Angelika Storrer

Coherence in text and hypertext

Preprint. To appear in: *Document Design*, 2002

Abstract:

The concept of text coherence was developed for linear text, i.e. text of sequentially organized content. The present article addresses to what extent this concept can be applied to *hypertext*. Following the introduction (section 1), I will define different aspects of text coherence (section 2). I will then explain the importance of the sequential order of text constituents for coherence-building, as explored by empirical studies on text comprehension (section 3). Section 4 discusses how hypertext-specific forms of reading affect the processes of coherence-building and coherence-design. Section 5 explores how the new challenges of hypertext comprehension may be met by hypertext-specific coherence cues. A summary and outlook is included (section 6).

1. Introduction

Coherence is a key concept of text linguistics. Many definitions of "text" include coherence as a necessary feature. Coherence is especially relevant to the research on text comprehension and text clarity: Authors should design a text in such a way that the addressee may detect the relationships linking individual text constituents and thus may build a coherent mental model of the text's content. This guideline is particularly valid in the context of knowledge transfer and learning. It is largely independent of the choice of medium and thus applies equally to the new writing/reading technology known as "hypertext".

However, a number of important differences between text and hypertext exist, affecting how a reader constructs a coherent mental text representation while reading ("coherence-building").[1] Therefore, it is unclear to what extent the knowledge on processes of coherence-building, which was gained using sequential text, applies to non-sequential hypertext. Which of the findings may be directly applied to or adapted for hypertext? Where do we need entirely new concepts and strategies? In addressing these issues, I will focus my analysis on text and hypertext used in the context of knowledge transfer. Regardless of the actual medium, in knowledge transfer the author intends to support the reader, as best as possible, in arriving at coherent knowledge structures. Hyperfiction applications, which represent a form of literary experiment with the new technology, often follow different motives and will therefore be excluded from the following considerations.

2. Aspects of coherence

The interdisciplinary discussion on the concept of coherence has been reviewed in a number of different studies.[2] In the following, I will concentrate on those aspects of the discussion that are relevant to the comparison of text vs. hypertext.

2.1. Product-based vs. process-based views of coherence

The interest in the interdependence of coherence and text clarity has prompted researchers to shift their focus from a *product-oriented* to a more *process-oriented* view of coherence. Product-oriented coherence studies have focused on the analysis of coherence cues in static text. Process-oriented coherence studies, in contrast, investigate the role of coherence in communication processes, focusing on either *coherence-building* and *coherence-design*:

- Coherence-*building* is a key aspect of models on discourse comprehension. These models describe how recipients build coherent knowledge structures while processing text and how this process is affected by the interaction of linguistic and non-linguistic factors.
- Coherence-*design* is the focus of models on discourse production. These models describe the strategies authors pursue in order to guide and promote the process of coherence-building, as well as the linguistic and non-linguistic tools they utilize.

Most of the process-oriented models have been developed with the idea in mind that author and reader (or: speaker and hearer) perceive and process discourse in the same sequential ordering. Nevertheless, a process-oriented perspective of coherence allows, in principle, to account for steps of coherence-building during the selective processing of information coming from multiple documents. Thus, the process-oriented perspective of coherence is suited to capture the selective and boundary-crossing reading modes which are typical for hypertext usage. Section 4 will discuss some of the effects that selective browsing of different documents in a hypertext environment has on coherence building and coherence design. The basis of this discussion is a process-oriented model of text comprehension which is outlined in section 3. Of course, this deductive approach must be validated by subsequent empirical studies.

2.2. Author's coherence and user's coherence

Text coherence can be reconstructed using a set of *coherence relations,* which relate the semantic constituents of a text to one another. The type of the relation is either made explicit, by means of *connectives* (as seen in example 1 below). Or the relation remains implicit and thus has to be inferred, via context clues and background knowledge, by the reader (example 2). To reconstruct the relation between individual constituents, such inference must often be based on quite complex *frame and script knowledge* – in example (3) knowledge of birthday parties and piggybanks.

(1) As she is sick, Jennifer stays home.
(2) Jennifer is sick. She stays home.
(3) Jane was invited to Jack's birthday party. She wondered if he would like a kite. She went to her room and shook her piggy bank. It made no sound. [3]

Since many coherence relations remain implicit and must be interpreted by the reader, one cannot determine the coherence structure of a text in a straightforward fashion. Rather, one has to differentiate between two perspectives:

- From the perspective of *discourse production*, coherence is a property of the mental representation of the content that the text composition is to convey. This property may be reconstructed as the *author`s coherence structure*. This structure determines the author's strategies for composing the text and is reflected in the surface text by means of *coherence cues*.
- These coherence cues, in turn, support the text recipient in building a coherent, mental model of the text content. Thus, from the perspective of *discourse comprehension*, coherence is a property of the mental representation that is built while reading the text. This property may be reconstructed as the *reader`s coherence structure*.

