Can diagrams be useful in second or foreign language learning?

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Abstract: The use of diagrams in second or foreign language instruction is not an obvious matter. There are however problems in grammar that are suitable for diagrammatic representations. One such problem is constituted by the grammar for the use of tense. A few grammar surveys include diagrams to explain this tricky grammar point to foreign learners. In this paper diagrams for tense use in English found in grammar surveys are examined from a semantic theoretic point of view. It is shown that they suffer from several semantic defects, which has an impact on their cognitive properties. After a careful inspection of the elements to be visualized, suggestions for improvement are proposed.

1 Introduction

Learning can take place in several ways. A well-known distinction made is the one between implicit and explicit learning. Implicit learning is acquisition of knowledge by a process which is natural, simple and without conscious operations. Knowledge can also be attained explicitly via given rules or by a process of searching for information, building hypotheses and then testing them (see [10], 1-2). Questions relating to these two types of learning have nowhere been more a matter of debate than in the realm of human language, both in native and second or foreign languages. Some teaching methods, like the ‘audiolingual’ method and more recent ‘natural’ and ‘communicative’ approaches maintain that the learning of second and other languages is just like first language acquisition and as a result have renounced explicit grammar-based instruction. Other teaching methods, like the traditional teaching, are rule-based in that they hold that perception and awareness of rules precede the use of these rules. Educational language practice shows pendulum swings between the implicit and the explicit approaches, and one seems not to be able to say which of these methods is best. There is need for more research.

Both implicit and explicit teaching methods make use of visualizations. In a communicative approach where students are invited to communicate in real world situations, visualization in the form of realistic videos, animations and textbook illustrations are used frequently and generally represent the contextual setting in which the communication takes place. In a more explicit approach where vocabulary and grammar are important learning components, one comes across fewer visual representations and these can be of a different nature. While vocabulary can be supported by representational pictures, grammar surveys make sometimes use of more abstract visual representations. Commonly accepted abstract visual representations are tables and trees, which are used to organize and clarify difficult-to-understand subject matter involving abstract concepts. However the written word is still the most important component of grammar surveys.

According to the literature, external visualizations (on paper or computer screens) can have facilitating effects with respect to communication, instruction and thinking (see [15], [11], [1] among others). As far as instruction is concerned, visual representations,
and in particular diagrammatic ones, can make learning easier. (see [25], [3], [7] among others). Winn [25] has explored research into the ways in which charts, graphs, and diagrams are used in educational materials. Whereas the major function of graphs and charts is to illustrate simple relationships among variables, diagrams can function as abstract descriptions of more or less complex processes and structures. A diagram presents all the main ideas in a piece of information, as well as certain relationships among them, at once. Their spatial nature allows possibilities of communication that are precluded from a purely textual representation. Diagrams have to be understood in terms of how they use sequences and patterns of elements. Certain strengths of learners, such as the ability to recognize geometric shapes and patterns as well as ‘right-brain’ processing can thus be exploited. Diagrams also draw upon more cognitive abilities, such as mental model construction, simultaneous processing, and organization of content. Moreover one other general benefit of visualization is easy recollection. Are these benefits of diagrams exploited in grammar books, and, if they are, are they useful for learning about the grammar point dealt with?

In this paper I will address this question by examining a complex language problem, viz. the rules of tense use in English. Most grammar surveys approach this problem by providing verbal rules illustrated by examples. A few surveys accompany the verbally stated rules with a visual representation. The verbal and diagrammatic representations of three of these grammars have been examined in detail and subjected to a semantic analysis within the framework proposed by Wang (see [22], [23]) for assigning meanings to pictures. The grammar data examined will be sketched in section 2. Section 3 will discuss the analyses of the diagrammatic data and their results. Some severe shortcomings will be pointed out. In section 4, prerequisites for the design of more meaningful diagrams will be presented and some hints will be made as to how foreign learners can take advantage of these diagrams in learning about tense in English. Section 5 will make some general concluding remarks.

