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Recalling and Summarizing Complex Discourse

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Abstract

In this paper we investigate the properties of complex semantic information processing involved in the comprehension, (re-)production and summarizing of longer narrative discourse. In the theoretical sections it is argued, with reference to earlier work in text grammar, text logic, action logic and their applications in narrative theory, that the processing of complex longer discourses cannot only be accounted for in terms of the sequence of propositions underlying the text (i.e. the text-base). What is further required is a macro-structural component, specifying global structures of the discourse, and the mapping rules relating these with the *sequence* of propositions of the text. These macro-rules are operations of semantic information reduction (deletion,

generalization, combination) applying under the specific constraints of action- and narrative-theoretical categories. It is assumed that what is 'best' stored in memory of a longer discourse is essentially its macro-structure. The macro-rules predict which sentences are recalled or forgotten and used or not used in summaries.

Seven informal and preliminary recall and summary experiments were carried out in order to collect some illustrative data. The theoretical predictions turned out to be correct. More in particular it was found that delayed (one-week) recall protocols are similar in content and structure with immediate summaries of the Boccaccio story which was used. Second order summaries, produced after summaries of segments of the story, are significantly shorter than direct summaries. Finally, some interactions between a given summary and the story it summarizes are studied.

1. Introduction *

1.1. In this paper a number of experiments will be described carried out in order to get some preliminary data about recalls and summaries of complex narrative discourse. Subjects of various groups, in different conditions, were asked to reproduce or summarize a four page (1680 word) story from Boccaccio's *Decameron*.

The experiments and their evaluation had an informal, exploratory character. Conditions have not been precisely controlled, the scoring analyses were rough, and no serious statistical account has been given.

The major aim of the experiments was to acquire sets of protocols as a first data base for descriptive and theoretical model construction about the processing of relatively long texts. Second, the experiments were set up in order to have a first impression of the tendencies in theoretically predicted semantic behavior.

More in particular, the relations were studied between recalls and summaries of a story, against the background of the hypothesis that both depend on the construction of semantic macro-structures.

1.2. Experimental work with complex materials such as longer stories or scientific texts is not new in psychology, and has been carried out already before the well-known recall experiments of Bartlett (1932). Still, only in recent years psychologists and psycho-linguists have gradually extended their

The experiments reponed below have been carried out with the help of the members of a seminar on the Psychology of Narrative, viz. Marjolein Aalders, Michel Barends, Henk Claassen, Wim van Gaal, Hans Geels, Jolanda Goedheer, Peter Lust, Hans Luyendijk. These were students of theoretical poetics, without previous training in cognitive experimental psychology, although in the seminar they were introduced into the major issues involved in experimental work on textual material. This paper was written in spring 1975.

'domain' from words (word lists), syntactic structures and semantic structures of sentences to structures underlying texts. Although much of this work on cognition and discourse remains within either the classical verbal learning tradition or within the syntactic chomskyan paradigm, essentially concerned with sentences or clauses, there has been a tendency towards more

■ course the processing of sentences/clauses as propositions is basic also for discourse comprehension, the processing of complex verbal discourse requires additional rules and strategies.¹

All this work will not be commented upon here. We may merely refer to recent work by Kintsch (1974), with whom we share much of our theoretical orientation, and Meyer (1974) who was one of the first psychologists having paid large attention to over-all structures of discourse, and their effect on recall. For references to other work, the reader is referred to these two books and to other theoretical papers now in preparation.

1.3. Finally, this paper will bring only a fragment of the theoretical background of the experiments. Part of this background has been our earlier work on text grammars and text logics, the logic of action, and their applications in a theory of narrative.² One of the crucial ideas in that work has been the assumption about a separate level of description for complex discourse, viz. a level of 'macro-structures', to be distinguished from the sequential level of sentences and propositions of the discourse (the 'micro-structure'). Arguments in favor of macro-structure were in part based on intuitive and experimental psychological facts, but a serious formal model could not be given so that linguists were reluctant to admit such an additional semantic level into the grammar. In the meantime we know a little bit more about macro-structures and macro-rules, and the experiments reported here, as well as other work in recent cognitive psychology and artificial intelligence, seem to confirm the original hypotheses about the relevance of macro-structures in models of semantic memory and information processing.

The theory of macro-structures is intended as a partial formalization of earlier psychological ideas about 'schemes', 'themes', 'plan' or 'frames', and does not only apply to verbal information processing but also to other complex cognitive abilities.

This insight appears only in a few experimental papers using discourse material, e.g. Kintsch (1975) and Rumelhart (1974). The majority of studies test recall for 'ideas', 'concepts' or 'propositions' from discourse, using linear, sentence/sequence based models.

² See van Dijk (1972, 1973 a, 1974 a, b, c, 1975). This work must be seen against the background of text-grammatical work in general, extensively referred to in the book and papers mentioned. For a bibliography, see Dressler & Schmidt (1973). For some further papers and references, see Petőfi & Rieser (eds.) (1973). For illustration of various approaches to one narrative text, see van Dijk & Petőfi, eds. (1977).

Work on the structural analysis of narrative is too abundant to refer to here. Meyer (1975) is one of the psychologists briefly discussing it. See also references in van Dijk (1972, 1974 a).

2. *The Structures of Discourse*

2.1. The relevance of the theoretical background briefly to be sketched here is based on the assumption that verbal behavior exhibited in recall and summary experiments depends on the subject's assignment of specific structures to the input materials. This very global assumption has been confirmed in all kinds of tests with words, syntactic structures and semantic representations. Most of the current linguistic and logical grammars and the cognitive models of which they form the abstract core are able to predict many of the phenomena of these input-output dependencies.

The range of problems at issue here is somewhat more complex however. Subjects being presented with a text of more than half a page (say 200 words) are known to be unable to reproduce the text verbatim — in normal circumstances, e.g. after one presentation — nor are they able to reproduce all the propositions of the text. In the recall protocols part of the propositions are 'forgotten', whereas others are 'combined' into one proposition. Now, it does not seem easy to predict such behavior by simply looking at the semantic (let alone syntactic) structure of the individual sentences or clauses of the input text. Hence, recall must be a function of the 'position' of the individual clauses/propositions with respect to other clauses/propositions. (Since it has been shown that memory for sentences is essentially semantic, we will without further arguments use the term 'proposition', neglecting syntactic and morphological surface structures of the discourse, even if it is true that under specific conditions we may recall certain 'stylistic' aspects of surface structure, a phenomenon well-known in literary communication.)

2.2. The question then arises in what terms these relationships between propositions in a discourse should be described, such that valid predictions can be derived for such different verbal performances as recall, recognition, summarizing, question answering, commenting, argumentation, etc. with respect to a given text.

At one level of description, a discourse is an ordered n-tuple of propositions (which may be mapped onto various 'synonymous' sequences of syntactic and morphological sentence structures). Since not any n-tuple of propositions can underlie an acceptable discourse, there are a number of semantic and logical constraints on this sequence of propositions (which we shall call, with Petőfi and Kintsch, a 'text base').³

The semantic well-formedness, i.e. the coherence, of a textbase does not only depend on general semantic or logical conditions, but also on features of the context, such as the knowledge of the speaker about particular facts of

³ For the notion of 'text base', see Kintsch (1974), and Petőfi (1973), although the notion in Petőfi's work is more technical.

possible worlds, including those of the actual speech context (knowledge of the hearer). We will here abstract from these contextual features.⁴

Natural language discourse is fragmentary, and so is its underlying text base: many of the propositions which would be necessary to define the text-base as coherent remain 'implicit'. That is, they are implied/presupposed by other propositions of the text-base or by the context of utterance. It seems important, therefore, to distinguish between the actual, implicit, text base (ITB) and the explicit, theoretically constructed text-base (ETB), which fully specifies all semantic information defining its coherence.

We assume that the Explicit Text-Base semantically implies the Implicit Text-Base, but not necessarily the converse. This means that an ITB may be ambiguous or 'vague', which is not the case for an ETB, which defines just one 'reading' of the text. The rules underlying the mapping of ETB's on to ITB's will not be discussed here. Formally, they are based on relations of semantic entailment of various strengths (from 'necessary' to 'possible'), to be interpreted in a suitable logical semantics. Cognitively, the rules are based on shared implications in the propositional knowledge structure of the speech participants. Note, that the Explicit Text-Base is also necessary in order to account for certain surface phenomena (e.g. the use of definite anides in noun phrases referring to things which have not yet been explicitly 'introduced' into the discourse-world with an indefinite noun phrase). For practical reasons, most descriptions of text-bases in linguistics and psychology (e.g. in Kintsch, 1974) are of the implicit type. A fully explicit text-base would consist of a sequence of rather complex 'proofs', demonstrating the connection of a given proposition (e.g. those of the implicit text-base) with previous, or sometimes following, propositions. An ETB is formally coherent iff all these 'proofs' (which are both deductive and inductive) are correct according to the admitted rules of semantic connection.⁵

Well-known in this set of rules is the condition of (referential) identity.

⁴ For a discussion about the textual and contextual notions of coherence, see van Dijk (1973 b, 1974d, e), and references given there. Part of the conditions involved are formally equivalent, when previous discourse is 'contextualized' by considering it as a sequence of utterances of previous sentences. In that case, we would reduce a pragmatic, i.e. context sensitive, text grammar, to a context sensitive sentence grammar, a reduction which however, can be shown to be inadmissible for formal and empirical reasons. By 'context' we here understand a subset of properties of the psycho-social 'situation' in which a text is produced and interpreted, viz. those properties determining structure and interpretation on the one hand and the function, in the speech act sequence or course of conversation, of the text, on the other hand.

⁵ A more or less formal treatment of text-bases as a sequence of 'proofs', comparable with the set of proofs of theorems in formal systems, had been given in van Dijk (1973 a) and is further discussed in van Dijk (1974c). This analogy must be seen against the background of the notion of 'derivation', both in logic and in grammar. I.e. a sentence/ proposition, may be derived ('proved') in a discourse, if the derivation rules are correct and correctly applied and if the axioms and previous theorems (sentences) are correct, viz. true. An idea of how complex an explicit text base should be in order to demonstrate coherence, has been given by Charniak (1972).

However, this condition is neither sufficient nor necessary (at least in the way as it is usually formulated). There need not be argument (or predicate) identity in subsequent propositions. The major condition, in fact, should not be given in terms of the structure of the proposition 'itself', but in terms of the connection(s) *between* the *facts* denoted by subsequent propositions. That is, a text base is (linearly) coherent iff each proposition is connected with at least one other proposition, where propositions are connected iff their values (the facts they refer to, in some possible world) are conditional for each other along a scale of varying strictness (from necessary to possible).⁶ Again, this formal definition is to be embedded in a more embracing definition taking into account pragmatic (social and psychological) features: the connection must exist for-some-speaker-in-a-given-context, and under the constraints of general features of convention for knowledge and assumptions shared by a group.

As we may easily see from coherent discourses as 'It has been raining. The grass is green', neither predicate (lexical) nor argument (referential) identity is required, merely a connection, e.g. of cause, between facts denoted by the propositions. This connection may be expressed by connectives (*and, but, so, ...*) of various categories, by nouns, verbs and adverbs, and by syntactic and phonological structures.