Even in the case of sequential text, the author's coherence structure does not correspond exactly to the structure that the reader reconstructs during text processing. Models which aim to describe the main steps and principles of coherence building and coherence design may neglect this discrepancy. Nevertheless, if these models should be applied to the selective reading modes, which are typical for hypertext usage, the divergence between the author's coherence structure and the coherence structure of the user is of a different quality: Hyperdocuments, in the typical case, will be processed only partially and in a sequence that is not predictable by the author. The coherence structure which results from this partial and selective reading will differ considerably from the coherence structure of the hypertext author. The strategies for using coherence cues in hypertext have to consider, from the beginning, that a crucial presupposition guiding sequential text composition – that text reception will happen in a continuous, predictable sequence from beginning to end – is no longer valid. This point will be elaborated in section 4.

2.3. Local vs. global coherence

Many approaches to text coherence distinguish between *local* and *global* aspects of coherence.

- *Local coherence* exists between neighboring parts of the text: Either merely between two consecutive discourse segments, according to the textlinguistic definition; or, according to a broader definition, between two semiotic neighbors in general (e.g., between a figure and its caption).
- *Global coherence*, in contrast, defines the linkage of text constituents, as it is mediated by the global theme addressed in the document, as well as by its rhetorical function in a larger context.

I will refer to these two aspects of coherence in the classification of hypertext-specific coherence cues, discussed in section 5, by distinguishing between local vs. global context cues.

The related terminological distinction between dynamic and static coherence is introduced by von Stutterheim, (1997, pp. 31):

- *Dynamic coherence* refers to the sequence and linkage of the different information chunks that are presented in the text.
- *Static coherence* refers to the global reference frame which forms the background to evaluate more detailed, additional information chunks.

Static coherence, by default, will remain unchanged throughout the text. For example, reading about a European summit meeting in the city of Paris, one can safely assume that the word "Paris" does not refer to Paris, Texas, or, for that matter, to the character found in ancient Greek sagas. This assumption is important to the discussion of hypertext coherence, because the often implicit, yet crucial presupposition guiding mono-sequential text composition – that the recipient will interpret any local coherence based on the same global reference frame – is no longer valid in hypertext. While browsing a hypertext environment like the World Wide Web, the user can easily jump – by a simple mouse click – between different nodes that are content-related but belong to different hyperdocuments. Such a jump always results in a change of the global reference frame which, via static coherence, provides the background for the local process of coherence building. In case this change goes unnoticed, coherence may fail or co-reference may be falsely assumed. This case is discussed by Hammwöhner, (1997, 48f), who uses an example in which the word "Berlin" refers to the German capital in one document, but to a small town in Canada in another. Section 5 will argue that such problems can be avoided by providing appropriate global context cues.

3. Coherence and building and coherence design in sequential text

Sequentially organized documents present their constituents in a single, and thus predictable sequence. This sequence ties the author's coherence design to the reader's coherence building. Thanks to the predictability of the sequence, the author knows, at any given point in the text, which information and references have already been introduced. He may therefore use backward references and also include forward references to information yet to come. The sequence has a defined direction (beginning to end) which identifies the subclass of endophoric expressions as either anaphoric or cataphoric, according to the location of the antecedent.[4] Furthermore, the direction provides important hints for the classification "given" vs. "new", which is crucial to structuring information within a sentence and across a series of sentences. Last but not least, the direction forms the basis of dichotomous categories such as "theme" vs. "rheme" and "topic" vs. "comment", “forward looking” vs. “backward looking”.

3.1. Schnotz’s model of coherence building

The assumption that text reception will happen in a continuous, predictable sequence, is the basis of almost any model on text comprehension, including the model of Schnotz (see Schnotz, 1994, esp. chapter 10.4) which I will outline here. Schnotz’s model is based on previous models (e.g., van Dijk & Kintsch, 1983, Johnson-Laird, 1983), and it appreciates empirical findings from psychological studies on learning and comprehension. It is, to my opinion, well suited to further illustrate the discussion held here for the following reasons:

- Similar to the present article, the model focuses on coherence building in the context of knowledge transfer and learning.
- It investigates in detail to what extent different structures of text design correlate with parameters of coherence building, such as reading task, processing depth, processing strategy, and memory performance.
- The model provides "hands-on" clues and explanations about which design strategies facilitate text comprehension and text-based learning. As the model is rather complex, the following, brief outline covers only those aspects that are relevant to hypertext coherence.
- Particular attention is given to the interdependence of topic continuity and the grade of coherence elaboration. Since the traversal of hyperlinks during hypertext processing often implies hard topic shifts (cf. section 4), the interdependence of topic continuity and the grade of coherence elaboration is highly relevant to the discussion of hypertext coherence.

