REPRINTED FROM

COMPREHENSION OF GRAPHICS

Wolfgang SCHNOTZ

Institute of Psychology
Friedrich Schiller University of Jena
Jena, Germany

Raymond W. KULHAVY

College of Education
Division of Psychology in Education
Arizona State University
Tempe, AZ, USA
Chapter 3

Spatial Metaphors and Logical Pictures

August Fenk

University of Klagenfurt, Austria

ABSTRACT

This paper studies the following, closely related questions: Where do "logical" pictures said to be arbitrary and non-representational get their form? And what makes them an appropriate cognitive and communicative instrument? Obviously these pictures do not portray visible objects and they cannot portray invisible mental models. Thus, logical pictures cannot be classified as "iconic", if the term "iconic" is reserved for cases of similarity established by imitating or simulating that which is represented. It is more likely that they are transformations of spatial metaphors into visual analogues, mapping the spatial allusion of the verbal metaphor into a two-dimensional representation. This visual analogue increases the efficiency of the metaphor as a heuristic tool in providing visual control of the construction of mental models. And if we are familiar with the verbal metaphor, the "arbitrary" picture determined by this metaphor is to a certain degree "self-explanatory". Two simple experiments, conducted by students, are reported: They demonstrate the application of guessing-game techniques in order to measure text-picture-transinformation, and their results indicate that the degree of enhancement of text-comprehension yielded by the logical picture depends on the success of the translation of the spatial metaphor into the illustration.

Several authors suggest a classification of instructional pictures as representational, analogical, or arbitrary. According to Alesandrinii, arbitrary pictures include graphs, diagrams, flowcharts and, in particular, graphic organizers, hierarchies and networks "representing
important relationships in the text such as comparing and contrasting concepts." (Alesandrini, 1984, p. 71). Arbitrary pictures are also termed "non-representational" or "logical" pictures "because those highly schematized visuals do not look like the things they represent but are related logically or conceptually." (ibid., p. 70). But which "things", if any, do they represent? And where do they get their shape from, if they are "arbitrary" and "non-representational"? What links them up with the language system and and makes them useful for text comprehension?

Weidenmann (1988) argues that texts as well as pictures should be regarded as "objectivations of mental models" (p. 40), and that for an operative pictorial effect, i.e. in order to influence the mode of processing, logical pictures are the most appropriate choice (p. 163). But why are precisely those pictures which are said to be "non-representational" assumed to be the most appropriate ones in the control and self regulation of mental processes and operations?

In order to answer such questions, this paper emphasizes the relations between logical pictures and metaphors - without losing sight of the convention (cf. Mac Cormac, 1985, p. 143) according to which the term "metaphor" is reserved for verbal expressions. These relations can best be illustrated by means of "logical pictures" in a narrow sense, i.e. in the sense of graphics used to depict those ("logical") relations between concepts which are prerequisites for, or part of, definitions and categorical syllogisms. Pure graphical components and pure graphical configurations are not apt to explain themselves, because they cannot achieve self-referential levels or metalevels of discourse (cf. Fenk, 1990, p. 367). Nevertheless they are useful within such a metalevel discourse: when linguistic expressions are used to state or explicate relations between other linguistic expressions - as it is the case in definitions and in semiotic discourse, where certain symbols (usually words) are used to describe the function of the "symbol" and of other signs - these relations can be made transparent by logical pictures.

The following brief survey presents the stages in our argument. Drawing on quotations from Peirce (1906, 1976) as well as Ogden & Richards (1923), Thesis I establishes the premise that "pure" symbols as well as "pure" icons are "incomplete". With the help of logical pictures, an attempt is made in Thesis 2 to sharpen the concept of the "icon" and, as a further step, to develop the concept of the "diagram": while the iconic symbol realizes both the symbolic and the imitative function, these two functions complement each other by means of special elements
in the diagram. Thesis 3 maintains that these abstract drawings are not
imitative in a strict sense; on the other hand they are not really
"arbitrary" but motivated by our spatial metaphors: diagrams and
logical pictures in general are two-dimensional figures capturing the
figural allusions of our figures of speech. The metaphor's virtual space
is materialized in a spatial, two-dimensional analogue. This analogue
prevents abstract propositional and mathematical thinking from losing
its firm foundation in topological thinking. Expressed with another
metaphor: this analogue provides a form for formal operations, and it
provides visual control of the construction of "mental models". A pilot-
study reported in section 3.2 demonstrates that a literal translation of
the metaphor's spatial references into a picture format increases text-
picture coherence and the extent to which the picture reduces the
cognitive load of processing the text and vice versa. The last section of
the paper compares different views of the relation and co-evolution of
external and internal representations. To sum up Thesis 4: spatial
methaphors seem to play the role of a cognitive tool which we can use
to create new tools, i.e. new metaphors and graphic analogues.