These few remarks about text-bases are intended to correct too simplified models of discourse, used for practical purposes in experiments. A satisfactory description of text-bases requires a suitable formal language (e.g. an extended — and often rather modified — modal predicate calculus, or algebraic or topological systems) with an appropriate semantics. At this level we may define specific 'model structures' (or 'frames' in the logical sense) for discourse. A discourse is coherent or interpretable if it can be true or false (or in general: can be satisfied) in a specific 'structure of model structures' or discourse model structure, in which possible worlds, facts, time/place individuals and properties are related in a specific way, not to be spelled out here.⁷

⁶ For a discussion about the notion of semantic implication or entailment, see van Dijk (1974 c) in which further references to logical and philosophical work on entailment and connectives in general are given.

The problems involved are rather technical and need not further be discussed here. One of the issues is whether entailment should be formalized in terms of the (material) conditional + a necessity operator, or whether it should be defined in terms of intensional (meaning) relations between propositions, at least in order to account for semantic implications in natural language. The whole discussion, although primarily about conditionals/implications of various sorts, also touches the properties of other connectives in logic and natural language, and the necessity to provide a serious semantics for them. See the contributions in Leblanc, ed. (1973) and Anderson & Belnap (1975).

Our assumption will be that all natural connectives are of the 'conditional' type (even conjunctions), but varying in strictness from possibility (compatibility), via probability or likeliness to various sorts of (logical, physical, biological and psychological) necessity.

⁷ For the notion of a logical model and model-structure, see Hughes and Cresswell (1972). A model-structure or frame is, roughly speaking, a very abstract representation of the 'universe of discourse', defined by an ordered n-tuple of a set of possible worlds, a set of individuals, some

2.3. Although there are considerable problems, both linguistic/logical and psychological, involved in the precise account of this level of description, viz. of the linear relations between propositions or sentences in a discourse, the sketch given above is rather straightforward.⁸

Experiments may be carried out in order to acquire more insight into the cognitive processes relating ITB and ETB, and those relating both with surface structures: what propositions are minimally required to produce an acceptable discourse in a given context, at what level of 'explicitness' do discourses become unnaturally trivial, what are the differences in comprehension (qualitatively and quantitatively) if numbers of propositions per sentence vary, if propositions vary in their position — as clauses — in the hierarchical structure, etc.? (see Kintsch, 1974, for a number of such experiments).

It is our contention, however, that the theoretical models referred to above are inadequate to account for the processes underlying the production and comprehension, as well as storage, retrieval, etc. of discourse. They do not predict which propositions of a discourse will have low or high probability of being recalled in reproduction or used in a summary, nor do they explain how propositions may be 'recalled' which are not part of the (implicit) text-base of the input text. More in general they do not even explain how subjects are able to recall a substantial amount (up to 50%) of the propositions of the text, whereas much less is recalled of a random list of propositions, and how subjects are able to make a summary at all.

What may be predicted are some recency effects (more propositions are sometimes recalled from the end of the story, but only after immediate reproduction) and perhaps a preferred selection of those propositions which are semantically 'predominant', as defined in terms of the number of propositions with which they are connected. The latter approach, however, is only partially valid, and merely indicates more important underlying regularities: the 'importance' of propositions in a discourse is not to be determined quantitatively but qualitatively, i.e. in terms of the structure in which these proposi-

relations defined over possible worlds, e.g. accessibility, and possibly further 'indices', defining the context. A formal language, viz. its sentences, are interpreted, by a valuation function, in such model-structures.

Most, if not all, work in linguistic and above all cognitive semantics, is of the intensional or 'conceptual' kind, ignoring logical (referential) semantics. A serious definition of all 'formal' models used in cognitive psychology and artificial intelligence, however, is only possible in terms of such logical semantics. For the use of formal semantics in the study of natural language, see Cresswell (1973) and Hintikka, Moravcsik & Suppes (eds.) (1973).

⁸ For details about the use of these propositional models in the study of memory, see Anderson & Bower (1973), Kintsch (1974), and Frederiksen (1974a), where further references are given. In our discussion we have neglected the internal structure of propositions, e.g. in terms of case relations. These will play no role in our analysis of the experimental protocols (although they should have).

It should be noted that since there is not yet an adequate formal semantics of case relations, all models using them can only be semi-formal.

tions occur. This means that the linear text-base should be assigned a *hierarchical* structure, such that, for example, propositions 'high' in the structure are more likely to be recalled than those 'low' in the structure. Meyer (1974), borrowing rules and categories from Grimes (1972) in order to specify such a hierarchical structure of discourse, has carried out experiments which confirm this hypothesis. In her system, propositions, which have the usual case structure, are related hierarchically by rhetorical relations, such as 'attribution', 'specific', 'mame?', 'setting' (time, location, trajectory), etc. Although there are no explicit rules defining the hierarchical structure, it is assumed that a proposition providing e.g. an 'attribution' of a thing is dominated by the proposition introducing this thing; similarly between event and location in time and place of the event.

This approach is certainly a large step in the right direction. Yet, it has a number of crucial and marginal deficiencies which do not seem easily overcome in the system as it stands:

- (i) there are no explicit rules and conditions determining formally when a proposition is in 'attribution', 'specific', etc. relation with another proposition;
- (ii) it is not clear in what respect the relations hold between propositions or only parts of them;
- (iii) the categories used are not homogeneous, e.g. 'attribution' seems to range over individuals, 'explanation' over (sets of) propositions, and 'setting' over events or facts.

These are methodological objections, but there are also a number of empirical problems. Assuming we would have rules assigning a proposition its place in the hierarchical structure, we would indeed have a basis for prediction in some verbal tasks. The system does not seem to fit the following facts, however:

- (iv) differences in recall for propositions at the same level in the structure, based on other semantic criteria of 'importance';
- (v) the structure of recall protocols, and a fortiori the structure of summaries, contains propositions which do not occur in the original text, e.g. paraphrases, generalizations and 'combinations' of several propositions from the text.

Apparently, processing complex discourse not only involves the assignment of hierarchical structure to the sequence of propositions, but also other operations. It does not seem likely that lower level propositions are simply 'forgotten' (whatever the precise cognitive process of 'forgetting' may be), but rather 'actively' deleted on the one hand and 'integrated' with other low level propositions into higher level propositions. We would in that case need a system in which the operations directly connects, a proposition to a higher level node by substitution of a more detailed' hierarchical structure of propositions. In Meyer's examples it is a coincidence that there are propositions in the text

itself which have this 'higher order' function, but this need not be the case at all. Let us therefore briefly sketch a theoretical approach which would also be able to cope with this and other difficulties.

3. *Macro-structures*

3.1. It seems an established fact that discourses in natural language have conventional, rule governed structures going beyond those of sentences or relations between sentences. The global structure of a psychological article has often been given as an example in case. More natural examples are the structure of (everyday) narratives, arguments and descriptions. Similarly, a formal proof is an ordered pair of a set of premises and a conclusion. The rhetorical categories of Grimes and Meyer like 'question' (or 'problem') and 'answer' ('solution') may be interpreted as labels for such macro-categories. Similarly, we may distinguish narrative macro-categories as those of Labov & Waletzky (1967): 'Introduction', 'Complication', 'Resolution', 'Evaluation', 'Coda', in this order. Variants, and further detailed macro-categories, exist in the literature on narrative structure.⁹

Characteristic of such categories is that they dominate (ordered) sets of sentences or propositions. These sets may vary in size: two stories may have the same macro-structure but greatly differ in length. The macro-structure does not seem to be always linear (like premises and conclusion, say). The 'Evaluation' in a story is given with respect to both 'Complication' and 'Resolution' and hence should be situated at a higher level, e.g. at a level 'Episode' dominating 'Complication' and 'Resolution'. Finally, it should be stressed that the categories involved do not appear to be 'linguistic' in the strict sense, i.e. they are not general structural categories holding for any discourse. Different types of discourse seem to have their own (conventional) macro-categories.

3.2. Whatever the precise formal structure of macro-structures may be, there are a number of cognitive considerations to be taken into account first.

Strictly speaking, a definite hierarchical structure may be assigned to a discourse sequence of propositions only after processing of the last propositions. For long discourses this would mean that all other propositions are kept

⁹ See note 2. The categories mentioned here are 'relational'. The structural analysis of narrative has mainly worked with 'content categories' or 'functions', as they have first been introduced by Propp (1958). Functions of this sort are for example 'departure of the hero', 'reward', etc. We did not give an analysis of the Boccaccio story in these terms. For a structural analysis of the *Decameron* stories, see Todorov (1969) and references given there.

For a discussion in English — much of the work is in French, e.g. Bremond (1973) — see, e.g. Lakoff (1972), Colby (1973).

The relational categories, e.g. those used by Labov & Waletzky (1967), seem to have more fundamental cognitive implications. For a definition in terms of action logic of these categories, see van Dijk (1974 a).

in some memory store. However, our data, as well as results from many other experiments, show that even in immediate reproduction tasks for longer discourse, subjects are unable to reproduce all propositions of the discourse, both from the 'beginning' and from the 'end' of the text.

Hence, we will have to assume that in linear discourse processing a number of strategies play a role which tentatively (as a hypothetical procedure) assign sentences, or sequences of sentences to some macro-category. In our story from Boccaccio, for example, the initial description of a region and a town in Italy, is likely to be assigned, as a whole, to some macro-category like 'Setting'. This strategy of hypothetical interpretation of input also occurs in sentences (see Bever, 1970). Such strategies are processes for an optimal and effective 'execution' of interpretation rules, but should be distinguished from the rules themselves. The rules themselves assign the definite structure to a string, which may imply a revision of a hypothetical interpretation assigned by the strategies.

There is another cognitive operation necessary in order to deal with large amounts of semantic information. Not only will sets of sentences be assigned to some macro-category, the set itself must also be somehow 'reduced'. In stead of recalling — at least after a considerable interval — a precise description of the Italian town which is the setting of the first episode in our story, a subject will just recall that the story (or its agent) is localized in some Italian town, with a possible attributive predicate 'beautiful'. We will see that in the summarizing tasks, such a proposition is precisely the one 'resuming' the whole initial Setting-description.

It seems to follow that discourse comprehension not only requires assignment of each proposition into some very complex hierarchical structure, but also a sort of macro-interpretation of the 'content' of sets of propositions assigned to macro-categories. In other words, sequences of propositions of the text are mapped on a sequence of propositions 'resuming' these sets in less propositions. Thus, a sequence like (Peter bought sand, stones ...; Peter laid foundations; Peter erected walls; ...;) may be mapped onto a proposition like 'Peter built a house'. The latter proposition, e.g. in a description of Peter's life, may with other propositions be subject to a higher level macro-operation resulting in e.g. 'Peter settled in the Far West'.