Following van Dijk & Kintsch, 1983, Schnotz 1994 assumes that processing a text generates mental representations of the text on three different levels:

- A *mental representation of the surface text* which captures the actual words and formal properties of the document.
- A *propositional text base* which is produced by syntactic and semantic processing of the propositions and which controls the coherence-building.
- A *mental model of the text content* which the recipient develops on a step-by-step basis, by processing the text itself as well as by considering background knowledge and information processed earlier in the text.

In Schnotz's model, text processing is described as an interplay between the propositions in the text base that are currently processed, the mental model built so far, and the background knowledge in the current focus of attention. In the course of this process, the mental model of the textual world gradually becomes more elaborate and detailed. The level of sophistication of the model may vary, depending on the reading task, the processing strategy, and the corresponding depth of processing. In other words, a single text may yield several mental models with varying levels of sophistication – Schnotz calls this "low" vs. "high" coherence levels, thus interpreting "coherence" as a scalable quality of mental models. In Schnotz's approach, knowledge is represented according to the theory of *cognitive schemata*: These are constructs for chunks of knowledge which generalize experiences and combine declarative and procedural knowledge into functional units. Cognitive schemata may be represented as frames or scripts.

Figure 1 illustrates how the interaction of the different levels of text processing leads to a gradual development of mental models: The processing of the propositions in the text basis activates cognitive schemata via "bottom-up processes". These schemata activate other, related schemata, which, via "top-down processes", are checked for consistency with the information received so far. At the same time, other, competing schemata are inhibited. This interaction of bottom-up and top-down activation of schemata gradually yields a scenario, which, in the context of everything read so far, reflects the most plausible interpretation of the current text information.

However, at any given time, only a limited number of schemata are available in the focus of attention. Therefore, the prerequisite knowledge, required to understand a certain section of text, should be introduced or re-activated immediately prior to that section. For only if all necessary knowledge units are simultaneously present and accessible in the mental model, can the coherence cues be identified and the matching coherence relation be generated. This "just-in-time" principle is crucial to the development of strategies for content sequencing, which aims to generate sophisticated, mental models with high levels of coherence.

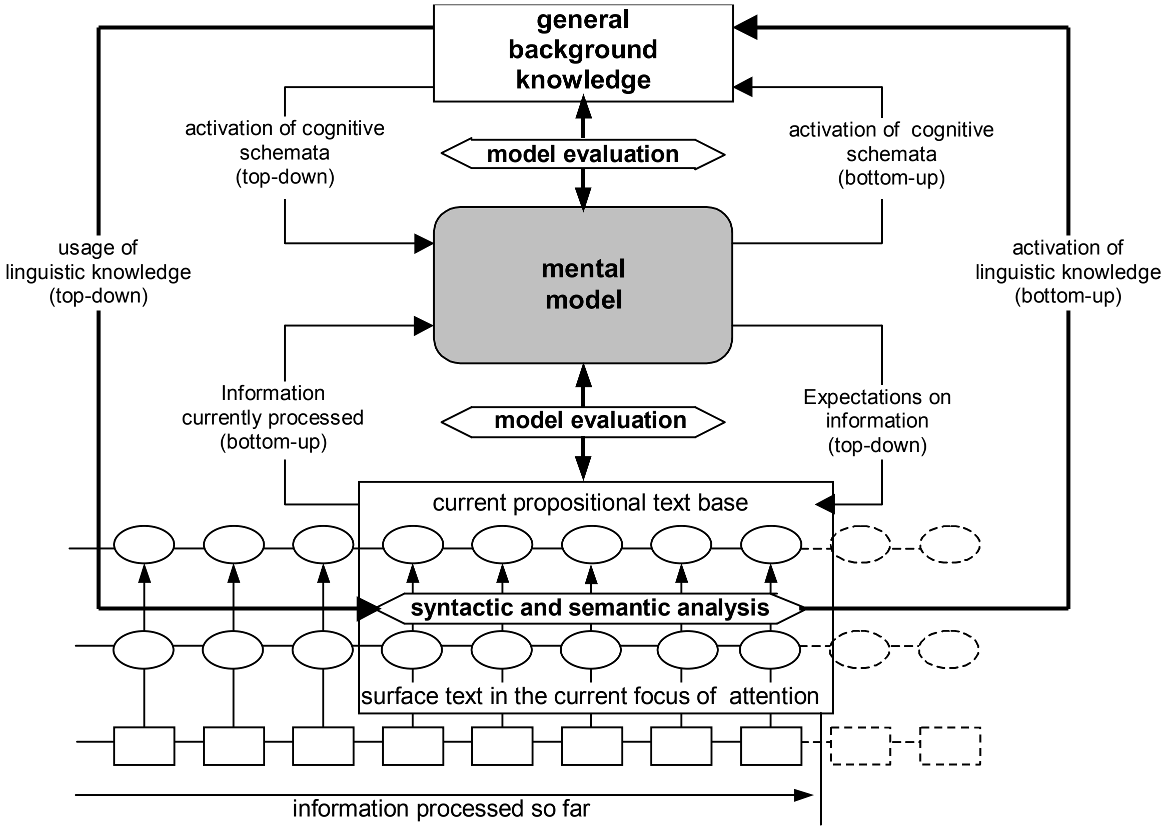

Figure 1: Interaction of different levels of processing during coherence building (based on the figure in Schnotz, 1994, pp. 214)