"Pure" symbols and "pure" icons are incomplete

Peirce on the one hand and Ogden & Richards on the other hand are
sometimes (e.g. von Glasersfeld, 1982, p. 194) referred to as
proponents of conflicting semiotic positions. But the following
quotations from these authors read like different versions of the
doctrine of a triadic nature of sign and of the thesis stated above.

Peirce distinguishes three qualities and/or classes of signs, called
"symbol", "icon" and "index", and characterizes them as follows: "They
seem to be all trichotomies, which form an attribute to the essentially
triadic nature of a Sign. I mean because three things are concerned in
the functioning of a Sign; the Sign itself, its Object and its Interpretant"
(1906, p. 496 f.). "(Strictly pure Symbols can signify only things
familiar, and those only insofar as they are familiar)" (ib., p. 513).

"A pure icon /.../ asserts nothing. /.../ A pure index simply forces
attention to the object /.../ An icon can only be a fragment of a
completer sign" (1976-edition, p. 242), "But a symbol, if sufficiently
complete always involves an index, just as an index sufficiently
complete involves an icon" (ib., p. 256).
Ogden & Richards (1923) comment on their famous triangle (see figure 1) as follows:

"Between the symbol and the referent there is no relevant relation other than the indirect one, which consists in its being used by someone to stand for a referent. Symbol and Referent, that is to say, are not connected directly (and when /.../ we imply such a relation, it will merely be an imputed, as opposed to a real, relation) but only indirectly round the two sides of the triangle" (ib., p. 11 f.) "An exceptional case occurs when the symbol used is more or less directly like the referent for which it is used, as for instance, it may be when it is an onomatopoeic word, or an image, or a gesture, or a drawing. In this case the triangle is completed; its base is supplied /.../ Its greater completeness does no doubt account for the immense superiority in efficiency of gesture languages /.../ Standing for and representing are different relations". (Footnote in Ogden & Richards, 1923, p. 12)

The remarks by Ogden & Richards on the efficiency of gesture language, and by Schopenhauer (n.d., p. 142 f) on the relationship between gesticulation and logics, might suggest that logical pictures - like the Ogden & Richards triangle - complete texts in the way gestures complete speech. Could it be the case that the form of gestures and the form of logical pictures have a common (mental? metaphorical?) origin? Or do the pictures take their form from gestures, as if they
were a recording of them? This possibility would merely shift the focus of our question: where does the form of gestures originate? At least with regard to the form of pictures we have a tentative answer (s. Thesis 3). The route to this answer leads via an analysis of two different modalities in which symbolic and iconic functions may complement and complete one another.

"Symbolising" and "imitating" fall together in the "iconic symbol" and complement each other, with special elements, in the diagram

The picture story in figure 3 (see also Fenk, 1990, p. 367) was partly inspired by the Ogden & Richards diagram, but here the term "thought" (Peirce's "interpretant") is replaced by the term "Concept" at the top of the triangle. In this way, the left side of the triangle can be associated with the intension of concepts while the right side is associated both with the extension of concepts (falling) and with the process of concept formation (rising).