2 Tense grammar

The choice of the three grammar surveys examined in more detail has been motivated by the different levels of their target audience, and by the fact that the rules for tense use are represented verbally as well as visually. The grammar surveys examined in detail are Stepping Stones [4], which addresses Dutch learners of English as a second or foreign language at beginner’s level, the Oxford Practice Grammar [8], which is meant for foreign learners at intermediate level, and the Englishpage.com [14], a grammar survey available on the web and whose target groups are intermediate and advanced learners.

In each of the surveys consulted, the sections on verb tenses contain the following clusters of information: (i) the terms used to refer to the different tenses (Simple Present, Past Continuous, Past Perfect, etc.); (ii) the morphology of the tensed verb forms belonging to a specific tense (e.g. Past Continuous is formed by the Simple Past tense form of to be + VERB + ing); (iii) rules how to use the tenses (e.g. the Past Continuous means that at a time in the past we were in the middle of an action (see [8], 20)); (iv) examples to illustrate form and use (e.g. We were waiting in the rain). The grammar rules are presented verbally and supported by visualizations. In the Oxford Practice Grammar, the visualizations consist of pictures that seem to be part of a comic strip. They can be
classified as realistic and representational pictures. They resemble what they stand for and they represent a concrete situation allowing one of the persons depicted utter a sentence in a certain tense. The other two surveys provide simple diagrammatic representations which contain both a time axis, a number of other graphical devices arranged on this axis, and a few labels. In the following, I have excluded the comic-like pictures, as these are not diagrammatic.

Figure 1 shows examples of the diagrams as used in Stepping Stones (left) and the Englishpage.com (right) for the Past Continuous.

Karen arrived

past having tea now future

past Present Future

The verbal rules given for the Past Continuous and going with the diagrams in 1 are the following:

Stepping Stones: Something was happening for some time at a certain moment in the past (translation from Dutch).

Englishpage.com: Use the past continuous to indicate that a longer action in the past was interrupted.

Two examples illustrating these diagrams are:

Stepping Stones: We were having tea when Karen arrived.

Englishpage.com: When the phone rang, she was writing a letter.

The two diagrammatic notational systems are slightly different. They both contain a labeled time axis that goes from the past at the left, via the present in the centre, to the future at the right. The use of shapes, colours, and sizes is different in the two systems. Stepping Stones only uses black crosses and orange rectangles, which can vary in size, depending on the time spans of the events involved. To some of its diagrams it adds labels referring to specific time points or periods, or specific events, that are mentioned in one of the examples added. The rules and the corresponding diagrams are fairly simple. In contrast, the Englishpage.com generally distinguishes several uses for one specific tense. These correspond to different diagrams. The diagrammatic system contains more different shapes. Some shapes always go together, indicating that the combination can be treated as a single shape (see e.g. the dot and the surrounding oval in figures 5 and 6 below). Size is not used as a discriminating attribute. The shapes have different colours, but, as in Stepping Stones, the colours seem to have no other function than distinguishing between the various shapes.

3 Semantic analysis

3.1 Analysis of verbal rules

The grammar surveys differ with respect to the number of different uses they distinguish for a specific tense (the more advanced the level, the more cases are distinguished), but the information given by the rules for the different uses distinguished do not differ much
among the three surveys. At an abstract level they all refer, explicitly or implicitly, to five kinds of information, which is represented in the following table:

<table>
<thead>
<tr>
<th>I</th>
<th>II</th>
<th>III</th>
<th>VI</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Something</td>
<td>happens / does not happen</td>
<td>in the past / present / future</td>
<td>at a time point / in a time interval / over a period of time</td>
<td>once / regularly / always / …</td>
</tr>
</tbody>
</table>