The units of mental representations assumed by the model (e.g., cognitive schemata and mental models) are obviously not immediately accessible through empirical studies. Schnotz explicitly does not claim their cognitive existence. Rather, as hypothetical constructs forming part of a theoretical framework, these representations aid to explain a number of findings on text comprehension and text-based learning. Hence, their legitimacy is based on the benefit they bring to the model, without claiming that they are mentally real. However, it is possible to test the model's assumptions during follow-up-communication (e.g., during memorization tests or tasks that require comprehension of the text content), thus tying the model to empirical evidence. Therefore, Schnotz's model is a well-suited starting point for inferring to what extent the new conditions of reading hypertext affect coherence-building, and how hypertext authors may cope with the new conditions during coherence-design.

3.2. Implications of the model for coherence design

Schnotz has discussed in detail the implications of the above model for composing and designing text. The following analysis will consider two aspects relevant to the discussion of hypertext. Supported by findings of empirical studies, Schnotz makes the assumption that building coherent mental models is facilitated by two factors: (1) Topic continuity and (2) concurrence with conventional text patterns. I will briefly explain how these two factors affect the process of coherence building:

(1) The concept of topic continuity, as discussed in Schnotz (1994, pp. 242ff), is based on a hierarchy of global topics and more specific subtopics. The hierarchy is generated by a topical analysis of the content to be conveyed by the text and, as such, provides the structural backbone for composing the text (Schnotz 1994, pp. 229ff).[5] Topically continuous text, instead of randomly switching between topics, will usually discuss and elaborate a given, global topic as long as possible before carefully introducing the next topic. In addition, it is advisable to arrange the topics according to consistent criteria (e.g., chronological order, geographic proximity) such that the relationship of subtopics may be easily identified. A number of empirical studies indicate that coherence building is facilitated if text is organized in such a fashion (cf. Schnotz 1994, pp.190ff). In the framework of Schnotz's model, this may be understood when considering that switching from topic A to topic B will interrupt the process of building a mental model of topic A. Meanwhile, new cognitive schemata have to be activated for building a mental model of topic B. Should the mental model of topic A be reactivated at a later stage in the text, it will be less vivid and detailed. As a result, the content conveyed by text with discontinuous topic sequence will, on average, be less present in a reader's mind than the content conveyed by text with continuous topic sequence. In topically discontinuous text, therefore, a reader will detect less semantic relations, and hence will achieve a lower coherence level than in topically continuous text.

(2) Text processing is guided, to a large extent, by the reader's expectation of conventional text patterns, so-called “superstructures”.[6] In Schnotz's model, the author's experience with text patterns – gathered and perfected by frequent reading of specific text genres – is modeled again as a set of cognitive schemata. For narrative text patterns, empirical studies have shown that comprehending, memorizing, and summarizing content is facilitated if text is organized following specific patterns, so called "story grammars". In other words, the more concurrent a text is with expected, conventional text patterns, the less cognitively demanding the text processing and thus the higher the level of coherence.

3.3. E-documents, hyperdocuments and hyperwebs

How can the model and these empirical findings be applied to coherence building and coherence design in hypertext environments? In order to address this question adequately, it is advisable to introduce distinct terms for three types of digital documents that are hosted on hypertext systems such as the World Wide Web: the e-document, the hyperdocument, and the hyperweb:

- An *e-document* is a sequentially organized text document available on the WWW. Frequently, e-documents are digital copies of printed text (e.g. dissertations, articles in scientific journals, or newspaper articles) which are published on the WWW in PDF or HTML format as this is cost-efficient and accessible world-wide.
- A *hyperdocument* is a network of nodes and links that serves a discernible text function and addresses a comprehensive, global theme. Both text function and global theme guide the coherence-building and set the global reference frame for static coherence, as was discussed in section 2. Hyperdocuments differ from e-documents in that their content is structured in modular hypertext nodes which are connected via hyperlinks. The access to the resulting network of nodes and links is provided by browsing and searching facilities of the hypertext-system: This software-dependency distinguishes non-sequential hyperdocuments from non-sequential documents in printed media, such as dictionaries, encyclopedias, or newspapers. In addition, most hyperdocuments are not "closed", but open-ended, allowing authors and users to attach additional nodes.
- A *hyperweb* interrelates a larger set of hyperdocuments and e-documents via hyperlinks. On a large scale, the WWW itself may be considered a single, world-spanning hyperweb. On a smaller scale, the WWW may be subdivided into partial webs, based on their subject or institution (WWW "sites"). Any hyperlinks in these partial webs can be classified as internal or external: Internal links are connected to nodes within the same hyperdoument or within the same site. External links provide links to other sites of the hyperweb whose content is beyond the immediate control of the author.