It is our contention that a hierarchical structure of such macro-propositions are in fact stored in memory, and that this macro-structure determines all forms of retrieval processes. More in particular, we assume that a summary is a direct verbalization of a macro-structure (or at least a subjective interpretation of such a macro-structure). Although there are objective semantic similarities between the macro-structures assigned by various subjects to the same text, there are factors of interest, knowledge, attention, etc. determining the variations of the recall and summary protocols. We will for the moment neglect these individual differences and focus upon the general semantic properties of macro-structures.

3.3. Before we are able to test the rather vague assumptions made above, we must specify the exact character of the mapping rules involved, and of the conditions under which they operate.¹⁰

A first general relation holding between micro-structure and macro-structure is that of *entailment* (semantic implication). Let (p_1, p_2, \dots, p_n) be a sequence of propositions and P_k a (macro-) proposition, then P_k is a macro-proposition of (p_1, p_2, \dots, p_n) only if:

(1) $(A \rightarrow B) \text{ IH } P_k$

In terms of a semantics for entailment this means that in all worlds where the antecedent is true the consequent is also true." This condition requires of any macro-rule that it be truth and (partial) content preserving.

A second condition is that for any sequence of macro-propositions $(P_k, P_{k+1}, \dots, P_m)$, the sequence must be coherent following the coherence constraints formulated earlier. This guarantees that if there is a summary-discourse T_s , expressing this macro-structure, T_s is semantically well-formed.

The first macro-rules operating under these conditions will provisionally be the following:

- (MR₁) Deletion: $\{A, p_i\} \rightarrow A$
- (MR₂) Generalization: $p_i \rightarrow P_k$
- (MR₃) Construction: $P_k \rightarrow p_i$

holding for e.g. the following examples, respectively:

- (2) Peter saw a blue ball
= (Peter saw a ball. The ball was blue) Peter saw a ball
- (3) (i) Peter saw a hawk Peter saw a bird
(ii) Peter saw a hawk. Peter saw a vulture. Peter saw birds
- (4) (Peter laid foundations, built walls, built a roof ..)
Peter built a house

The deletion-rule MR₁ says that in general attributive detail can be omitted in a macro-structure. The important condition, following from general condition 2 (coherence of macro-structures) requires however that the deleted proposition is not a necessary presupposition of some following macro-proposition. In our example (2) this would mean that the fact that the ball was blue must be 'irrelevant' for the rest of the text.

The same condition holds of course for MR₂. Whereas MR₃ allows for the 'deletion' of accidental properties, the generalization rule allows the abstraction from 'necessary' properties (defining 'hawk-ness' in our example). The generalization rule has the advantage that sets of propositions may be substituted by a conceptually higher ordered proposition, according to the existing

¹⁰ For a more extensive discussion of the macro-rules, see van Dijk (1974b).

¹¹ See note 6.

semantic relations in the lexicon (c.q. our semantic memory), which will not be discussed here.¹²

The construction rule, MR_3 , certainly is the most interesting in our perspective. Unlike in the other rules, the resulting macro-proposition is not entailed by one of the micro-propositions, but jointly by a sequence of micro-propositions. Assuming that the macro-proposition in question denotes a complex fact (e.g. an event), the micro-propositions denote necessary component facts of the more general fact, or at least the set of necessary component facts propositions must be a subset of the antecedent sequence. In our example: it is not important to know *how* Peter built the house, or what the walls were made of in order for the rule to operate, as long as the necessary components of house building are present. Note, that the three rules satisfy the entailment condition.

There is a variant of MR_3 , which in fact combines MR_3 with MR_i :

($MR_{3,i}$) **Implication** ($p_i, p_i, \text{) } p$, if $p, \text{ II- } p$,
like in the following examples:

- (5) (Peter intended to buy a house (...) Peter bought a house)
Peter bought a house
(6) (Peter lighted pipe (...) Peter smoked pipe)
Peter smoked a pipe.

In other words, all propositional information may be deleted which is implied by another proposition of the text, which then may become a macro-proposition. Now, the rules given here are rather general and there are a number of other rules operating in the comprehension of discourse, depending on various factors (e.g. the type of discourse involved).

At a more abstract level, the macro-rules formulated here are consistent with the *summary-rules* formulated by Rumelhart (1974), holding between a (narrative) discourse and its summary. As we assumed above, a macro-structure is a tentative underlying structure of a summary. The additional hypothesis, however, is that a macro-structure is assigned to a (part of a) discourse, in order to be able to 'control' its complex semantic content, in *all* tasks.

3.4. Among other general conditions it should be noted that of course macro-operations must have an 'upper-bound'. They are, as we saw, in principle recursive. That is, a resulting macro-structure may again be mapped onto a more general macro-structure. Both MR_2 and MR_3 require that the resulting macro-structure be the least general possible (in formal semantics terms: defines the smallest superset of possible worlds where the antecedent is true). This guarantees that the highest-level macro-structure of a discourse is not

¹² See Kintsch (1974), Anderson & Bower (1973) and the contributions in Tulving & Donaldson (1972).

trivial (e.g. Somebody did something'). There are some further difficulties with the power and the ordering of the macro-rules which will not be discussed here.

4. *Narrative*

4.1. The remarks made above are probably valid for most types of discourse. In order to get some insight into the properties of recall, summary, and other cognitive processes operating on the story we used as material, additional remarks are necessary about the specific structure of narrative.¹³

For various reasons it is advisable to make a (gradual) distinction between *natural* and *artificial* narrative. Natural narratives are those which are told in natural, everyday communicative contexts, whereas artificial narratives require a specific context, often a specific narrator. All forms of literature, telling (or singing) folktales and myths, etc. belong to the latter category. Although natural and artificial narratives have some basic narrative structures in common, artificial narratives may have additional syntactic and semantic rules which would obscure an inquiry into the general forms of narrative and their cognitive basis. Boccaccio's story is of the artificial type. However, it is rather simple and straightforward in its narrative structure, and thus is rather close to the structure of natural narratives.

4.2. A narrative, both natural and artificial, is a specific type of *action discourse*. An action discourse is a discourse which contains action descriptions. An action description is a sequence of propositions denoting actions or component properties, causes/reasons and consequences, of actions. An action is a state change (in some possible world or 'situation') brought about, intentionally, by a conscious human being (a 'person'). This implies that a (simple) action is an ordered pair of some mental state or event, e.g. an intention and/or purpose, on the one hand, and a bodily movement, or 'doing', on the other hand.

Actions may also be 'negative' in the sense that a normal or expected action is — also intentionally — not carried out (omissions), or some bodily movement is intended to prevent some state change in the world.

Most of our actions, however, are complex. At least, these are the actions we are normally aware of, which we are consciously planning and programming. They consist of ordered sequences of doings, each with their own 'local' intention, but globally monitored by a mental plan of purpose, determining in which respect each action serves some final goal, i.e. the desired state of affairs or events. A serious theory of action would require of course more than these

¹³ See note (9). The discussion here is a very brief summary of our results in van Dijk (1974a, 1975).

cursory remarks, but they give at least a first impression of the components of action which may serve as the denotata of action description."

An action discourse need not consist exclusively of action descriptions. We have state descriptions which are initial and final state descriptions of the actions involved, e.g. a description of the setting (place, time) of the action, the 'state of mind' of the agents, a description of the appearance of the agents, etc. This is well-known, and needs no further comment. A typology may be made on the basis of proportions and types of descriptions in action discourses.

4.3. Not every action discourse, however, is a narrative. That is, a narrative has at least further pragmatic conditions in order to be acceptable as such. There are numerous actions we daily accomplish without ever telling stories about them. To resume a long theoretical treatment which is irrelevant in this paper: a narrative is an action discourse which is non-trivial or interesting, i.e. which refers to actions, or consequences thereof, which are improbable in most courses of events (from the point of view of the speaker and the hearer). This holds for natural narratives. In literature there are different and additional rules (e.g. that the structure of the narrative itself be non-trivial or interesting, from various points of view). The underlying pragmatic condition that something must be told which is somehow weakly or strongly spectacular, determines the semantic structure of the narrative. Referring back to the categories of Labov & Waletzky (1967), we therefore structurally must have some form of 'complication' after any description of setting or introduction. Similarly, the narrative syntax at least requires a category like 'resolution' to be interpreted as giving a description of the resulting events or actions, leading to success or failure of the agent. Other (optional) categories, like 'evaluation' or 'conclusion', have again a pragmatic character. They are meant to express the impact of the events told on the speaker/narrator, and to draw the consequences for future action, not only of the speaker, but also of the hearer (the story-advice). Precise rules and transformations may be formulated for the regularities mentioned above (see Appendix D).

4.4. We are however interested here in the implications of this (still far from perfect) theory for our insight into the cognitive processes of complex

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levels, of which only some will be discussed here:

- (i) the relations between the underlying cognitive structures determining our actions and the planning of actions, on the one hand, and those determin-

¹⁴ For references to the logic of action, see van Dijk (1974 a). The importance of the analysis of actions has been recognized in the models of Schank (1973) and Frederiksen (1975 a). For a collection of philosophical papers on action, see Care & Landesman, eds. (1968), for work on action logic, see especially von Wright (1967) and Davidson (1967). We are more in particular indebted to the thesis of Brennenstuhl (1974) who further elaborates von Wright's theory of action.

ing our ability to produce and comprehend complex action discourse, on the other hand;

- (ü) knowledge of the structure of action permits to formulate further rules for macro-interpretation and summarizing of action descriptions in narrative;
- (iii) our knowledge of action structure — see (i) — enables narrators to omit many propositions from the text base which would in principle (in ETB) be necessary to make it coherent;

The narrative macro-rules determining our comprehension, storage and retrieval of stories are to be formulated under the general assumption that stories are about 'interesting' actions and events involving persons. Information to be 'dropped' or integrated first, according to the given macro-rules, pertain to those propositions which are irrelevant or only indirectly relevant to 'major action' descriptions.

Let us give a provisional list of the types of propositions usually satisfying this condition. They are the propositions which have the highest probability of being forgotten in reproductions and/or omitted in summaries. Note that these narrative macro-rules (NMR's) are specific cases of the general semantic macro-rules specified above.

NMR₁ Description of intentions or purposes of actions, if the actions themselves are described.

NMR₂ Description of mental states (wishes, regrets, desires, hopes, etc.) interpreted as reasons for actions, or as consequences of events and actions.

NMR₃ Description of alternative possible courses of action which are not realized but only considered by the agent.

NMR₄ Description of auxiliary actions which are probable conditions for the success of a major action.

NMR₅ Description of probable consequences of actions or events.

NMR₆ Description of properties of time and location (setting), atmosphere.

NMR₇ Description of objects and persons (agents or patients), if not conditions for following actions.

NMR₈ Propositions repeating, summarizing, pre-viewing, paraphrasing, commenting, etc. other propositions in the text.

NMR₉ Description of dialogue.