Table 1

Column I contains information about the type of eventuality involved by the tense. A broad range of different terms are used. *Something* and *action* are the terms that are used most frequently. Among the more specific terms used are *state, duration, situation, experience, accomplishment, habit, intention*. II refers to the happening of the eventuality, or the lack of its happening. The verbs *happen* and *occur* are often used, but also so-called aspectual verbs such as *start, continue, and finish*. III locates the eventuality globally on a time line, viz. in the past, present or future. VI situates the eventuality more locally in one of the global intervals. More specific temporal information can be given here. Often the most frequent temporal adverbials characteristic of the tense use explained are added. V indicates the frequency of the eventuality. All rules can be rewritten in this format. Often the rules do not mention explicitly all kinds of information. For instance, the rule given for the Present Perfect Continuous by the *Oxford Practice Grammar*, viz. ‘this tense is used for an action happening over a period of time. The period can last up to the present’, does not fill in explicitly III and V, but can be reformulated as I: *an action* II: *is happening* V: *once* III: *in the past* IV: *over a period of time that can last up to the present.*

### 3.2 Analysis of diagrams

No keys to the graphic symbols are provided in any of the surveys. We can only guess what the diagrams mean. The most obvious link is the one between the diagrams and the abstract verbal rules. When we link the diagrammatic objects to the notions implied by the verbal rules, some undesirable properties emerge for both diagrammatic notational systems. I will show this by referring to the diagrams provided by the Englishpage.com. The diagrams have been analyzed within the theoretical framework proposed by Wang (see [22], [23]).

#### 3.2.1 Semantics of pictures: Wang’s theoretical framework

Wang [22] uses the term visual communication for communication involving the use of visual representations, which he also calls pictures. In his view, visual communication involves three parts:

1. a graphical domain, the pictures,
2. an application domain, the subject matter
3. a link which associates the graphical domain with the application domain

The link in 3 constitutes the semantics of the pictures. Without any link, the pictures are meaningless and only carry spatial information. The link’s function is to transfer spatial information into useful information about the application domain. The link is approached
in two ways, by interpretation, and by picture specification. In the interpretation approach meanings are assigned to each graphical entity explicitly and the semantics of a picture is determined by the meanings of its components, their spatial properties and their spatial relations. In the picture specification approach, meanings are assigned to pictures in an implicit way. Picture classes are described according to the conceptualization of the information in the application domain and the constraints involved.

In order to study the interpretation of pictures, the pictures themselves need to be described carefully. Describing pictures implies the choice of a formal framework for specifying picture description languages and a characterization of what one can ‘see’ in a picture. Order-sorted logical languages are used as languages for describing the pictures. The syntax of an order-sorted language is provided by an order-sorted signature (based on [12]), which generates the expressions of the language. Given a picture description language, pictures get a geometrical characterization. The geometrical information a picture carries is captured by the kinds of graphical objects and properties that occur in the picture and by the properties these objects actually have in the picture. For the first kind of information, Wang introduces the notion of ‘subsignature’, for the second kind the notion of ‘situation over a subsignature’. A situation for a picture contains basic, consistent and maximal information about the properties of the graphical objects occurring in it. So, a picture description language allows one to describe pictures as sets of graphical objects (basic as well as emerging) and spatial properties (including relational ones) of these objects which satisfy certain conditions. These conditions reflect what one can ‘see’ in a picture. According to Wang one can only ‘see’ basic, consistent (pictures do not contain contradictory graphical information) and maximal (pictures give us maximal information about the properties of the graphical objects, there are no concealed properties) facts in a picture.

Interpretation is captured by a generalized notion of renaming. The renaming consists in a mapping from names of graphical objects and their possible properties to those in the representation language of the application domain. This mapping is formalized by a ‘signature morphism’. The same picture can have different meanings. This depends on the interpretation. Circles can be interpreted as sets as in Venn diagrams, but can also be interpreted as cities as in road maps. The meaning of a picture is embedded in its intended use in communication.