In order to compare hypertext to sequential, printed text – as far as issues of coherence are concerned – the applicable case is that of the hyperdocument. The case of e-documents is less interesting; even though e-documents should be incorporated into the hyperweb in a sensible way, other coherence-imposed requirements for e-documents remain the same as those for sequential text. The main task in designing a WWW-Site is to identify transparent filing methodologies to quickly locate hyperdocuments and to easily file new ones (cf. e.g., Rosenfeld & Morville, 1998, Fleming, 1998). The design and administration of sites is thus closely related to the task of structuring a library, rather than to the composition of text itself.

4. Coherence-building and coherence-design in hypertext

When comparing hyperdocuments to sequential print text, three factors have an impact on coherence-building and coherence-design. In the following we will discuss, how these factors may lead to problems during the process of coherence building. Section 5 will outline how these problems may be prevented by the appropriate usage of hypertext-specific coherence cues.

1) *Discontinuous text processing*: Information processing in hypertext environments requires the reader to choose, time and again, which one of the currently accessible successor nodes he wants to pick. Thus, reading is continuous only within the boundaries of a single node.[7] This obligation to choose between hyperlinks and navigation tools reduces the user's attention that is available for text comprehension – a problem known in hypertext research as "cognitive overhead" (Conklin, 1987, pp.40). As the author cannot gauge the coherence-design to a predictable sequence, the recipient himself must identify the topical relationship of any two succeeding nodes he has picked. In comparison to designing sequential text, the author's means to ensure topic continuity are limited. Topic discontinuity, as well as unintended switches between topics, may be avoided – if at all – by means of the local and global context cues discussed in section 5.

2) *Lack of visible document boundaries*: As they are tied to the tangible, physical media such as books, printed documents have fixed, well defined boundaries. Hyperdocuments, in contrast, are presented as single nodes distributed on the screen; the hyperdocument as a whole remains invisible – in hypertext research, this problem is referred to as "informational shortsightedness" (Conklin, 1987, pp.40). Without structure overviews (see section 5) neither the structure nor the size of the hyperdocument may be estimated by the user. Since activating external links is no more difficult than activating inter-textual or intra-textual links, the lack of tangible, physical boundaries may cause the hypertext user to cross, quickly and possibly unknowingly, the boundary of a hyperdocument or a site. While in designing linear text, it is explicitly or implicitly assumed that local coherence will be built based on the same global reference frame, in hypertext environments this assumption can no longer be taken for granted.

3) *Lack of a fixed text sequence*: Sequential text published in printed media presents content in a fixed sequence. This sequence, as shown in section 3 above, relates the author's coherence-design to the reader's coherence-building. In hypertext environments, such a sequence exists only *within* nodes, not however *across* different nodes. Rather, each node may have several possible predecessors and successors. Hence, while composing a subtopic in a hypertext node, the author does not know for certain which information the reader will have processed so far, which of the possible referents will have been introduced, and which of those references will be accessible in the reader's current focus of attention. This uncertainty complicates the planning of the dynamic coherence beyond the current node. In composing hyperdocuments, strategies of information distribution, which are based on the dichotomy of given vs. new, have to be modified and adapted. The challenge of dynamic coherence planning in hypertext environ-

ments is to address subtopics in hypertext nodes in a way such that the nodes may be read in various, unpredictable sequences.

Even though processes of hypertext usage do have a sequence in time, this sequence varies across different users and cannot be predicted by the author. Typically, hyperwebs are traversed in circles, i.e. the same node is visited multiple times, either during processes of "backtracking" or by repeated opening of central, structural hubs, such as web views, home pages, or search engines. While the guiding metaphor for the composition of *sequential text* is the reading path along which the author guides his reader from start to finish, in *hypertext*, the appropriate metaphor for hypertext composition is the *dialogue* between the user and the hypertext system. In contrast to face-to-face dialogues between human communicators, the author cannot control this dialogue while it takes place. Instead, he may only shape and restrict the user's interaction with the hypertext by means of hypertext-specific coherence cues. In the following section, I will highlight how authors can utilize cues in order to adapt the process of coherence-design to the changed environment of hypertext coherence-building.