These deletion and integration rules transform a text base into the core of the story, or essential text base, which we may simply call a *macro-text-base*. The rules are based on the general conditions and rules given above, which we may summarize under two principles:

- A. The principle of relative irrelevance
- B. The principle of probable inference

The first principle says that all information may be deleted which is irrelevant for the interpretation of subsequent propositions. In formal terms this could be termed as follows: a proposition *p* is irrelevant for a set of propositions *Q*

iff there is no member q of Q such that (the value of) p is a condition for (the value of) q . The value or interpretation of a proposition, in our terms, is a fact in some possible world. In other words: a proposition is irrelevant (with respect to the subsequent discourse, and in a given context) if it could be deleted without necessary changes in the course of conversation/narration.

The second principle assumes that all propositional information may be deleted or integrated if it can be inferred from other propositional information. The rules underlying these inferences may be rather weak: not only formal or semantic deduction (modus ponens, etc.), but also inferences based on 'likely' conclusions are allowed. This sort of 'probable implication' holds in most possible worlds or courses of events. This principle at the same time implies that all propositional information which is 'unexpected' should not be deleted in principle. This is an old information theoretical insight, e.g. determining processes of attention, and also the principles of communication (see Grice, 1967).

Rules NMR_1 — NMR_3 organizing our comprehension and storage of narrative discourse are essentially of the deletion type. Other narrative macro-rules are based on MR_3 , and substitute global action propositions for a sequence of component action descriptions, if none of the component actions is directly relevant for another global (major) action. The definition of a *major action* is not easily given. In terms of interpretation strategies (which as we saw are probabilistic) we may specify quantitative conditions: length of the action description, e.g. in terms of the number of auxiliary and component actions described, the number of actual or possible consequent events and actions, etc. In qualitative terms, based on the basic narrative rules, a major action is any action which directly, or with other major actions, has the intended final state (the 'goal' of the agent) as its consequence, or which prevents the agent to bring about this final consequence. Under the same definition, we may speak of a *major event*. In the story by Boccaccio, the main intention of the hero-agent is becoming (twice as) rich. Selling merchandises, robbing ships and finding jewels are actions or events directly leading to the intended goal, whereas a storm, being robbed, etc. diverts from this goal.

4.5. Although only an informal fragment of a theory of discourse structure and of macro-structures, rules, conditions and strategies has now been provided, we are in a position to predict most of the recall and summary properties of our data.

We have seen that both the narrative formation rules and the 'transformation' rules mapping narrative text bases onto narrative macro-text-bases, derive from specific, discourse-type dependent, and pragmatic ('rhetorical') rules and conventions on the one hand, and more general rules and principles pertaining to the structure of the world (e.g. of actions) as we have conceptually represented it in semantic memory, on the other hand. In other words, and simplifying grossly: when we read a narrative we understand it, and may

predict the fines of the subsequent part of the story, because we know the conventions of F ory telling *and* because we know the underlying logic of events and actions and the probabilities of facts in the possible worlds we have access to.

4.6. Macro-rules operate on base structures. In Appendix D we have formulated a set of rules generating the base structure of our story. Many of the rules might be further refined, but in that case they would no longer be proper narrative rules, but a still further description of the structure of the world in which actions occur. Perhaps only some of the rules are properly narrative, i.e. pertaining to the structure of the discourse itself. As for linguistic and cognitive semantics in general, we again here meet the problem in which respect concepts and structures are those of the `world' and those of our thinking and language. Clearly, if present at all (for methodological reasons), the boundaries are not sharp.

5. *Cognition*

5.1. In the previous section we have repeatedly hinted at cognitive implications of our theory of macro-structures. In fact, one of the reasons to assume the presence of macro-structures has been the assumed properties of complex information processing. That is, in order to overcome the obvious limitations of our working memories (processors of different kinds) and data-base memories, when faced with the problem of storage and retrieval of enormous amounts of propositional (verbal and non-verbal) information, rules and structures become necessary which organize this information. Macro-structures and -rules are obvious candidates in this respect. And although our experiments are not perfectly conclusive, they seem to suggest that this assumption is correct.

5.2. What is required, then, is not only á model for the structures and rules of discourse processing, but also a model for the structure of our processing systems. Without fully spelling out such a cognitive (memory) model, we here will simply make the following assumptions: ¹⁵

- (i) there are various types of semantic memory:
 - A. Processing stores
 - B. Data stores

¹⁵ Although of course we draw much of our insight about memory from work cited in note 12, we think there are reasons to adopt a model which is more complex, and which can account for the processing of proposition sequences into macro-structures (van Dijk, 1974b). However, this model is merely tentative and not yet formalized or experimentally tested, except for the suggestions to be derived from the present experiments.

- (ii) Processing stores (working on a 'clean-desk' principle) may be distinguished for the following operations:
- a. the interpretation of clauses/sentences, i.e. the assignment of propositions;
 - b. the linear operation on proposition sequences, e.g. referent identification, connection identification, disambiguation, specification, etc.;
 - c. macro-interpretation, i.e. the assignment of macro-categories/structures to proposition sequences;
- (The stores involved may be called: the proposition store, the sequence store and the macro-store.)
- (iii) Data stores collect the results from the previous operations, especially of macro-interpretation, under interaction of other types of operations (e.g. those determined by attention, task, interest, beliefs, etc.).
- There are reasons to assume various data stores:
- B1: Episodic memory (memory for strictly 'auto-biographical' facts, i.e. an 'input-recorder');
- B2: Fact memory, i.e. knowledge about particular facts in the 'world', derived from:
- B1-data, by setting abstraction
 - B3-data, by particularizing inference
- B3: General or systematic memory: general, conceptual knowledge (grammar, laws, rules, concepts, etc.).
- N. B. In fact B3 is not a 'memory' in the strict sense, but a system constructed inductively from memory data in B2.

In B1 will be recorded that certain propositions occurred in a particular text. It essentially determines phenomena of recognition. The structures stored in B2 are predominantly macro-structures of the text. Episodic information gradually fades: we know certain global facts about the (real or fictional) world, but without remembering when and where this information was recorded.

Macro-structures themselves are combined and further abstracted from, yielding more general information, defining our knowledge and beliefs. These operations of epistemic and doxastic rules, and their underlying logic and conventions, will not be discussed here. In fact, we know very little about them.

5.3. With respect to processing of complex narrative discourse these assumptions lead to the following hypotheses:

- (1) some macro-structure of the text is constructed and stored in B1 /B2;
- (2) in simple recall experiments, a semantic clue, e.g. the title, retrieves the macro-structure; this is possible because this 'clue' is just one proposition from the macro-structure;
- (3) a recall protocol must be considered as a production process in its own right, otherwise different forms of 'importation', 'errors', etc. cannot be explained;

- (4) (re)production is based on the properly recalled macro-structure, by operations which are the reverse of our macro-rules: they generate expanded propositions, sequences according to criteria of likeliness, inference, etc;
- (5) the generated sequences are matched with what is left of the content of the processing stores (i.e. sequence store) in some middle range data store;
- (6) If this match is positive a proposition is expressed. Errors here may be explained by the fact that the fact store also records inference data from macro-structure which have not been in the processing store, but which would have a high probability of having occurred there;
- (7) Information is 'forgotten' if it cannot be retrieved by the (inverse) macro-rules (by inference) or if it never reached the data stores, e.g. by immediate deletion (according to the rules given).

These hypotheses are very imprecise, and only partly formalizable in terms of the theory given above. The precise operations of inferential 'generation' from macro-structures and its interaction with assumed 'matching' procedures with propositions in processing stores is unknown. In fact, we do hardly know on what grounds 'detail'-propositions (as well as properties of surface structure) reach the data stores. This problem cannot be solved in this paper. We merely have a general, systematic insight into which sort of propositions will reach the data stores, and which most likely will not. Although the experimental data are clearly convergent on these regularities, we have the usual probabilistic fuzziness for the intermediate-range phenomena: propositions which are 'recalled' by one subject, but not by another. Here, the individual (e.g. 'style') differences play a role (e.g. in the sense of Paul, 1959).

There is an important additional hypothesis which we have not tested, but which is connected with hypothesis nr. 3 above. Not only recalls or summaries are produced on the basis of a macro-structure, but all discourse is produced on such a global semantic plan. That is, when we want to produce a rather complex sentence or discourse, we first must construct at least part of a macro-structure, which will indicate globally which 'direction' the to be produced linear sequence will have to take. The expansion rules involved are the inverse macro-rules mentioned above. For example, the subsequent component or auxiliary actions, causes, setting, etc. of an action may be expressed only if we have 'an idea' which action, with what purpose and final state we want to describe. These processes are in natural circumstances not necessarily conscious, although for example we may make a 'sketch' of a paper or talk. In natural narrative, the actual story may thus be preceded by a very short (partial) abstract, already preparing the macro-hypothesis of the hearer (see titles and introductions of news paper information). We will not further discuss the specific problems of production. The processes involved are largely those described for comprehension.

Yet, a full account of recall protocol analyses must take into account that a recall is a discourse produced like any other, only with some specific constraints determined by the tasks.

6. *The Experiments*

6.1. *Preliminary Remarks*

6.1.1. We have carried out nine experiments, of which seven will be reported here: two recall experiments, one with oral presentation the other with written presentation of the text, and five summary experiments of various types.

The experiments had an informal character. They were merely intended to get some rough preliminary data for a theoretical model and for having a first insight into the plausibility of our hypotheses. We did not have a laboratory at our disposal with its necessary control instruments. Nor did we have paid subjects or assistants. The data collection took place in high school classrooms, during a class of Dutch, with the usual 45-minutes limit for the whole experiment. In general this time limit did not impose too heavy restrictions, but some recall protocols were incomplete due to it. Data collection took place under supervision of a teacher, instructed by the collaborators of the seminar.

6.1.2. *Material:* The text used in all experiments was a short story by Boccaccio, viz. the fourth story of the second day of his *Decameron*.¹⁶ A Dutch translation version was used, which had long complex sentences of several lines long (each sometimes of more than 10 propositions). The style of this version was somewhat old-fashioned. The advantage of these surface structure properties was that the sentences could never be recalled verbatim or in their syntactic structure. The focus was on semantic processing of the propositions. There was no time limit on presentation, so that this surface difficulties had probably no great effect on recall (as demonstrated by Kintsch, 1974). The story was four and a half page long (1680 words). The narrative structure of the story is conventional. No specific literary transformations worth noticing occur. The story is complex in that the 'episode' category is recursive. Presentation was in printed form in experiments II, III, IV, and in oral form in I, V, VI, VII.

6.1.3. *Subjects*

Subjects were high school students of about 18 years old, whereas in III having had a high school education (they were between 18 and 22 years old). The subjects in IV were younger high school students (14-15).

6.1.4. *Scoring*

As usual in this kind of experiments the analysis of the recall and summary protocols produced a number of considerable theoretical and practical difficulties. The recall protocols were often several hand-written pages long.

¹⁶ The same story, viz. in its English version, has been used by Kintsch (1976) for a number of experiments, of which the results have not yet been integrated into our discussion.