The picture story is also inspired by Peirce's terminology, but "symbol" and "icon" refer explicitly to different functions and not to different classes of sign. The distinction between "index", "icon" and "symbol" cannot be upheld if we mean distinct classes (instead of functions) of signs (Fenk, 1992b). Since we interpret every event as an indication of something else (of causes, correlations, etc.) the concept of "sign" becomes empty when it includes "indices" (in the sense of indications and symptoms). Moreover, similarity is neither a sufficient nor even necessary condition for "reference" (cf. Goel, 1991, p. 41) nor for "representation" and for "signs" subsumed under 'representation'; only when similarity is achieved by imitation, can we speak of a case of external "representation" (s. fig. 2). The necessary and sufficient condition for the symbolic function (and, depending on the interpretation of this term, also for the sign-function in general) is the encoding of a concept or proposition. We may speak of iconic symbols when symbols - as in the case of pictograms and onomatopoetic words - imitate or simulate the objects that fall under the encoded concept. Logical pictures and diagrams, however, must be considered as combinations of separate graphic and symbolic elements; the graphic elements take on their significance, or their context-related meaning only be means of the symbolic elements.
"Pure" symbol:
As illustrated in the first triangle at the top of figure 3, the "pure" symbol, first of all, denotes (the "intension"? of) a concept.

The concept is the result of cognitive processes like the detection of invariants, like abstraction and classification - including the classification of an object as a symbol, and the detection of what is invariant in the contexts where this object is used to depict other "objects". "Objects" is used here in a broad sense, comprising even "symbols" which are "objects" interpreted as referring to a concept and thus functioning as symbols (see figure 2); each symbol, and also the symbol "symbol", can become the referent of another symbol. In self-referential or meta-level discourse the direct connection between S and O proves to be superficial, or "imputed".

"Pure" icon:
The situation changes in the case of a representation, which we here call "imitative". What is meant is the essence of terms such as "imitating", "simulating", "picturing", "modelling", "enacting" ... - all of which are processes where the goal and the result is similarity between representation and represented.
Figure 3. A picture story, ending with a diagram of the diagrammatic function. From Fenk, A. (1990, p. 367). Copyright by Leuchtturm-Verlag. Reprinted by permission.

Similarity, however, as we know, is often caused by processes other than imitative as well; the reflection of a tree in water resembles the tree, but no one can maintain that the water is "imitating" or "simulating" the tree. (Even in a landscaped garden where the reflection of a tree or a castle in a pond is deliberately arranged by the architect, the similarity between the castle and its reflection is a result of natural laws and not of imitation). Such common features or similarities are neither necessary nor sufficient for representation. But this is only a negative "definition" of representation. Our positive argument says: When similarity is established by imitation, this is a sufficient condition for representation and for the kind of representation we call "iconicity".¹
But even in those cases when similarity is achieved by imitation, imitation is not directly referring to a concept. For this imitative representation we construct a similar triangle as for the symbolic representation; in this second triangle (in figure 3) the connection with the concept is "imputed" (shown by the dotted line in the diagram).

**Iconic symbol:**
If we superimpose our triangle 2 on triangle 1, we see three solid sides. The symbol is, in Peirce's terminology, "completed"; symbolic function and imitative function coincide. This is the case in "iconic symbols", like onomatopoetic words or pictograms. This third triangle in our picture-story is, in some way, "authorized" by Ogden & Richards (see their footnote quoted under Thesis 1). But their expression "representing" was not adopted to depict the base line of our triangle, because nowadays this term is currently used in a broader sense, including symbolising, imitating, and "standing for".

**Diagram:**
When the two triangles are unfolded along the "C-O" axis, S and I are in diametrically opposite positions, namely as those functions which are only conceptually separable in the case of the iconic symbol and are realised by separate and complementary elements in the diagram: Graphic elements take on the imitative function, symbols (like "I", "O") give meaning to the graphic elements.

Eco (1985, p. 213) maintains that a picture does not resemble the object represented but merely our "perceptive model of the object". If we read the "O" of our parallelogram as the "perceptive model of the object" (or as the mental image), two types of internal representation oppose one another along the short diagonal (C,O), between which according to Winn (1988, p. 63) the "mental model" proposed by Johnson-Laird (1983) would be located, while on the long diagonal (S, I) there are two types of external representation each linked to a direct partner in the internal representation.