5. Hypertext-specific coherence cues

To compensate for the difficulties resulting from the discontinuous text processing, the lack of a fixed text sequence, and the lack of visible document boundaries, hypertext technology offers a number of specific tools to be used as coherence cues.[8] For selective reading modes, effective use of these tools may facilitate an even higher degree of coherence during hypertext reading than that achieved during partial and selective reading of printed documents. From the viewpoint of coherence design, we will differentiate between the following three types of hypertext-specific coherence cues:

- *Structure overviews* support the user in developing a mental model of the size and the structure of the hyperdocument or site, thus compensating for the problem of "informational shortsightedness". By helping users to identify the main entry points and the structural backbone of the hyperdocument, disorientation and retrieval problems may be prevented.
- *Global context cues* emphasize the topical contribution of each single node to the global theme of the hyperdocument. By helping the user to identify the status of the node currently processed in the overall structure of the hyperdocument, they facilitate global coherence-building in the selective and discontinuous reading modes, which are typical for hypertext usage.
- *Local context cues* list the target nodes that are accessible from the currently visited node, and explain how they are semantically related. Thus, local context cues give useful hints to identify the topical relationship between two succeeding nodes. In supporting the user in planning the subsequent steps of

his individual reading path they may compensate for the problem of cognitive overhead.

Often used forms of structural overviews are *web views* (or "site maps") which visualize the structure of a hyperbase. Web views are built by extracting the central nodes and links from the complete structure and presenting them as clickable image maps. Users can view details of the nodes' environment by simple mouse clicks, or access the nodes' content directly from the web view.[9] Similarly, *topic maps* may be used to visualize the topical structure of a hypertext object. Topic maps allow the readers to decide for themselves which topics and what amount of detail are of interest to them.

Interface metaphors have a long-standing tradition in facilitating human-computer interaction. Interface metaphors may also be used as a reference frame which helps the user to identify and memorize the way in which content is organized in a hyperdocument or site. In the context of knowledge transfer and learning, interface metaphors are often borrowed from the world of library and office administration: Electronic books and filing cabinets are implemented into electronic libraries; electronic note pads and organizers take over functions similar to those of their paper-based predecessors. Such text genre-based metaphors indeed aid to compensate for the lack of visible document boundaries, facilitating the functional and topical consolidation of a multitude of nodes into a single entity, such as a digital dictionary or a digital course catalogue. The metaphor evokes known concepts, which in turn control the expectation of specific activity templates. Nevertheless, the positive effect of an interface metaphor depends on the correspondence between its source domain (e.g. the domain of printed books) and its target domain (e.g. the function of the book metaphor in locating and accessing information). Differences between the real-life object and its metaphorical counterpart may lead to misconceptions and usage problems (cf. e.g. Hutchins, Hollan, & Norman, 1986, Carroll, Mack, & Kellog, 1988).

Global context cues are crucial, as they allow the user to correctly relate the currently visited node to the global theme of the corresponding hyperdocument.
Text-based global context cues are node titles, node headings, and topical sentences. These *topic indicators* relate the local topic of a particular node to the global theme of the hyperdocument as a whole. Another method is to explicitly mark the location of a node in a navigation bar or in a structural overview of the corresponding hyperweb (web view, site map, topic map).

Global coherence cues are particularly important when navigating with search engines or with links that were generated automatically using techniques of key word evaluation. If nodes share a subject keyword that is ambiguous – e.g., "cohesion" in physics vs. "cohesion" in text linguistics – links between these nodes are easily implied even though their topics are not at all related. Even if the user realizes his mistake, the flow and ease of information processing is compromised. Even more prone to causing confusion is the traversal between two nodes that discuss the same scientific topic, however within different theories. In such cases, both nodes may address the same term, however as part of different theoretical frameworks. For example, the term "cohesion" in the theory of Halliday & Hasan, 1976 does not correspond to the term "cohesion" as it is used in de Beaugrande & Dressler, 1981. Similar to the "false friends" phenomenon found when dealing with foreign languages, a correspondence of meaning is *implied*, although this correspondence does not in fact exist.

In order to avoid such misinterpretations, which result from the lack of visible text boundaries, it is important to notify the user, when he crosses the boundaries of a particular hyperdocument. This is especially valid in the case of scientific hyperwebs. The most effective tool to notify the recipient when he is transgressing the boundaries of the current document is to explicitly mark the corresponding links as external links. This can be achieved by using characteristic symbols (e.g., arrows) and colors, or by using link titles. Link titles are labels which pop up as soon as the user points the mouse above the link[10]. When link titles are labeled as internal or external links, the user can tell whether the target node belongs to the current content – composed and guaranteed for by the author – or whether the node must be related to a new global reference frame.

Local context cues guide the user's expectations about the motivation of the links that are available from the currently visited node und facilitate the building of local coherence when traversing between nodes. For this purpose, link titles (see above) serve an important function. The titles indicate the rhetorical relation that motivates the link and gives clues about the target node type. This supports the user in choosing between different links, thus ensuring that text processing is not interrupted by activating irrelevant links. Whereas meta-communicative link descriptions (such as "click here for definition") tend to interrupt the process of content processing, the usage of link titles allows for a more fluent reading as the titles are displayed on demand only. Mostly for technical reasons, hyperdocuments on the WWW, at present, make spare use of link titles. However, technical advances such as additional functions for the semantic explanation of links (part of the XML-based linking standard Xlink, cf. DeRose, Maler, Orchard, & Trafford, 2000) may change this in the future.