In order to show how Wang’s theoretical framework can be used to determine the interpretation of the type of diagrams found in the grammar surveys, I give an example below. The diagram analyzed is given in the picture of table 2 and accompanies the verbal rule given by the Englishpage.com for one of the uses of the Simple Past. The rule says that we use the Simple Past to list a series of completed actions in the past. These actions happen 1st, 2nd, 3rd, 4th… . One of the examples appended is the sentence: I finished work, walked to the beach, and found a nice place to swim. Table 2 further contains the geometrical characterization and a probable interpretation of the diagram. I add the adjective ‘probable’ for no explicit link is given. The interpretation follows the most obvious intention of the grammarians. For the sake of convenience, I only give here those elements that are relevant for the illustration. For instance I have not given the full signature allowing to describe all diagrams given in the Englishpage.com. In the subsignature, I give the class of terms representing the different graphical objects and the sorts they belong to, and the predicate symbols used to construct the sentences which
represent the relations between the graphical objects which we can see in the diagram. Of a situation for the diagram, I only give the basic sentences. I assume that the omitted sentences, indicated by etc., are obvious. In order to give an interpretation of this specific diagram, a representational language for the application domain is needed. The verbal rule is taken as guide. Relevant conceptual information of the kinds indicated by the format given in table 1 above is extracted from it, and the graphical objects and their properties are mapped onto this information.

**Picture: Simple Past**

![Diagram showing three points labeled 1, 2, and 3, with lines indicating past, present, and future]

**Subsignature:**

- Past: LeftHorizontalLine;
- Future: RightHorizontalLine;
- Present: MiddleTJoint;
- in, outside: Cross X LeftHorizontalLine;
  Cross X RightHorizontalLine;
  Cross X MiddleTJoint;
- at_left, at_right: Cross X Cross;

**Basic sentences:**

- in (1, Past); ~outside (1, Past); ~in (1, Present); outside (1, Present); ~in (1, Future);
- outside (1, Future); in (2, Past), etc.; in (3, Past), etc.;
- at_left (1, 2); ~at_right (1, 2); at_left (1, 3); ~at_right (1, 3);
- at_right (2, 1); ~at_left (2, 1); at_left (2, 3); ~at_right (2, 3);
- at_right (3, 1); ~at_left (3, 1); at_right (3, 2); ~at_left (3, 2);

**Interpretation:**

- [ Cross ] = completed action; [ 1 ] = completed action 1; [ 2 ] = completed action 2; etc.
- [ Past ] = past; [ Present ] = now; [ Future ] = future;
- [ in (1, Past) ] = completed action 1 happens in the past;
- [ outside (1, Present) ] = completed action 1 does not happen in the present; etc.
- [ in (2, Past) ] = completed action 2 happens in the past; etc.
- [ at_left (1, 2) ] = completed action 1 happens before completed action 2;
- [ ~at_right (1, 2) ] = completed action 1 does not happen after completed action 2; etc.
- [ at_right (3, 1) ] = completed action 2 happens before completed action 3; etc.

**Table 2**

The description of the components of the graphical domain and their links to concepts in the application domain allows us to say what the diagram means. In the above case, the diagram ‘tells’ us that there are three completed actions that happen in the past one after the other.
The kind of information in the application domain often determines the construction of the pictures. Concepts that are important to distinguish in the application domain are related to specific configurations of picture elements. The structure of the pictures conveys meanings in an implicit way. Picture specification techniques allow certain types of pictures to be organized together to represent a class of objects in the application domain. Wang develops a new method for picture specifications. Its theoretical foundations are given by a type-theoretic framework which provides a rich specification language with abstraction mechanisms by means of which classes of pictures with sophisticated structure can be specified in a clear and natural way. The picture specification language allows to describe so-called ‘pictorial concepts’, which are a class of pictures and a set of attributes defined over this class. The language allows to specify a pictorial concept by a picture type and the constraints of the concept. The description of such a concept generally consists of a class name, its components and the constraints put on the properties of these components. Picture specifications are especially useful in design. They can be used to check whether or not a certain picture is allowed as a possible design. To illustrate the semantics of tense diagrams by specification, I consider the \textit{Simple Present}. Figure 2 shows the three diagrams visualizing the three uses of this tense distinguished by the Englishpage.com.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure2.png}
\caption{\textit{Simple Present}}
\end{figure}