Our attempt to develop a concept of the "diagram" from the concept of iconicity can only be considered successful if one follows Peirce in calling "pure forms" "iconic" and regards "iconicity" as an extremely broad term. If, however, the concept of iconicity is reserved for instances of a perceived similarity between representation and represented, achieved by simulation, then the concept of "object" and of "simulation" must be broadly defined so that such pictures can be classified as "iconic". For which (mental?) "object" e.g. in our
triangular diagram (fig. 3) is "simulated"? The triangles which were used to explain the concept of iconicity cannot portray, simulate or be isomorphic with this or any other concept of iconicity. Hence the form of logical pictures cannot be seen to be the result of direct imitation or simulation. Nevertheless their form is obviously not completely arbitrary. But what precisely is the origin of their particular form?

Logical pictures are determined by spatial metaphors

Theoretical considerations

An analysis of the semantic function of logical pictures might follow a line of arguments concerning (a) some special qualities of metaphors and (b) their function on the meta-level of discourse where (c) the use of logical pictures concretizing spatial metaphors activates our visual "surveying-system" and (d) induces "analogical" interpretations with a minimum of cognitive costs:

(a) Schroeder (1989, p. 14) points out that Peirce introduced the term "hypoicon" in order to describe the icon as something, which is not only like anything else, but is used as a sign (of that thing), in which, says Peirce, "likeness is aided by conventional rules." These hypoicons comprise images (likeness is the most prominent feature), diagrams (in a very broad sense) and "metaphors" (see figure 4).

According to Peirce metaphors are those hypoicons "which represent the representative character of a representation by representing a parallel in something else". But if reckoned among (hypo)icons at all, metaphors seem to play a very special role there: apart from a direct interaction with the extralinguistic world, only metaphors offer a possibility of generating new concepts (Rauh, 1989, p. 258 f). And because of their "intralinguistic" origin (Rauh, 1989, p. 261), "likeness" has a very special quality in metaphors.

(b) The majority of our expressions for "phenomena" in cognition and communication is metaphorical (e.g. Waltz, 1978, Johnson & Lakoff, 1982), and according to Macdonald-Ross (1979, p. 233) "all our metaphors of knowledge are spatial". (One might even doubt whether these expressions, which apply spatial concepts to other aspects of 'reality', should be classified as metaphors, because there are no non-
figural alternatives: "The language, whatever it is, leaves us no choice." (Miller, 1985, p. 154)

(c) In illustrations, abstract ideas can be concretized via spatial metaphors (Winn, 1988, p. 59); and "all our knowledge, when placed in a diagram becomes thus spatial, and thus amenable to pattern-recognition capability inherent in our perceptual system." (Macdonald-Ross, 1979, p. 232 f.)

(d) For those who are acquainted with a certain verbal metaphor (or metaphor theme), the visuals determined by this metaphor are not arbitrary and - like metaphors - are "self-explanatory" to a certain degree. Logical pictures induce - without demanding too many legends and explanatory notes - an interpretation of graphic figures "by analogy" to the relevant figure of speech (and an interpretation of propositions by analogy to graphical figures). They constitute suitable material for "comprehension", if "comprehension" is the detection and construction of correspondences between different representations.

Take, for example, the visuals in this paper. Figures 1 - 4 are "logical" pictures in a rather literal meaning of "logical" picture, i.e. in the sense of graphics applicable in semiotics and in class logic. They try to make relations between semiotic concepts transparent by superimposing graphic figures on our figures of speech:

Figure 4 refers to the metaphor of conceptual hierarchies and subsumptions. And figure 2, showing the symbol coming out of the shell, refers to the metaphor of concepts including less extensive concepts; the overlap cannot exceed the size of the narrow concept, and only the circle with the larger circumference and diameter - only the wider or broader concept - can contain or include the other one. The triangles (figures 1 and 3) allude to the metaphor of the direct (straight and short) or indirect ways in which concepts are connected. Metrical properties become even more important in figure 5 which refers to empirical (rather than "logical") stated relations: Only if one is used to think of concepts like "time" or "relationship" as a quantity or a dimension or a scale is one able to construct and correctly interpret such more or less Cartesian diagrams (Fenk, 1987, p. 30). Again, the linear scale is sometimes referred to as a special case of the path metaphor (see Rice, 1991).
The results of a pilot-study

Two simple experiments were carried out in order to demonstrate the influence of the metaphorical expressions in a text on text-picture composition (Exp. 1) and to test the assumption that the closest translation of the spatial metaphor into the two-dimensional representation would be the most effective one for reducing the informational content of a given text (Exp. 2). The basic idea for an economical experimental design of both experiments was to create a situation where the hypothesized influence of the metaphor comes into conflict with other tendencies determining the diagram, so that the metaphor’s influence would become apparent in interacting with, and perhaps overcoming the conflicting factor.