6. Conclusion and outlook

Theories and empirical findings on *sequential* text processing are a good starting point for identifying and explaining the differences between text and hypertext coherence. Based on such insight, hypertext design strategies and tools may be developed and evaluated, which compensate for the difficulties resulting from the discontinuous text processing, the lack of a fixed text sequence, and the lack of visible document boundaries. For text and hypertext alike, coherence design in the context of knowledge transfer should start by analyzing the *structure* of the content to be conveyed in the text. As outlined in section 3, the result of such a structure analysis may be captured by a topic hierarchy. In hypertext, this hierarchy can be immediately presented as a clickable topic map. If each hypertext node covers exactly one topic or subtopic, the user may use such a topic map to select the topics in an order and a depth of detail consistent with his current interest. The function of each individual node within the hyperdocument as a whole can be reconstructed using the map, thus compensating for the "informational shortsightedness" caused by the on screen reading. In contrast to sequential text, the author is thus no longer obliged to choose a single, unique sequencing of content.

Authors of hypertext, however, are not limited to composing documents that are void of any sequential ordering. Instead, they may incorporate multiple sequential paths (so called "hypertrails" or “guided tours”) into the non-sequentially organized hyperdocument. Whereas printed media require that the author settle for a fixed sequence, hypertext technology supports dynamic sequencing of content according to context specific and user-adaptive parameters (cf. Lobin, 1999). To facilitate coherence-building, such flexible hypertrails have to be designed following a detailed analysis of which topics contain prerequisite knowledge necessary to understand other topics. Once these relations are explicitly programmed into the hypertext system, the system can determine which other nodes are crucial to understanding the node currently received – and thus can create automatic links to those nodes. By presenting the required nodes in spatial and temporal proximity, hypertext systems can apply the coherence promoting "just-in-time" principle (see section 3) even better than printed media. Although early research on hypertext already identified the possible benefits of this flexibility, its implementation into HTML-based WWW-technology has been difficult. The XML-based "semantic web" promises the design of "intelligent hyperdocuments" which support the user's coherence-building by means of a situation- and context-adaptive content presentation.

References

Carroll, J. M., Mack, R. L., & Kellog, W. (1988). Interface metaphors and user interface design. In M. Helander (Ed.), *Handbook of human-computer interaction* (pp. 67-85). Amsterdam: North-Holland.

Chen, C., & Rada, R. (1996). Interacting with hypertext: A meta-analysis of experimental studies. *Human-Computer Interaction, 1996*, 125-156.

Conklin, J. (1987). Hypertext: An introduction and survey. *Computer, 20*, 17-41.

de Beaugrande, R.-A., & Dressler, W. U. (1981). *Introduction to Text Linguistics*. London/ New York: Longman.

DeRose, S., Maler, E., Orchard, D., & Trafford, B. (Eds.). (2000). *XML Linking Language (XLink) Version 1.0*. Internet. available: http://www.w3.org/TR/2000/CR-xlink-20000703/.

Farkas, D. K., & Farkas, J. B. (2002). *Principles of Web Design*. Boston: A&B Longman.

Fleming, J. (1998). *Web Navigation. Designing the User Experience*. Bejing, Cambridge u.a.: O'Reilly.

Foltz, P. W. (1996). Comprehension, Coherence, and Strategies in Hypertext and Linear Text. In J.-F. Rouet & J. J. Levonen & A. Dillon & R. J. Spiro (Eds.), *Hypertext and Cognition* (pp. 109-136). Mahwah/New Jersey: Lawrence Erlbaum Associates Publishers.

Fritz, G. (1982). *Kohärenz: Grundfragen der Dialoganalyse*. Tübingen: Narr.

Fritz, G. (1999). Coherence in Hypertext. In W. Bublitz & U. Lenk & V. Eija (Eds.), *Coherence in Spoken and Written Discourse.* (pp. 221-232). Amsterdam/Philadelphia: John Benjamins.

Halliday, M. A. K., & Hasan, R. (1976). *Cohesion in English*. London: Longman Group.

Hammwöhner, R. (1997). *Offene Hypertextsysteme. Das Konstanzer Hypertextsystem (KHS) im wissenschaftlichen und technischen Kontext*. Konstanz: Universitätsverlag.

Hofmann, M., & Simon, L. (1995). *Problemlösung Hypertext. Grundlagen - Entwicklung - Anwendung*. München/Wien: Hanser.

Hutchins, E. L., Hollan, J. D., & Norman, D. (1986). Direct manipulation interfaces. In D. A. Norman & S. Draper (Eds.), *User centered system design* (pp. 87-124). Hillsdale: Erlbaum.