A possible picture specification for this class of pictures representing the tense concept of ‘Simple Present’ could be the following:

\begin{itemize}
\item \textbf{Class Name:} \textit{Simple Present}
\item \textbf{Components:} \hspace{0.5cm} Eventuality: Ext(List(Cross), Seq) \hspace{0.5cm} \hspace{0.5cm} HorizontalLine \hspace{0.5cm} \hspace{0.5cm} Arc
\hspace{1cm} Present: MiddleTJoint
\item \textbf{Constraints:} \hspace{0.5cm} Eventuality and Present overlap
\end{itemize}

In order to specify the series of crosses, some of the possible operations on pictorial concepts are used. ‘List(Cross)’ specifies a class of pictures consisting of an arbitrary number of crosses. ‘Ext’ extends this new pictorial concept with the constraint that these crosses should be put into a sequence (hence the predicate ‘Seq’). \(\oplus\) indicates that the eventuality component is represented either by a sequence of crosses, a horizontal line or an arc.

Having specified this class \textit{Simple Present}, it is easy to see whether or not a diagram is an object in this class. The picture in table 2 above of the 2\textsuperscript{nd} use of the \textit{Simple Past} clearly will not belong to this class. Unfortunately one of the diagrams representing the \textit{Present Continuous} will. On the other hand, the diagram components might be manipulated. For instance, we can drag the horizontal line to the right. As long as it will overlap with the present, the diagram will belong to the class.
Assigning meanings to pictures by interpretations is more general than assigning meanings by picture specifications. In fact, picture specification can be viewed as a special case of interpretation.

### 3.2.2 Results
Attempts have been made to assign meanings to the diagrams provided by the grammar surveys by interpretation as well as by specification. These attempts fail, even when the first obstacles are removed by making some assumptions. One of the obstacles is constituted by the lack of an explicit link between the graphical domain (the diagrams) and the application domain (the tense system of English). I have assumed that the graphical elements of the diagram correspond to the concepts referred to in the verbal rules. The uncertainty about the basic or composed nature of some graphical objects constitutes another obstacle. I have assumed that certain graphical objects that look as if they are composed of more elementary picture objects are basic. In this decision, the concepts in the application domain served as a guide. The other way round, I have split up the object corresponding to the time line in three basic graphical objects. However, even when the above assumptions are made we get into trouble, in whatever way we try to assign meanings to the diagrams: by interpretation or by specification.

If we try to interpret the diagrams, we observe that they fail to be syntactically correct. Syntactic correctness means that the interpretation is such that terms and properties of graphical objects are mapped to application domain objects and properties by functions that are domain-preserving. For instance, it is syntactically incorrect when a graphical object in one diagram corresponds to one domain object, while the same graphical object corresponds to another domain object when occurring in another diagram. Vice versa, it is incorrect when one domain object gets different visual representations in the diagrams. To see that this is exactly what happens in the set of diagrams of the Englishpage.com, let us take a look at the diagrams belonging to the Simple Past and the Past Continuous (see figures 3 and 4 below). It is assumed that ‘action’, ‘habit’, ‘repetition’, ‘duration’ are all different concepts of the application domain. It can be observed that a series of crosses corresponds to a habit in one diagram, and to a repetition in another. The other way round, a horizontal line corresponds to an action in one diagram, in another an action is visualized as a cross, in yet another as an arc. Notice that in figures 3 and 4 there are two identical diagrams associated to two different tenses and where the sequences of crosses correspond to different concepts in the application domain.

![Figure 3: Simple Past](Image)
It might be the case that assigning meaning to the diagrams by diagram specification is more successful, and that the diagrams should be used as specifications of the crucial tense concepts. Let us examine the diagrams given for the Present Perfect and the Past Perfect in figures 5 and 6. We would like to find something which all these diagrams have in common in order to be able to specify a pictorial concept of ‘Perfect Tense’, which is an important notion to learn about when tense use is under discussion. This would be possible when in the diagram for the 3rd use (specific times, see [14]) of the Past Perfect, the two crosses touch each other, for then the fact that two basic graphical objects abut on each other would be the characterizing constraint on this concept. Unfortunately, in this case and in other cases (e.g. the Continuous Tenses), no characteristic patterns can be associated to relevant concepts in the application domain.

