pp.165-174
19. Marshall, C.C., Halasz, F.G., Rogers, R.A., Janssen, W.C. Jr. (1991). Aquanet: a hypertext tool to hold your knowledge in place. In *Proceedings of ACM Hypertext `91*, ACM Press, pp. 261-275
20. Metz, Ch. (1972). *Essai sur la Signification au Cinéma -II*. Editions Klincksieck
21. Miles, A. (2000). Hypertext Syntagmas: Cinematic Narration with Links. *Journal of Digital Information*, 1(7). http://jodi.ecs.soton.ac.uk/Articles/v01/i07/Miles/
22. Miles, A. (2001). Hypertext Structure as the Event of Connection. In *Proceedings of ACM Hypertext '01*, ACM Press, pp.61-68
23. Miles-Board, T., Carr, L., Hall, W. (2002). Looking for Linking: Associative Links on the Web. In *Proceedings of ACM Hypertext '02*, ACM Press, pp.76-77
24. Pander Maat, H. (1999). The Differential Linguistic Realisation of Comparative and Additive Coherence Relations. *Cognitive Linguistics*, 10(2), pp.147-184
25. Riley, K., Parker, F. (1998). Parallels Between Visual and Textual Processing. *IEEE Transactions on Professional Communication*, 41(3), pp.175-185
26. Rosenberg, J. (2001). And *And*: conjunctive hypertext and the structure acteme juncture. In *Proceedings of ACM Hypertext '02*, pp.51-60
27. Rosenberg, J. (2002). *Conditional Spatiality*. Second Workshop on Spatial Hypertext, ACM Hypertext '02, 12 June, University of Maryland
28. Sanders, T.J.M, Spooren, W. (2001). Text Representation as an Interface Between Language and its Users. In Sanders, T.J.M., Schilperoord, J., Spooren, W. (Eds.), *Text Representation. Linguistic and psycholinguistic aspects*. University of Utrecht, University of Tilburg, Free University of Amsterdam Press, pp.1-26
29. Sanders, T.J.M., Spooren, W.P.M., Noordman, L.G.M. (1993). Coherence Relations in a Cognitive Theory of Discourse Representation. *Cognitive Linguistics*, 4(2), pp.93-133
30. Sanders, T.J.M. (1997). Semantic and Pragmatic Sources of Coherence: On the Categorisation of Coherence Relations in Context. *Discourse processes*, 24, pp.119-147
31. Shipman, F.M. III, Marshall, C.C. (1999). Spatial Hypertext: An Alternative to Navigational and Semantic Links. *ACM Computing Surveys*. 31(4), Article n.14
32. Slatin, J. (1991). Reading Hypertext: Order and Coherence in a New Medium. In Delany, P., Landow, G.P. (Eds.) *Hypermedia and Literary Studies*, MIT Press, pp.153-170
33. Trigg, R.H., Weiser, M. (1986). TEXTNET: A Network-Based Approach to Text Handling. *ACM Transactions on Office Information Systems*, 4(1), pp. l-23
34. Wertheimer, M. (1938). Laws of organization in perceptual forms. In Ellis, W.B. (Eds), *A Sourcebook of Gestalt Psycychology*. Routledge and Kegan Paul, pp. 71-88.