Since our common front and back terms (and our forward and backward gestures) for the future and the past do not readily offer themselves for a direct transformation into a two-dimensional representation of the time axis, the direction of the time axis might be inspired by the content-specific metaphors in the corresponding text. If, for instance, the diagram refers to the evolution of species, the use of the metaphorical expression “phylogenetic tree” and of associated expressions in the corresponding text is expected to induce a tendency to an upward ordering of the time axis, i.e. in the vertical direction in which trees usually grow.
A candidate for a conflicting factor is the direction of text-processing: In European languages the written text "grows" and reads from left to right within the line. Remembering Trangott's (1975, p. 214) remark that verbal "left-right expressions for time are virtually nonexistent", this text-direction - instead of any metaphors - should be made responsible for the strong tendency found in English speakers, as compared to Hebrew and Arabic speakers, "to portray temporal concepts from left to right" (Tversky et al., 1991, p. 529) when drawing a diagram. Moreover, this text-direction might be responsible for the fact, that the left-to-right orientation of the time axis and of flow diagrams became the "normal" format, from which the (English speaking) subjects in the experiments of Winn (1982, 1983) extracted information faster and more accurately than in the case of an "unanticipated format" ordering the evolution of dinosaurs from right to left.

Experiment 1

Sixteen "experimenters" - I am indebted to the students attending a lecture on empirical methods in media research (winter 91/92) - asked a total of 84 subjects, which one of four given drafts they would combine with a given text on the evolution of Hominoidea. These drafts were four different orientations (upward, downward, to the right, to the left) of a phylogenetic tree (figure 5); the names of the species (Pongo, Pan, Gorilla, ...) were always written in horizontal position within a circle at the end of the "branches".

The upward-orientation was expected to be preferred, followed by the downward-version, i.e. the tree's mirror-inverted counterpart, which might also benefit from another direction of text-processing - from line to line and from top to bottom - and from the fact, that this is a quite "normal" format of genealogical tables in history books. The right-to-left version was assumed to be worse, because neither trees (nor their root-stocks) nor texts "grow" from right to left. (These hypotheses have been stated in a theoretical study by the author, 1991, p. 14, and were examined in Fenk, 1992a.)

The results: The hypothesized rank order proved to be valid with the exception that the left-to-right version surpassed the downward version. The four versions with the number of choices in brackets: upward (42), to the right (20), downward (16), to the left (6). Hence, 69% of the subjects (58 out of 84) chose one of the two vertical orientations, and
50% of the subjects chose the upward version - despite the fact, that the upward ordering neglects both directions of text-processing as well as the usual direction of the time axis in diagrams, and presumably due to the spatial metaphors occuring in the corresponding text. (For instance: "Die stammesgeschichtliche Entwicklung und Ausdifferenzierung bis in die Gegenwart herauf ..." - "The phylogenetic evolution and differentiation up to the present ... "). The right-to-left order, which does not map with any direction of "growing" in anything relevant (trees; texts; time axis in "normal" diagrams) marks the endpoint of the rank order.

Experiment 2

In this experiment a more time-consuming performance score was used in order to measure picture-text "transinformation", or, to be more precise, to measure the reduction of the subjective text-information (in bits) induced by a given picture. This performance score is in some respects similar to Goldsmith's (1984) "impoverished text" method measuring the "predictability" of a text, but quantifies "predictability" in terms of information theory. Only the two extreme positions of the hypothesized rank order (see experiment 1) were compared. Three students tested thirteen subjects. 8 of the subjects were shown the upward position, 5 of them the right-to-left position. Then all subjects were presented with the corresponding text. This time, a few crucial words (a total of 54 letters) in the text were omitted and had to be guessed letter by letter; there was only one guess per letter, and in cases of a wrong response the experimenter answered with the correct letter (The guessing game and accompanying formula to calculate information
Table 1. The results of a guessing game (see text. Source: Fenk, 1992a, p. 165)