3.3 Conclusion so far
As there is not (yet) a standard notational system for representing linguistic tense issues diagrammatically, the diagrams one comes across in grammar surveys have been designed differently. More seriously, the various attempts made fail to do this job properly. The lack of a clear link between the graphical domain and the application domain jeopardizes the assignment of meaning to them. This makes that the diagrams are in fact meaningless. Yet, we can think of how they are intended to be used, especially when we consider the verbal rules and the examples as well. An implicit link can be established between the representing diagrams and the problem represented. When we take all graphics involved in all tense use representing diagrams as belonging to the same graphical signature, we find that the diagrams fail to be syntactically correct. This causes confusion and can lead to mistakes in learning about the different tenses. For example, the sequence of crosses located on the left horizontal line of the time axis can be interpreted as a habit in the past (figure 3), but can then be wrongly associated with the Past Continuous (figure 4), and thus with the incorrect morphology on the verb. The
syntactic incorrectness can have effects on the semantic correctness. All three semantic properties distinguished by Wang [22], viz. consistency, soundness, and conservativity, risk to be affected by the syntactic incorrectness. For instance, interpretations may become inconsistent. In one of the Simple Present diagrams (see figure 2), the horizontal line represents a fact or generalization in the application domain. In one of the diagrams of the Past Continuous (see figure 4), the two horizontal lines located on the left horizontal line might get therefore the interpretation that two facts were true in the past, but this is not the intended interpretation in view of the corresponding verbal representation, which tells about the application domain that two actions were happening in the past at the same time.

When the specification relation between the diagrams and the world they represent is considered, it can be noticed that it is not easy to find characteristic patterns of graphical elements corresponding to crucial notions in the application domain. Such patterns would be very helpful in learning, for they can be easily recollected. The more the specification of a concept in the application domain is constrained, the easier the concept is understood and applied. The attempts to interpret the diagrams by specification lead to rather unconstrained specifications of tense concepts that are crucial, though difficult, for the learning about tense use. Stenning and Inder (see [21]) use semantic concepts involved in the analysis of visual representations to predict their cognitive properties. They show that the more the representational systems are constrained, the less expressive they are, but the more the systems are computationally tractable. So easy tractability, one of the benefits of diagrams, is affected as well by the diagram systems of the tense grammars examined. The conclusions of the diagram analyses seem to call into question the initial assumption that grammar problems such as the use of tenses are suitable for getting a diagrammatic representation. A more rigorous inspection of the tense grammar problem as presented in the grammar surveys consulted might throw some light on this point. According to me, the critical information is the information referred to in the verbal rules, which explain, from a traditional view, how the English tense system works. The rules only imply linguistic conceptual knowledge. They bother less with linguistic procedural information, as they focus on single tensed sentences instead of sequences of tensed sentences (tensed discourse). Non-linguistic, contextual, information (such as natural causal relations between eventualities) is not considered at all. Yet all these kinds of information influence the interpretation of tensed sentences (see [18], [19]). Contextual information can override the rule of the Simple Past, as represented in the picture of table 2 (see e.g. Jane cried. Henry hit her). The critical information addressed in the surveys thus seems to be limited, but well delimited.

Regarding the elements of the critical information, one observes that the main components are abstract concepts denoted by terms such as action, present, time period, and relational notions as expressed verbally by before then, at a time in the past, at this very moment, up until now. The terminology as used in the grammar surveys consulted is a doubtful point, especially with respect to the information about the eventuality described by a tensed sentence. The analysis of the verbal rules shows that a broad range of general and more specific terms are used to refer to eventualities described by tensed sentences (ranging from ‘something’ to ‘feeling’). What does that mean? Should we take all these different terms to correspond to different concepts in the application domain, or are we supposed to relate them to a restricted set of basic concepts, which are each
referred to by different terms? Clues are not given, but might be derived from the diagrams, but since these are difficult to interpret, it does not bring us any further. A more accurate and systematic analysis of the critical information is required to make the problem more appropriate for more useful diagrammatic representation.