With our limited means serious scoring was therefore impossible, in many respects.¹⁷

First of all, a list of 'propositions' was prepared of the original text. In fact, this was rather a list of clauses or 'kernel sentences'. There were a few errors in this list which were discovered after the experiments, but these do not affect the overall-results. We thus had a list of 184 'propositions', such that the propositions were easily identified in both the input texts and the protocols. Serious proposition construction has many theoretical difficulties, since neither in logic nor in grammar we have unambiguous results about the scope of propositions. A simple clause like 'The rich man lost all his property' may be analyzed in several component atomic propositions: (i) there is a man (ii) this man is identical with a man [already mentioned] (iii) the man is rich (iv) the man lost something (v) this was property (vi) this was all [his]property (vii) this property belonged to him (viii) the losing-of-his-property' took place in the past (ix) there is a fact such that (...). These atomic propositions would require an appropriate format in some predicate logic. It is clear that in the present circumstances such a formal analysis of more than hundred protocols was unfeasible, although it would be the only serious measure for determining whether some piece of information would be or not in the protocol. We therefore had to count whether some clause-proposition was 'essentially' present in the protocol. In general, a proposition was counted if it was implied by the input proposition. If two propositions were integrated in one proposition both were counted. Incorrectness or absence of proper names was not considered a ground for not counting a proposition. According to these scoring limitations, few propositions were exactly identical with those constructed, but only acceptable variants. Since the scoring criteria were not fully explicit, there are some differences between the various analyses of the collaborators. We will assume that these differences are averaged in the overall-results. Apart from the very simple design of the experiments, these scoring limitations are the reasons why the experiments may not be viewed as conclusive evidence for any hypothesis, although they have produced very suggestive results in the expected directions. It is clear that all sorts of experiments with complex discourse material must find a solution for the analysis of complex protocols. Unless there are many assistants or some form of mechanic analysis (which is impossible at the moment), we have to be satisfied with fragmentary qualitative analysis or rough quantitative data. Counting words, as in traditional recall tests, is of course unsatisfactory for theoretical reasons not to be repeated here.

¹⁷ For more reliable scoring criteria — with the theoretical provisions made — see the work by Meyer (1975) and the recent results by Frederiksen (1974b, c). Barnard (1974) in his work on discourse recall does not use theoretically founded structural analyses, but works with operational criteria of coherence. Although such criteria may be workable in practice, they precisely ignore the problems to be explained: *why* and *how* judges are able to reach consensus about coherence of discourse.

No systematic analysis was given of the typically 'added' propositions, i.e. due to the personal fantasy of the subjects or to their style. The problem in these tests is that many subjects do not merely try to recall/reconstruct propositions, but also display their own narrative abilities.

6.2. *Experiment I* (in collaboration with Marjolein Aalders and Henk Claassen).

6.2.1. The first two experiments were simple recall tests, after oral and written presentation, respectively. The purposes of these tests were the following:

- (i) to replicate classical recall experiments (in the line of Barden) for longer narrative texts in order to see whether there are specific phenomena involved in the processing of larger amounts of verbal information;
- (ii) to provide a basis for a comparison with the summary tasks in order to test the hypotheses that identical underlying structures and processes determine both.

6.2.2. *Procedure*

The text in experiment I was read to a class of 20 high school students. After presentation the subjects were requested to reproduce the story as precisely as possible, but in their own words. Reproductions are hand-written. Approximate reading-time: 10 minutes. Max. reproduction time: 30 minutes. A *second trial* was performed nine days later, where the subjects were requested to reproduce everything they remembered of the story told.

6.2.3. *Results*

Of the subjects ($N = 20$) only 17 completed their protocol. The three incomplete ones are left out of the analysis (although there would perhaps be interesting structural reasons for this incomplete recalls due to time limitations). The first trial is called IA, the second IB.

We were interested in the following properties:

1. the total set (and identity) of propositions recalled by all subjects, and the number of those never recalled.
2. the propositions occurring in more than two-third of all protocols, and those occurring in less than one-third.
3. the structure and role of the propositions occurring, not occurring or disappearing in the second trial.

The *number of propositions* occurring in IA, under a rather liberal count, was 150. In the second trial, IB, this total number, ranging over all subjects, had dropped to 105. That is, at least 34 propositions never occurred in any protocol, a number which has more than doubled (79) in the second trial.

The *average length of a protocol* was 50 propositions (+ several proposi-

tions not present in the original, nor a variation of it),¹⁸ in the first trial, and 35 propositions in the second trial. That is, a subject recalls less than a third of the original text, whereas the whole group taken together recalls two third in the first trial. These values are reduced to less than a fifth and a bit more than a half in the second trial.

Variation in the individual recalls is considerable in the first trial, ranging from 30 to 85 propositions, and from 10 to 50 in the second trial. Standard deviation was 18.0 in IA, and 14.4 in IB.

The *number of propositions occurring in two-third of the protocols* was 15 in IA, and 10 in IB. That is, somewhat less than a third of each protocol is identical for most subjects in both trials.

Propositions occurring in less than one-third of the protocols of the first trial were 110, and in the second trial 140, of which as we saw, 34 and 79 never occurred in IA and IB, respectively.

The theoretically important conclusions from these data are that there is a small number of propositions (less than 10% of the original number) consistently used by most subjects in recall, and a very large number (a half to two-third) hardly ever or never used by the subjects. Taking equal probabilities for each proposition to reoccur in a recall protocol as a null hypothesis, the data show that this hypothesis must be rejected. In order to explain this fact we must analyse the structure and the hierarchical position of the propositions consistently recalled and those forgotten.

Let us give a list of those propositions which are most frequently reproduced in this recall-test (a. 12 out of 17) (Cf. Appendix B):

1. (12) [There: In Italy/Ravello] was a very rich man.
2. (13) His narre was Landolfo Rufolo.
3. (18) He bought a large ship.
4. (34/35) [From the proceeds of ship and cargo] he bought a light pirate-vessel.
5. (41/42) [By having raided so many Turkish ships] he was now twice as rich as before.
6. (45) He (decided to) return(ed) borne.
7. (51) There was a storm.
8. (53) He sought protection in a bay.
9. (56) Two Genuese ships did likewise.
10. (73) They captured L.'s ship.
11. (76) L. was taken aboard on their ships.
12. (83) There was a storm.

¹⁸ In general the length of our protocols was measured with respect to the number of propositions recalled from the text. Of course this number does not indicate the real average lengths. As we have mentioned for the other experiments, we should at least add 10% of propositions which are imported by the subjects, e.g. personal comments, and the usual grammatical and narrative output constrained propositions (see below).

13. (85) The ship [on which L. was] was wretched.
14. (98) L. clung to a spar.
15. (106) A sudden squall hurdled a chest against the spar, so L. went under.
16. (110/111) He clung himself on the chest.
17. (118) He was thrown onto the coast of Corfu.
18. (122) There was a woman [cleaning her pots and pans].
19. (140) She nursed him (for several days).
20. (150) L. opened the chest.
21. (152) L. found many jewels.
22. (179) [He went home] and sold the jewels.
23. (180) He sent a sum of money to the woman who had helped him.

Striking in these purely quantitatively selected propositions is that together they form nearly the complete 'thread' of the story. Taken as a sequence the propositions make nearly a very acceptable summary of the story. Hence the hypothesis seems to suggest itself *that those propositions occurring most in recalls are the same as those selected for summaries.*

Looking closer at the propositions recalled we see that they are of the following categories:

- a. introduction of agents (presupposed in further action)
- b. major action descriptions
- c. major event descriptions
- d. final and intermediate state descriptions, (in)consistent with main purpose.

The majority of the propositions recalled are action descriptions or event descriptions in which the major agent is involved. We may therefore conclude, conform to our hypotheses, that a story is essentially stored and recalled as an action description having undergone macro-rules, i.e. a narrative macro-structure.

Another striking fact was that the set enumerated above was resistant against forgetting: it came back also in most recalls of the second trial, whereas other propositions, even if still recalled on first trial, were forgotten in the second. In fact, the second trial protocols were very similar to the sequence given above, together with variously recalled descriptive detail and personal importations. This fact further strengthens the hypothesis about macro-structure storage.

Yet, the list of most frequent propositions recalled is not strictly identical with the macro-structure. According to the theory, not only will propositions occur in macro-structure which are 'left' after application of the deletion rules, but also propositions which are constructed from sets of propositions or are (partial) 'representatives' for such sets. What is lacking for example is a high frequency of some propositions from the text in the first episode of the story (heavy losses due to competition). Although most propositions of this episode are recalled by more than half of the subjects, we notice that other proposi-

tions are used in order to summarize the episode. The recall of propositions from the text itself depends on their direct function as major event/action descriptions or on their summarizing function for a given episode. An important example is proposition (140), which occurs in the text and at the same time resumes the various nursing activities of the hero's helper.

In order to test recall independently of occurring propositions, we constructed a list of 23 propositions denoting the major episodes (actions, events) of the story. A proposition was then scored if it was implied by an episode description in a protocol. According to that count nearly all (12) subjects recalled these macro-structural propositions (see Appendix C). Four subjects (out of 17) made errors about the first episodes of the story, but all correctly recalled the essential final episodes (shipwreck, chest, woman, jewels, back home rich), which is the direct condition for realizing the purpose of the agent. It does not seem likely that this better recall for the last episodes is due to recency effects, since the same holds for the second trial. There are however some stylistic reasons for this optimal recall, e.g. the vividness and the spectacularity of the description and the episode, respectively. These factors are not strictly due to the macro-structure alone (the structural importance of the last episode), but to what is felt to be 'interesting' by the subjects, according to their own experiences and their knowledge of the world.

As we shall see in the other tests, in each group there are some subjects which make very little of their reproduction, making serious ordering errors and erroneous deletions and combinations between events. These poor performances must be accounted for in other terms (lack of interest, fatigue, etc.). At various points, the subjects impose 'false' information, consistent with the macro-structure but absent from the text (or inconsistent with detail-information from the text): apart from general formula like 'once upon a time', 'and they/he lived happy for the rest of their/his years', mistakes are made in the names of places and agents, indications of time intervals, etc. Thus, many subjects made the woman-helper 'old' for some reason. For ten of the 17 subjects it was briefly checked what their performance was in both trials on the proper names of the story; numbers between brackets are those of second trial:

Reggio-Gaeta	0	(0)
Italy	6	(5)
Salerno	2	(2)
Amalfi	0	(0)
Ravello	5	(3)
Landolfo	5	(4)
Landolfo Rufolo	0	(0)
Cyprus	3	(2)
Turks	7	(3)
Genoese	5	(2)
Constantinople	2	(1)

Cephalonia	O (0)
Corfu	3 (2)
Brindisi	O (0)
Trani	2 (1)

From this list we see that (i) only general name/place indications tend to be recalled if they are the setting of the story or its agent (Italy, Ravello), (ü) the proper name of the hero and of principal opponents (Landolfo, Turks, Genoese), (iii) place names of intermediary events are nearly all forgotten (iv) only half of the subjects tend to recall the important names (y) and of this group a third at least forget the name on second trial. Striking was that in this oral presentation test names were better recalled than in written presentation, although one would expect the inverse, especially due to the strangeness of many of the names. Misspelling, of course, was frequent.