<table>
<thead>
<tr>
<th></th>
<th>mean number of errors</th>
<th>informational content</th>
<th>mean time taken for guessing</th>
</tr>
</thead>
<tbody>
<tr>
<td>upward group</td>
<td>13.75</td>
<td>1.525 bit</td>
<td>9.87 min</td>
</tr>
<tr>
<td>right-to-left group</td>
<td>17.40</td>
<td>1.859 bit</td>
<td>10.20 min</td>
</tr>
</tbody>
</table>

content from the relative frequency of errors is taken from Weltner, 1973).³

The hypothesis that the "upward-group" would perform better than the "right-to-left group" was verified (see table 1). This indicates that the upward growing phylogenetic tree was more "successful" in reducing the cognitive costs of processing the corresponding text. And the subjects of the "right-to-left group", as compared to the "upward group", did not take much notice of the diagram during the cloze procedure; obviously, they did not expect as much help for their guessing-performance.

Spatial metaphors are heuristic tools and are used to create new metaphors and visual analogues

Let us return to the point that logical pictures (like our figures 1-5) do not directly imitate or simulate any reference-object existing in our perceptual world, and that they do not imitate or simulate any perceptive model of such an object. On a more general level, this problem might be discussed within a theory of "structural representation" and "surrogative reasoning" (Swoyer, 1991). Instead of that we will adhere to our focus and advance the question, what might be "representational" and "iconic" in "non-representational" pictures. Some lines of argument relevant to our question are:

(a) Diagrams are viewed as "externalised" mental models and mental operations. (Suggestions of this type are discussed in Fenk, 1991).
Sometimes they are regarded as "simulating" mental processes. This view corresponds to Salomon's "supplantation"-hypothesis: "Thus, to the extent that a symbol system entails coding elements that simulate (or can be made to simulate) a hypothesized internal process of elaboration, it can supplant the process and become internalized for use as a mental tool /.../ Yet, there is no theoretical reason to believe that overt modeling, or supplantation, of an elaborative transformation could not also be accomplished by nonnotational systems. To the extent that specific mental elaborations are of the logical-verbal rather than imagery type, nonnotational overt modeling should be capable of supplanting them and hence make them available to learning by observation" (Salomon, 1979, p. 234).

This view of diagrams as well as Weidenmann's (1988) view of pictures as "objectifications" of mental models assume that there is, in some way, an "isomorphic" relation between internal and external representations. On the other hand: Mental processes, even when dealing with forms and shapes, do not have any form or shape that might be externalised or simulated. (Only in our metaphors on mental "phenomena" is there talk about the form, or structure, or architecture of such "phenomena". See point c).

(b) Peirce's theory disposes of this problem in a very radical way. In this theory, the division "internal/external world" is more or less abolished, and the term "sign" is broad enough to comprise thoughts. And the term "iconicity" is broad enough to comprise the syntactical form of sentences and syllogisms:

"For Reasoning, nay, Logic generally, hinges entirely on Forms. You, Reader, will not need to be told that a regularly stated Syllogism is a Diagram /.../ No pure Icons represent anything but Forms! no pure Forms are represented by anything but Icons." (Peirce, 1906, p. 513).

Our logical pictures, without the symbols completing them, might then be classified as "pure icons".

(c) We regard logical pictures as the descendants of spatial metaphors and as visual analogues of more or less "self-explanatory" metaphors. (This view seems to hold - irrespective of the role we ascribe to gesticulation: Logical pictures accompanying written texts on abstract thoughts, as well as the more dynamic gestures accompanying the spoken text, may be seen as direct transformations of spatial metaphors; but gestures might also be seen as mediators in the process mapping
spatial metaphors into logical pictures.) The advantages of this view: We do not need to make any assumptions about the "form" of thoughts. And it does not afford an "overextension" of the concept of "iconicity". Metaphorical expressions (like "overextension of concepts") may be "figurative" and "graphical" in a metaphorical sense - but they are not "iconic" in our restricted sense of the word, because they do not produce perceptual similarity.