4 Towards more meaningful tense diagrams

4.1 Application domain

The semantic analyses of the existing diagrams have shown some defects. It is hypothesized that they can be improved on by structuring the application domain, constituted by the tense grammar problem, in a more accurate way. Natural language tense has received considerable attention in linguistics and logical semantics. It is a well-known complex issue that involves not only temporal factors but also aspectual ones. Existing theories might well lend a hand in ordering the application domain so that it contain clearly defined objects, properties and relations. For the purpose of illustration, I have adopted the view of Kamp and Reyle (see [13]) on tense and aspect. Kamp and Reyle take natural language interpretation as the process by which humans determine what the sentences they hear or read mean. Interpretations of sentences and texts are constructed in the form of abstract structures, so-called Discourse Representation Structures (DRSs), obtained by construction rules that not only look at a sentence in isolation and its components but also at previous DRSs. Kamp and Reyle propose DRSs and an interpretation model to account for tensed discourse. These DRSs represent the particular mechanisms which natural language exploits in order to convey the complex temporal information that is within its power to express. An interpretation model models the temporal structure of the world. Both problems, representing temporal information and modelling temporal structure, are very complicated. DRSs that represent tensed discourse account for the semantics of tensed sentences including the phenomenon that these sentences are interpreted as temporally related to previous sentences. While the grammar surveys examined generally focus on single sentences, Kamp and Reyle’s DRSs focus on discourse and represent linguistic conceptual and procedural information. Kamp and Reyle’s approach does not commit us to view time structures in a special way: we can stick to models based on linear time structure.

According to Kamp and Reyle, event-based semantics is the type of semantics tensed sentences need, despite the ill- or undefined ontological category of event. In the DRSs events and states are adopted as irreducible semantic entities. Notice that the grammar surveys also imply such semantic entities, viz. when they talk about action, duration, experience, process, etc. No clear criteria are used by the grammars, while Kamp and Reyle rely on linguistic information to distinguish events and states. The fact is that natural language enables us to conceptualize the same bit of reality either as an event or a state. Henry walked downstairs is an event-describing sentence, Henry was

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1 I could have used other approaches as well. For instance ter Meulen’s view on temporal meaning in texts (see [17]) is an interesting one, especially as she introduces so-called Dynamic Aspect Trees, representing temporal dependencies in English texts. The option of Kamp and Reyle is motivated by the fact that they supply critical information appropriate to be visualized by diagrams comparable to the ones analyzed above. Ter Meulen offers tree diagrams. Which diagrams are more effective for learning about tense is an interesting subsequent question to investigate.
walking downstairs a state-describing one. The former sentence describes a completed activity and involves a change. At the start of the walking activity Henry is upstairs, at the end he is downstairs. In the latter the activity of walking is viewed from the inside. To make things more clear and explicit Kamp and Reyle distinguish tense and aspect as two different classifying properties of tensed sentences. Aspectual properties refer to the stages an eventuality can be in. These stages are preparatory state, culmination point, and result state. Sentences involving continuous (progressive) or perfect tenses are treated as containing aspectual operators.

Both event- and state-describing sentences describe some eventuality, the temporal location of which is indicated by the tense of the verb as well as, perhaps, by other devices of temporal reference such as temporal adverbials. As a first approximation, a sentence in the past tense locates the eventuality it describes in the past, i.e. before the utterance time, sentences in the future tense serve to describe eventualities later than the time of utterance, and a present tense sentence is typically used to present a condition as holding over some period which surrounds the utterance. Events are always included into their location time, states either include or overlap with their location time.