Although the test interval was only 9 days, there was an interesting tendency in what information was still recalled in the first trial, but forgotten (or less recalled) in the second trial (between brackets the corresponding propositions):

1. The description of L. R.'s home country (1-11)
2. The preparations for his trip to Cyprus (14-18,20)
3. The mental consequences of his loss, and the deliberations what to do next (25-33)
4. His preparations for and success as a pirate (36-50)
5. Seeking protection in a bay (52)
6. The component actions and decisions of the Genoese to robb L. R. (57-72)
7. Details of the rapture and further travel (74, 75, 77, 80-82, 84)
8. Detailed description of the wreck (86-96)
9. Detailed description of L. R. in the sea (99-117, except 111)
10. State description of L. R. when arriving at the coast (119-139)
11. Preparatory events before chest is opened (141-149)
12. Description of the jewels and planning to go back (153-171)
13. Details of his trip back home (174-176, 178).
14. The final formula (183-184).

The tendency to forget these propositions is precisely predicted by the theory, since the macro-rules reduce the following types of information:

- (a) setting descriptions
- (b) preparatory actions
- (c) preparatory and consequence mental acts and states
- (d) action sequences which may be combined (e.g. as in 6.: 57-72)
- (e) detailed state descriptions (e.g. in 9.)

and in general all those propositions denoting states and events not essentially

conditioning the further course of events. Some typical examples of propositions which are forgotten by all subjects are (first trial):

- This region is called Amalfi (5)
 - (which is) dotted with small towns, gardens and fountains (6-8)
 - As a result (...) he nearly lost his life (16)
 - L. R. made preliminary calculations (17)
 - He had set out a rich man (31)
 - L. R. wanted to avoid the risk of repeating his former mistake (44)
 - He was wary of commercial ventures and did not invest his money (46-47)
 - (the Genoese are) by nature a rapacious, money-grabbing set of people (63)
 - This happened near the island of Cephalonia (87)
 - The poor wretches (...) began to cling ... (92-94)
 - L.. who had in fact been calling for death ... (97)
 - She started back with a cry of alarm (125-126)
 - He couldn't see nor speak (127-128)
 - She took him from the bath (138)
- etc. (see Appendix B).

These propositions are macro-structurally deleted according to the rules: setting description, previews, preliminary actions, mental processes of decision making, likely consequences (e.g. 138), etc. This list (which is not complete) has more than doubled in second trial, according to the deletions mentioned above. Still, on first trial, many descriptive details still subsist in memory, although distributed over the whole group of subjects, each recalling specific details. On the whole, memory for the story was surprisingly good (within the bounds of the given rules), and even on second trial, a certain number of 'detail'-propositions can still be recalled/reconstructed. Thus, propositions describing component acts by opponents tend to be forgotten in general. Still, at least five subjects recall such propositions as:

- They put ashore a party of well-armed men with crossbows (65-67)
- The gale separated the two garracks from each other (84)

There are three episodes which theoretically should be more forgotten than they actually are: viz.

- The fact that L. R. first clung to a spar, and that a wind huddled a chest against it so that L. R. went under (98-111)
- The fact that the woman on the beach was cleaning her pots and pans (122)
- The fact that L. R. proposed the woman to exchange the chest for a sack (162)

There is no direct cognitive reason why the episode with the spar should be remembered, because it has no further function in the narrative. That it is present in the original text, probably should be explained with specific rules of narrative **although the story would hardly have become less natural if L. R. had saved himself directly on a chest.** Recall for the spar

6.4. *Experiment III* (in collaboration with Peter Lust)

6.4.1. The following experiments are different summary tasks. Most of the motivating hypotheses for these experiments have been discussed in the theoretical part of this paper. First of all, we need insight into summarizing behavior in general: how can speakers of a language give summaries of any discourse of their language? Second, how should it be explained why summaries (as well as recalls) have propositions which are not identical with those of the input text? Third, what are the underlying relations between recall and summary processes: why, for example, are recalls after longer delays so close to immediate summaries (as we shall see)? And, finally, what does summarizing behavior tell us about the processing of complex information in general, and what are the relations with other cognitive abilities, e.g. in perception and action?

6.4.2. The first summary task was simple. The *design and procedure* were as follows. The Boccaccio story was presented to a class of high school students ($N = 15$), with as task specification to give a summary of the story. A necessary addition was that this meant that the most important events of the story should be retold in their own words. Although summary tasks are part of the Dutch programs in high schools — tested in the final examination — there are no specific, well-trained conceptions about how discourses like summaries should be constructed and along which criteria. This means that the understanding of the notion of a summary, and hence of the aim of the task, is largely based on intuition. It is this type of linguistic intuition which is tested. This further implies, of course, intuitive insight into the properties of stories, and what counts as an acceptable summary of a story. In fact, we display this behavior daily in our conversations in which we report what others have told us. The summaries were given in written form. There was no time limit apart from the usual class time restriction (45 minutes for the whole experiment, including reading time). Scoring was like in the previous experiments.

6.4.3. *Results*

The *total number of propositions* (re-)produced by the group was 108 (58.7%). This means that immediately 74 propositions are 'deleted' by the subjects. Given the previous recall tasks, this means that a great number of propositions has been left out consciously because much more could be recalled.

The *average length* of the summary protocols was 31 propositions, which is also considerably less than in a recall protocol: subjects had really tried to summarize what was left in memory about the text. The *variation* went from 16 up to 48 propositions for the various subjects. Deviations from the mean length were less than in the previous tasks; they were also less than in delayed recall: the standard deviation was 8.66. Our impression, however, was that if some sort of 'ideal' summary could be constructed, this would have about 22

propositions, precisely the number of most frequent propositions in the recall test. In the last three summary experiments, we have used this assumption. It follows for this test, that the summaries in fact were (in average) too long: too much detail was still present, even when the summaries were only one-sixth of the total length of the input text.

Most striking is the fact that the summary length, as well as the total number of propositions used by the group is fully consistent with the second trial recalls in the previous experiments. This naturally seems to lead to the assumption that long range processes of storage of complex information and its retrieval is 'simulated' by immediate summaries, i.e. that they have similar underlying laws and rules.

The number of propositions produced by less than a third of the group was 72, whereas there were only 10 propositions used by more than two-third of the subjects. Curiously, there was strictly speaking no proposition scored for all subjects, and only 2 (nr. 12 and 152, viz. 'There was a [rich] man' and 'He found the jewels') by 14 out of 15. We must conclude from these data that the subjects indeed do not care to reproduce exactly the (micro-)structure of the discourse, but construct propositions representing propositions of the text, on the one hand, or use different propositions from the text to summarize certain episodes. See, indeed, the high score in Appendix C. The list of propositions occurring in most two-third) of the protocols is: 12, 13, 45, 51, 85, 118, 140, 150, 152, 180.

This list is a full subset of the highest frequency list in the first experiment. The other propositions of that list have a frequency of just below our boundary of 2/3 viz. score 8 and 9. Compared to the recall protocols, there were several episodes of the story which in the summaries are not described in detail: the robbing of his ship by the Genoese, his misfortune in the sea, and the details of being saved by the woman on Corfu. Since in recall (first trial) the subjects were often still capable of reconstructing-retrieving detail-propositions, these are now nearly always left out. Again, there is a similarity with the second trial recalls here: propositions being scored low in first trial, tend to disappear in second trial. Another observation which needs some attention is the fact that both in recalls and in summaries, the protocols tend to have certain 'concentration points'. That is, if there is a proposition recalled or constructed by nearly every subject, then (the more varying) recall of other propositions was clustered around this 'important' proposition. Although there are various underlying factors, as well as structural properties of the story, determining this phenomenon, the most obvious explanation is that the subjects first retrieve the macro-structure, such that each proposition of the macro-structure is then 'spelled out' by the inverse macro-rules: specifying preparatory actions and causes, consequences, states of minds, etc.

One of the differences between the recall protocols of tests I and II on the one hand, and the summary protocols of test III, on the other hand, is that there is less variance in the length of the summaries. This seems to mean that

there is more convergence on what propositions are important for a summary, than in the non-conscious process of forgetting, in which individual differences will tend to play a role also in the second trial. This assumption will also be confirmed by the gradual summaries in the next test, of which the deviations from the mean are also much lower than in the recalls, although the total protocol length is the same as on first trial recall. In Appendix C, we see that this sort of conscious deletions affect macro-propositions such as nr. 14 and 20, which have, indeed, only marginal narrative function, although they may be recalled in the recall tests.

6.5. *Experiment IV* (in collaboration with Michel Barens)

6.5.1. The second summary experiment was intended to get some insight both in the ways summaries are (cognitively) constructed, which according to our assumptions would mean an understanding of how macro-structures are constructed from linear input text. Further the test was meant to provide some data about possible pro-active facilitation of summaries on later summaries.

6.5.2. *Design and Procedure*

The story was divided into five sequences, containing major episodes of the story:

1. prop. 1-44
2. prop. 45-94
3. prop. 95-121
4. prop. 122-158
5. prop. 159-184

We do not feel that this is the best segmentation of the story, but it was made also according to the lengths of the segments. Subjects were, like in the previous summary test, high school students ($N = 21$), of 14 and 15 years old. The instruction was roughly as follows: "we have clipped a story in several parts; each part will be read to you in the correct order; after having heard each part, you give a short summary of that segment of the story; this means: summarize the most important events in your own words; after having completed the last summary, you give a summary of the whole story, without looking at the summaries you have already made, and without looking at the text itself." The latter condition (not looking at the own previous summaries) is of course essential, but we have little guarantee that all subjects have respected it. So the data may be somewhat biased for some subjects.

6.5.3. *Results and Discussion*

The *total number of propositions* recalled in this test was 144 (78.3%). This figure is to be compared with that for first trial, immediate, recall experiments. It is not only due to the higher number of subjects, but also to the fact that on the whole more propositions are 'important' relative to each fragment. It may

be asked whether the normal comprehension process is based on a strategy of gradually constructing macro-structures. Each fragment is summarized by an average of 11 propositions, making the *total length of the gradual summary* *SS propositions long*, which is also consistent with a recall protocol's properties. *The number of propositions recalled by more than two-third* (14) of the subjects was rather high, viz. 38 (20.7%), which is twice as high as for the recall experiments. Apparently, when summaries can be given in chunks a much larger homogeneity of the information stored as being most important is possible.

Most striking, however, were the properties of the subsequently given *overall-summary*. The *total number of propositions* used by the group was only 51 (27.2%), which is less than half of the number in the previous test. The *average length* of the final summary, then, was merely 12 propositions, which is less than a third of a direct overall-summary. This length was without important *variations* (SD: 4.4), ranging from 3 to 26. There were no propositions identical in most (11-14) of the final abstracts, and 8 propositions identical for more than half of the subjects. Again, the subjects seem to construe the summary in their own terms, or selecting propositions differently. Taking, however, the list of macro-propositions constructed earlier, most recalls are subsets of this list: i.e. most subjects have somehow rendered the essential content of the story. The list of propositions occurring most in the partial summaries is in large part identical with the list of most frequently recalled propositions in the recall tests:

1, 12, 13, 18, 19, 21, 24, 35/5, 41, 41, 45, 51, 53, 56, 76, 83, L5, 98, 102, 102, 106, 107, 110, 112, 118, 123, 140, 143, 150, 152, 162, 167, 168, 175, 179, 180, 181, 184.