Johnson-Laird, P. N. (1983). *Mental models. Towards a cognitive science of language, inference and consciousness*. Cambridge: Cambridge University Press.

Kuhlen, R. (1991). *Hypertext. Ein nicht-lineares Medium zwischen Buch und Wissensbank*. Berlin et al.: Springer.

Lobin, H. (1999). Intelligente Dokumente. In H. Lobin (Ed.), *Text im digitalen Medium. Linguistische Aspekte von Textdesign, Texttechnologie und Hypertext Engineering* (pp. 155-177). Opladen/Wiesbaden: Westdeutscher Verlag.

Minsky, M. L. (1975). A framework for representing knowledge. In P. H. Winston (Ed.), *The psychology of computer vision* (pp. 211-277). New York: McGraw Hill.

Morkes, J., & Nielsen, J. (1997). Concise, Scannable, and Objective: How to Write for the Web [online]. http://www.useit.com/papers/webwriting/writing.html.

Nielsen, J. (1995). *Multimedia and Hypertext. The Internet and Beyond*. Boston: AP Professional.

Rickheit, G., & Schade, U. (2000). Kohärenz und Kohäsion. In K. Brinker & G. Antos & W. Heinemann & S. F. Sager (Eds.), *Text- und Gesprächs-*

linguistik -- ein internationales Handbuch zeitgenössischer Forschung. 1.Halbband (pp. 275-282). Berlin/ New York: de Gruyter.

Sandig, B. (1997). Formulieren und Textmuster. Am Beispiel von Wissenschaftstexten. In E.-M. Jakobs & D. Knorr (Eds.), *Schreiben in den Wissenschaften* (pp. 25-44). Frankfurt/M.: Peter Lang.

Schade, U., Langer, H., Rutz, H., & Sichelschmidt, L. (1991). Kohärenz als Prozeß. In G. Rickheit (Ed.), *Kohärenzprozesse. Modellierung von Sprachverarbeitung in Texten und Diskursen.* (pp. 7-58). Opladen: Westdeutscher Verlag.

Schnotz, W. (1994). *Aufbau von Wissensstrukturen. Untersuchungen zur Kohärenzbildung bei Wissenserwerb mit Texten*. Weinheim: Beltz.

Strohner, H., & Rickheit, G. (1990). Kognitive, kommunikative und sprachliche Zusammenhänge: Eine systemtheoretische Konzeption linguistischer Kohärenz. *Linguistische Berichte*, 3-23.

Thüring, M., Hannemann, J., & Haake, J. M. (1995). Hypermedia and Cognition: Designing for Comprehension. *Communications of the ACM, 1995*(8), 57-66.

van Dijk, T. A. (1980). *Macrostructures. An Interdisciplinary Study of Global Structures in Discourse, Interaction, and Cognition*. Hillsdale, New Jersey: Lawrence Erlbaum Associates, Publishers.

van Dijk, T. A., & Kintsch, W. (Eds.). (1983). *Strategies of Discourse Comprehension*. New York/London et al.: Academic Press.

von Stutterheim, C. (1997). *Einige Prinzipien des Textaufbaus. Empirische Untersuchungen zur Produktion mündlicher Texte*. Tübingen: Niemeyer.

---

[1] The analysis in this article builds on the discussion of hypertext coherence in Kuhlen, 1991, Hammwöhner (1997, Kap. 2), Thüring, Hannemann, & Haake, 1995, Foltz, 1996, and Fritz, 1999.

[2] E.g., Fritz, 1982, Strohner & Rickheit, 1990, Schade, Langer, Rutz, & Sichelschmidt, 1991, Rickheit & Schade, 2000.

[3] Example 3 was taken from Minsky, 1975.

[4] See de Beaugrande & Dressler, (1981, pp 60ff)

[5] The term "topic" is used here in the sense of Schnotz 1994.

[6] Cf. van Dijk, (1980, chapter 3), Sandig, 1997.

[7] Even within single nodes, readers first perform a superficial scan for keywords before processing parts of the node in more detail, studies such as Morkes & Nielsen, 1997 have shown. Thus the concept of a linear reception of text, particularly on screen, is not realistic. This additional aspect will not be considered in this article. Instead, the focus will be more generally on the question how the lack of a fixed text sequence in hyperdocuments effects coherence building and coherence design.

[8] An overview of tools and strategies in earlier hypertext systems is found in Kuhlen, 1991, Hofmann & Simon, 1995, Nielsen, 1995. For the WWW, support of navigation and orientation in developing hypertext is addressed by Fleming, 1998 and Farkas & Farkas, 2002. This section discusses only those aspects that are relevant to coherence design issues.

[9] Chen & Rada's meta-analysis of studies on hypertext usage (Chen & Rada, 1996) found that graphical maps and structure overwiews have positive impact on hypertext usage.

[10] See e.g. Nielsen: http://www.useit.com/alertbox/980111.html