My proposal is to base diagrams on the temporal and aspectual information as represented in Kamp and Reyle’s DRSs. Diagrams thus represent linguistic semantic time-related entities as expressible by natural language. The application domain to be linked to the diagrammatic components contains at least events e, states s and times t. Of particular interest are the two-place predicates applied to events, states and/or times: precedence, overlap, abut and inclusion.

4.2 Graphical domain
The graphical domain can be taken to contain elements that belong to the visual forms as viewed in the context of information visualization. Structured data are mapped to visual structures, which “augment a spatial substrate with marks and graphical properties to encode information” (see [6], 23). As spatial substrate, an ordinal axis will be used to represent time regions, and spatial position on this axis will be used to represent eventualities (states and events) and times. Alignment, barely used in the diagrams analyzed, expresses the order of the eventualities as presented in the discourse. With respect to marks, a left and a right horizontal line and a T-joint represent the time axis, circles are used for events and rectangles for states. Circles with dotted lines are extended events, i.e. events seen from the inside. Rectangles can be unbounded at the two sides, in order to indicate the incompletely character this eventuality can have. This will be indicated by dotted lines. Vertical lines mark times. These latter marks are not used when the corresponding domain objects are left unspecified in the discourse. As far as the marks’ graphical properties are concerned, color will not be used in this paper, but can serve to differentiate between states and events on the one hand, and between different states and different events on the other hand. Including text and labels can be a good idea as it can have an explanatory function, add information, and reinforce memory for the concept (see [16]).

Figure 7 shows examples of diagrams based on Kamp and Reyle [13] and the choices made above with respect to the graphical domain. The left diagram visualizes a discourse consisting of two sentences in the Simple Past, the right one a discourse consisting of a sentence in the Simple Past, and followed by one in the Past Perfect. The
former can be exemplified by S1: A bomb exploded. S2: Henry ran downstairs, the latter by S1: Henry ran downstairs. S2: A bomb had exploded.

4.3 Learning tasks

With respect to the learning of tense grammar, two global learning tasks can be discerned: comprehension of the temporal and aspectual structure of a discourse and production of correct tensed discourses. Visual communicative forms related to interpretation such as illustration, demonstration and reasoning (see [21]), seem to be fit to comprehension tasks. For instance to illustrate the difference between the Simple Present (She reads the Woman’s Weekly) and the Present Continuous (She was reading the Woman’s Weekly), the left and right diagrams in figure 8 can be used respectively.

One often comes across tense exercises of the following form: When Claire arrived, Henry was walking up and down. Which started earlier, Claire’s arrival, or Henry’s walking? (example taken from [8]). By drawing a diagram, one can quickly come to the conclusion that Henry’s walking started earlier than Claire’s arrival.

On the other hand geometrical constraint maintenance, a form of visual communication related to specification, can make important temporal and aspectual concepts clear. For instance a diagram visualizing a perfect tense should always have an event touch a (result) state.

5 Conclusion

Grammar problems that require abstract notions and properties to allow a learner to learn about them seem to be suitable for diagrammatic representations. A well delimited and structured application domain is however a prerequisite for the design of diagrams with potential beneficial effects for learning. As far as the main characteristics of visual representations in general are concerned (see [20]), tense diagrams, like the ones proposed in the previous section, can support learning tasks, as they provide for free rides (one can see the order of occurrence of the eventualities referred to in the discourse at once), can reveal unacceptable discourse easily (Peter was now in the kitchen has no diagrammatic representation), and can allow for semantic derivations such as the number of events preceding or following some particular event, or whether there are overlapping
eventualities or not. There is however one characteristic, viz. specificity, that throws a spanner in the works. The relations between eventualities are sometimes too abstract to allow for just one expression in the diagram. For instance when two states s1 and s2 overlap, a diagram of the proposed type will not allow us to remain unclear about the exact configuration of the s1 and s2: does s1 starts before s2, or the other way round? When learning tasks involve the capturing of such ambiguities, the diagrams are too constrained, and should be replaced by more expressive representational systems.

References