The underlined propositions are those most frequent also in the final abstract.

Clearly, the significant difference in length between the final summary given in this test, and the overall-summary given in the previous test (31 resp. 12) is due to the construction of previous summaries. It seems as if summary construction is indeed 'gradual', and hence facilitated by results of previous summarizing structures of fragments of the test, on which further summary rules are applied. This 'intermediate base' is not explicitly expressed in a direct full summary construction, so that intermediate information must be kept in store. This means that intermediate or partial macro-structures still can be mixed with lower-level propositions, which explains the length of direct summaries. Another factor which may be involved in the further contraction of second-order summaries, is increasing lack of interest, fatigue, and the feeling of 'I have told that already', which may cause a more acute application of deletion rules.

At the same time, the second-order summaries indicate the probable fate of macro-structures. Once constructed (and expressed) they continue to be subject to further macro-operations. In the long run, then, like for recalls after

long intervals (months and longer), the macro-structure is itself reduced to a couple (about 5, which is the minimum of a well-formed story-summary, representable in one or two sentences) of propositions, denoting the central 'topic' or 'theme' of the story. In our story, these are apparently the propositions of the latter episodes. A typical, correct, final summary is for example the following:

"A rich man went on a business trip, but lost all his goods. He turned pirate and again had much money. One day he was captured. In a storm his ship was wrecked on the cliffs. He arrived with a chest on an island. The chest contained many jewels and he returned home happily."

Characteristic is that in such short summaries the major episodes are represented but there are no logical connections- established between the propositions, whereas all further details are fully deleted.

The main narrative purpose of the story is well-represented in the following abstract, in which the proper *functions* of each episode are represented:

"A rich man wanted to have much money, becomes very poor, becomes pirate, becomes rich again, is robbed and captured, is shipwrecked, is washed ashore, becomes rich again due to a chest on which he had been drifting, and which contained jewels."

Erroneous contractions in such cases occur of course. In some protocols, even in the recalls, the man directly is or turns pirate. The chest and jewel episodes however are always present. This may have at least three reasons:

- (i) this part of macro-structure is the definite successful event leading to the desired final state;
- (ii) the episode is most striking of all, due to the unusual nature of its events; also it is most 'risky';
- (iii) it is the last major episode of the story.

The converse could be said of the first (trading) episode, which therefore is first deleted or contaminated with other parts of macro-structure. Finally, it is interesting to see that, indeed, propositions and lexical items of the final summary are really generalizing, abstracting and integrating over micro-propositions or intermediate macro-structures. Thus the 'failure in business' episode is often reduced to 'He went bankrupt (after trading goods)'. The same holds for 'He became a pirate', 'He was robbed', 'Washed ashore on a chest', etc. Propositions still very frequent in recalls, e.g. the one describing L. R.'s first grabbing a spar, are fully left out. Apparently, in retrieving a most general structure, irrelevant propositions disappear, even if they were often recalled for other reasons (perhaps the visual imagination of the shipwreck-sea scene).

The main conclusions from this experiment seem to be that summarizing has a gradual character, is facilitated by partial (expressed) summaries, that macro-rules are applied recursively, leaving a structure which is each time more concise and more general, leaving the crucial and most striking major

episode intact. Since again these findings are parallel to properties of long-term recalls after long intervals, the hypotheses that the same processes determine 'conscious' (though intuitive of course) summarizing and 'sub-conscious' forgetting/reproduction/recall.

We see that 'chunked' summaries are a plausible 'model' for the processing of information during normal reading-comprehension: what is stored and recalled in the immediate recalls is similar to the information contained in the chunked summaries. Differences, as we saw (also in the previous test) pertain to the convergence on the most important propositions: twice as much 'important' propositions occur in most protocols, and deviations from the mean length are much lower. We also see (d. Appendices B and C) that the notion of macro-structure is *relative* with respect to a (part of the) text: what is a macro-proposition in the first chunk, no longer may be at the level of the story as a whole, e.g. the proposition (nr. 14) about the spar. It follows that macro-operations are recursive: they reapply as soon further information is added so that the whole is too complex to be 'handled'.

6.6. Experiment V

6.6.1. The last three experiments to be reported here are summary tasks under specific conditions, viz. the interaction of summaries with the texts they are summarizing. Within the line of similar experiments in the verbal learning tradition, it may be asked in which respects previously given summaries determine comprehension and further processing of the text itself. Thus, we would expect that a given summary, interpreted as an expression of underlying macro-structure facilitates or otherwise influences the construction of macro-structures in the reading process. As is the case for problem solving tasks, adjunct questions, and similar organizing contexts, we expect that the subject will need not make hypotheses about the macro-structural function of each proposition or sequence of propositions, whereas his attention will selectively be drawn to those propositions most closely satisfying the previously given summary.

The theoretical interest of these experiments should also be seen in the perspective of the assumptions tested in the previous experiments. If, indeed, it is the case that information from complex verbal discourse is ultimately stored as some form of macro-structure, we not only might get some insight in how previous information influenced our perception and retention of a given text, but also how a given text may 'corred' previous information. Clearly, if a serious model for this interaction between discourses would be available, we would have some basis for possible applications in social psychology (spread of rumours, distortion of news, influence of propaganda), a topic which also was crucial for Bartlett, but which is neglected in current experiments with discourse in cognitive psychology. Thus, our theoretical work on discourse

not only aims at an understanding of the underlying cognitive processes, but also at more explicit knowledge about processes of communication in the social context and the 'flow of information'. In this respect, the results of current work on the psychology of discourse may provide the necessary corrections to the vague assumption and methods in such areas as content analysis, both in social psychology and in mass communication research.

6.6.2. *Subjects*

Subjects in these three tests were students in a school of chemical analysts. Their age was about 18-19 years. For this first test the number of subjects was 18. They were not paid for their services: the experiments were carried out by their teacher in a class of Dutch.

6.6.3. *Design and Procedure*

The design of this test was to test memory for a given summary, as a discourse after presentation of the text itself, and to see in which respects the macro-structure constructed during reading of the text would retro-actively affect the structures stored from the summary. The story was again the one used in the previous experiments. A summary was constructed by the experimenter along intuitive criteria. Including the title, this summary had a length of 23 'propositions', i.e. the sort of 'molecular' (in stead of atomic) propositions underlying a minimal clause of natural language. It turned out that, of course, this summary was not arbitrary: it in fact was nearly identical with the list of 23 propositions remembered by most subjects in the recall experiments. The summary is a Dutch version of the following text:

The punished pirate [the title of the Dutch translation]

A rich merchant wanted to double his fortune and therefore loaded a ship with cargo in order to trade. Due to heavy competition he was, however, forced to sell his goods far below their price.

Because he did not want to return home as a poor man, he became a pirate and as such he was more successful. However, on his way home, a storm forced him to drop anchor in a bay, where merchants cornered him and took him as a prisoner. On their way there was another storm so that he [the merchant] fell into the sea. But he managed to keep himself floating on a chest and after many hardships arrived on a coast where a woman cared for him. He discovered that the chest contained a fortune in jewels, so that he could return home rich.

(This English translation is kept as close to the Dutch version as possible).

Note that some episodes are deleted in this summary: the shipwreck as such and the episode with the spar, and also the final episodes of returning home, meeting landsmen, and sending a reward to the woman and the landsmen who had helped him. Originally, we did not consider these episodes to be structurally crucial, but given the results of the earlier recalls, they were considered to be important macro-structures anyway. The advantage of these omissions for this test, however, are clear: it would be probable that the 'omitted' proposi-

tions would be filled in by the subjects after having read the text itself. The procedure was as follows: the subjects were told that a psychological test had to be taken for some university research about summaries. It was told that a summary of a story would be read followed by that story, but without specifying previously the task required. Then, the summary was read, followed by the story itself. The subjects were not allowed to make notes. After presentation, the subjects were requested to write down as precisely as possible, though in their own words, the summary itself.

6.6.4. Results and Discussion

The *number of propositions from the abstract* recalled by the whole group was 23 (100%). In fact, more than 7 subjects recalled all propositions, whereas 16 propositions (69.6%) were *recalled by most* of them ($Z = 12$). Six propositions were recalled by all (but one) subjects. The mean *number of propositions of the summary recalled* was 17 on a liberal count (according to the criteria given above) and 7.7 on a strict count. In the strict scores the propositions counted had to be equivalent with the original propositions. No protocol was fully correct, but 6 protocols scored at least 20 of the original 23 propositions (the title, as in the other tests, was often forgotten: it occurred only twice).

The *length of the protocols* ran from 20 to 35 propositions, with an average length of 26. Hence, some propositions were added, either by inference from the summary propositions or by retro-active interference from the text. The standard deviation from the mean of 17 was 3.7.

One of the subjects only recalled the last part of the summary (from the shipwreck onwards), which in all experiments, as we saw, was best recalled in general. Three further subjects left out one or two important episodes, whereas other less important omissions occurred at least in half of the protocols.

In all cases some *influence of the text itself* could be traced in *the recall of the summary*. There were at least 21 propositions from the text, but not occurring in the summary, occurring in the protocols. Imposed from the text in three or more protocols where the following propositions:

- There is a beautiful coast in Italy (2-3)
- He sailed with his ship to Cyprus (21)
- There were many other ships with the same goods (22-23)
- He sold his ship and cargo and bought a pirate vessel (34-35)
- As a pirate he had doubled his fortune (42)
- Two [Genoese] merchants also dropped anchor in the bay (56)
- The ship crashed on a sand-bank (85)
- He lived in splendour for the rest of his life (184).

No definite conclusions can be drawn from these results, but the following provisional observations can be made. First of all, recall of propositions, as such, is never very frequent, both in the recall and the summary experiments,

if a strict scoring (equivalence) is used. This means that in most cases propositions are partially recalled, combined with others, or abstracted from in more general propositions.

In a more liberal count, however, most of the propositions were recalled by most of the subjects. We need of course further data, in order to establish that recall of a summary is facilitated after presentation of the story itself. It seems however, that the nearly 70% recall is higher than a recall of a previously given different story summary. The relatively high recall percentages may not only be due to the partial equivalence in macro-structure of both the summary and the text, but also to the fact that a summary is a relatively short discourse, of which recall is of course in general better than for longer stories. In that case, the propositions of the summary itself tend to be recalled in their own right. The effect in that case would be strengthened by the equivalence with the macro-structures of the text itself, as is clear from Appendix C.

The influence of the text itself is beyond doubt. First of all, it seems to determine the length of those protocols which are significantly longer than the summary, but of which the propositions cannot simply be inferred from the summary alone. Thus, a generalized sentence as 'He had competition' is expanded in at least 6 protocols with the information that there were other ships with the same cargo. Similarly, the reason why L. R. fell into the sea (viz. that his ship was wrecked) also comes from the story itself. The general conclusion seems to be that an existing macro-structure is 'affirmed' by another macro-structure, but that 'missing' macro-structural propositions are added. Furthermore, the recall protocol again shows the typical properties of any type of discourse (here a story summary), which leads to possible particularization of general propositions either by probable inference or by recognition with stored less general propositions.