This "economic" view leaves out the question as to the origin of the spatial metaphors determining our logical pictures. A probable answer to the question follows:

It is our spatial thinking that has invented spatial metaphors as an appropriate tool for metalevel cognition and communication and that has created logical pictures for just the same purpose. These pictures are a very recent cultural achievement (Tversky et al., 1991), and so they could go back to the spatial allusions of already existing metaphors. (Some of our metaphors in contemporary scientific language again seem to be inspired by already existing logical pictures.) From this point of view the metaphor of language as the "Procrustean bed" of thinking should be replaced by the metaphor of language as a tool of cognition and communication; this instrument or tool determines thinking, but is in turn created - and permanently modified - by our cognitive system. Spatial metaphors seem to play a key-role in this co-evolution of language and thinking and in the co-evolution of mental modelling and overt symbolic manipulation: with the aid of metaphors we produce new metaphors and visual analogues in just the way we use tools to manufacture new tools.

Our considerations have been of a merely terminological and theoretical character. But together with the experiments reported they provide at least one recommendation for the designer of instructional "text-picture compositions": In order to achieve high text-picture coherence, one should put stress on "viable" figures of speech and design pictures precisely mapping these spatial metaphors! These pictures then increase the efficiency of the metaphor as a heuristic instrument in providing a form or a matrix permitting direct visual control of the admissability of mental drafts, models, and operations. Thus, logical pictures in context are apt to activate that deeply rooted and highly developed potential for topological orientation, which has created our spatial metaphors.
Notes

1 A second possibility of developing a simple and sound concept of iconicity (Fenk, 1987, 1990) should be mentioned in passing here. In one respect it essentially boils down to Peirce’s considerations: “pure” icons do not really exist! However, in other respects, this second possibility implies a radical rejection of Peirce’s distinction between signs (see fig. 4): given the premise that symbolicity, i.e. the function of denoting a concept or a proposition, is a necessary and sufficient condition for “sign”, iconicity is not more than a possible attribute of signs. The provocative consequence: nothing but a symbol can be iconic!

2 In our “iconic symbols”, likeness is also aided by conventional rules. (Each symbol has to follow some conventions regarding its form in order to be identifiable as a certain symbol.) If one wanted to classify iconic symbols as hypoicons (see fig. 4), this would mean neglecting their function as symbols and cause additional difficulties: should, for example, pictograms and onomatopoetic words be classified as diagrams or even as metaphors? Or rather as "images": but how could we then claim that in pictograms or in onomatopoetic words "likeness is the most prominent feature"?

3 Actually, Weltner’s procedure is not standardized for small gaps. Hence, for the main experiment a different procedure (cf. Fenk & Vanoucek, 1992) with a more global scope is applied.

Résumé

Cet article étudie les deux questions suivantes, étroitement liées: où les dessins "logiques", dits arbitraires et non représentationnels, prennent-ils leur forme ? Et qu’est-ce-qui en fait un instrument cognitif et de communication approprié ? De toute évidence, ces dessins ne représentent pas d’objets visibles et ne peuvent figurer des modèles mentaux invisibles. Les dessins logiques ne peuvent donc pas être classés comme "iconiques", si on considère que le terme iconique est réservé aux cas de similitude établie par imitation ou par simulation du représenté. Il est plus probable qu’il s’agisse de transformations de métaphores spatiales en analogues visuels, mettant en correspondance l’allusion spatiale de la métaphore verbale avec une représentation bidimensionnelle. Cet analogue visuel augmente l’efficacité de la métaphore en tant qu’outil heuristique, fournissant un contrôle visuel de la construction des modèles mentaux. Et pour qui est familier avec la métaphore verbale, l’image arbitraire déterminée par cette métaphore
est, dans une certaine mesure, "auto-explicative". Deux expériences simples, conduites par des étudiants, sont rapportées. Elles montrent l'application de techniques type devinettes pour mesurer l'information qui transite entre texte et dessin. Leurs résultats indiquent en outre que le degré d'amélioration de la compréhension atteint avec le dessin, dépend du succès de la traduction de la métaphore spatiale en illustration.

References