6.7. *Experiment VI*

6.7.1. The design of the sixth experiment is the reverse of that in the previous experiment. We wanted to test whether 'wrong' information would be corrected by presentation of detailed 'correct' information presented later. More in particular we were interested in the fate of a structural error on the construction of a macro-structure of a story.

6.7.2. *Design and Procedure*

Subjects were another group (N = 13) from the same school as in the previous experiment, same age. Time limitations were as in the previous experiment: a class of Dutch of 45 minutes, of which 5 minutes for explanation of the task, and 10 for reading the summary and the story. For this test a false summary was constructed of the story, running as follows:

The punished pirate.

A rich merchant wanted to double his fortune and therefore equipped a

pirate vessel, with which he robbed a large number of ships. On his way home, however, he was forced by a storm to drop anchor in a bay, where he was cornered by merchants and robbed of all his loot. Because he did not want to return home as a poor man, and because he understood that he had no right to enrich himself by unlawful means, he bought cargo of his last money. He was able to sell this with very high profit. On his way home, however, there was again a storm. His ship was wretched but he was able to keep himself afloat on a big chest, and after many hardships he arrived on a coast where a woman cared for him. He discovered that the chest contained a fortune in jewels, so that he could return home rich.

The initial instructions for the subjects were the same: no previous remarks were given about the precise task of the test. The incorrect summary was read and followed by the story itself. The teacher then said: "You have of course noticed that the story runs in a different way as summarized in the summary. Please, give a correct summary of the story". This instruction, of course, slightly biased the data, because, it might have been the case that the subjects had not perceived the difference. From the data, however it is clear that all subjects had perfectly understood that the summary was incorrect, which is also clear from the next test.

6.7.3. Results and Discussion

The *total number of propositions* used by the group was 100 (54.3%), which nearly coincides with the other summary protocols. This seems to indicate that no constraints by the length and propositions of the (false) summary operate in the choice and construction of propositions for a correct summary: the correct summary in this respect only depends on the story itself.

The *number of propositions used by more than two-third* of the subjects was 21 (11.4%), of which 11 also occurred in the abstract. This number is higher than for experiment III, where there were only 10 propositions identical in most summaries. The number of 21 rather should be compared with the corresponding frequency in free recall tasks. The fact that in this test subjects tend to select more from identical propositions, i.e. have a greater convergence on what are considered 'important' propositions, may be caused by the previously given false abstract, which already provides 11 of the number of 21, irrespective of their incorrect order.

The *average length of the protocols* in terms of propositions of the story was 37 propositions, to which again at least three propositions must be added as being 'new', i.e. inferred or imagined. Length varied from 22 to 45 propositions, with a standard deviation of 7.2. The average length of the protocols here is higher than that in experiment III, where it is 31. If the previously given summary (although wrong) would have had influence on the length of the summary to be given — e.g. as an 'example' of a summary — we rather would have expected shorter summaries in this task.

The most frequently recalled propositions 9) are:

12, 15, 18, 19, 21, 22, 24, 34/35, 45, 51, 53, 76, 85, 98, 111, 118, 140, 152, 177, 180, 181, 184.

Apart from the description of how he got ruined as a merchant, the list highly correlates with that of the most frequent propositions in the first test, and with the list of the gradual summaries in experiment IV.

There is only one subject having introduced part of the wrong order of the previously given summary: beginning with a merchant who directly turns pirate. However, the other parts of the summary are not taken over, so that even this only one case could very well be interpreted as a short-cut error, leaving out the whole first episode, which was the case in several protocols of the other tests. It follows, at least for our data, that subjects are able to discriminate between two macro-structures which are structurally different but have nearly the same content, that there is hardly any pro-active interference or that last constructed macro-structures dominate those acquired earlier, and/or that a macro-structure constructed with elaborate data of a longer story are more 'firmly' stored, than those acquired from reading a summary. Indeed, it should again be emphasized that a summary is also a discourse, in our case a very short story, on which the usual macro-rules, if possible, apply.

That subjects make their own macro-structures without too much interference from correct or incorrect 'example' summaries, can be seen again in the frequency of recall for propositions 180, 181, and 184 who were not used in our own summaries. The 'giving of a reward to a helper' appears to be an essential narrative constraint on stories, hence also on summaries of stories, which according to our theory must also be narratives. Similarly for the formulaic last sentence of the story. The subjects not only try to reproduce the essential parts of the story, but also follow usual production rules for telling stories. This is very clear in the recall tests, where many subjects tried to enhance certain stylistic effects with adverbs and adjectives which they would rather use in their everyday story telling behavior among each other.

6.8. *Experiment VII*

6.8.1. *Design and Procedure*

The aim of this test was similar to that of the preceding experiment, but we now wanted to see in what respect subjects were able to reconstruct previously heard incorrect information.

Subjects (N = 13) were of the same school, age, etc. as in the two previous experiments. Further external conditions of the test were also the same.

The incorrect summary was read, and then the story. The task was to reproduce as precisely as possible the previously given summary, whether it is correct or incorrect. Again the instruction may have influenced the perception of incorrectness, but again it is clear from the data that the subjects had already noticed the error.

6.8.2. Results and Comments

The *group recalled* 22 of the 23 propositions of the false abstract. The sentence which was not recalled in any of the protocols was: "He understood that he had no right to enrich himself by unlawful mean", the only sentence which does not occur in the proper story at all, but which was necessary in the incorrect summary in order to explain the permutation of the first major episodes. However, 13 and 14 are only partly identical with propositions from the text (in fact they are contradictions), and are much better recalled. Given the fact that further the proposition "He did not want to return home as a poor man", which occurs both in the incorrect abstract and in the text itself, is also poorly reproduced (by two subjects), we will have to assume that the normal macro-deletion rule for mental reasoning (motivation) has led to the disappearance in the protocols of the sentence in question.

From the total number of 23 propositions in the incorrect summary, 15 are *recalled by more than two-third* of the subjects. This number practically coincides with that of experiment V for the recall of the correct summary. The average number of propositions recalled from the summary was 16 (on a liberal count, and 11 on a strict scorage count). There are 5 propositions recalled by all subjects. Deviation from the mean number of propositions (out of the summary) was 2.4. The most striking difference with experiment V is that none of the subjects made a fully correct reproduction. The incorrect order apparently produced serious difficulties. More than half of the subjects completely omitted the episode in which the merchant, having lost his pirate loot becomes honest again and has luck with selling goods. One subject made a nearly correct reproduction and four essentially have understood and recalled the logic of the incorrect summary, although leaving out some propositions.

Yet, the permutation in the order of the episodes has been noticed by all subjects (but one): they all let the merchant become first a pirate, who then in a storm is robbed by other merchants. The problems begin with the sequence initiated by the proposition "He did not want to return home as a poor man". Most subjects then directly go the episode where he is shipwrecked, saved on a chest, etc., just as in the story itself. Apparently, the order of the story retroactively influences the macro-structure of the wrong summary. Let us

- A° : There is a rich man (in Italy) who wanted to become twice as rich.
- B- : He trades but loses all his money.
- C+ : He turns to piracy and becomes rich.
- D- : On his way home there is a storm. He is robbed and captured by merchants.
- E- : He is shipwrecked, falls into the sea and floats on a chest.
- F° : He arrives on a coast, is saved and cared for by a woman.
- G+ : He finds jewels in the chest.

H+: He returns home, helped by his countrymen, sells the jewels, sends rewards to his helpers, and lives in splendour for the rest of his days.

Depending on whether an episode ends neutrally (or undecided), positively or negatively, we have added upper °, to the letters denoting the episodes, to be defined in terms of (in-)consistency with the intended final state (X is twice as rich). We briefly disregard the hierarchical structure of the sequence.

Now, the incorrect summary must be denoted by the following sequence: (A°, C+, D-, —B+, E-, F°, G+, H+), where —B is negative (i.e. the contrary of B in the story). However, by contamination most subjects recall:

(A°, C+, D-, E-, F°, G+, H+). That is, instead of permuting the order from BCD to CD—B, they simply delete —B, and directly connect D and E, as in the story.

The *average length of the protocols* was 16 from the summary or story +3 from the story +2 imported propositions, i.e. 21 propositions. This is markedly less than in the recall of a correct summary (26), and is partly due to the deletion of episode B (or —B). As for test V, however, the recall of summaries is more selective than giving an 'own' summary, which is between 30 and 40 propositions long. Thus, although propositional elements of the text intrude in our memory for a previously given summary with similar macro-structure (correct or transformed) as the text itself, the recall of the summary is not entirely based on the construction of a macro-structure for the whole text. In other words: the subjects recall the fact that the summary was more concise, and reduce at least their own summary to this estimated length and complexity.

6.8.4. One of the striking details of the summary recalls and the given summary of the last three experiments is that most of them start with the first sentence (or a transformational variant of it) given in the summary: "Once diere was a rich merchant who wanted to double his wealth". The summaries given in experiment III do not have this property and mostly include both a reference to Italy, the Amalfi coast and Ravello, and mention the name of the merchant. The last three tests seem to indicate that the subjects take over a summarizing 'hint' from the previously given summary, even if they have to provide a correct summary themselves (as in VI).

Although the theme 'x wants to double his fortune' occurs in the story as the central motivation of the agent's action, the subjects recall this element more in the summary-recall tests than in the free recall tests, viz. twice as much (80% vs. 40%). This also seems to indicate that the summary controls at least in some respects the comprehension, macro-construction and storage of information of the text itself. Another striking fact was that in none of the recalls of the summary there was an intrusion of the spare episode from the text: all protocols followed the macro-structure as expressed by the summary: "He kept himself afloat on a chest". Similarly an implied detail in the text which is expressed in the summary, viz. that the woman cared for him *lovingly* (Dutch:

een vrouw verzorgde hem *liefderijk*) is also taken over in the recall, perhaps also because the whole expression in Dutch is nearly standard.

From the 23 propositions of the summary an average of 7 is omitted (one subject scored 21), viz. the title, the second time he is sailing home, and the four propositions of the permuted episode (also half of the subjects mentioned that he goes back into business after being robbed). Deleted are the mental decisions and the 'moral' of the incorrect summary. The propositions imported are partially added from the text and/or based on inferences, e.g. the fact that he was (twice as) rich after having robbed many ships, and that he opened the chest. Propositions added are often also subordinate clauses used as *output constraints*, i.e. clauses expressing presuppositions making the summary-recall more coherent: "Robbed from all his possessions, the merchant ...", "The ship, on which he was taken away, ...". These are rather grammatical output constraints, whereas clauses like "Now he was poor/rich (again)" are narrative constraints, keeping track of the decisive positive or negative states of the story.

7. General Discussion and Conclusions

7.1. The experiments described above had a very provisional character. Hence, no precise conclusions can be drawn. Still, they seem to provide enough empirical results to confirm a certain number of our hypotheses. Let us briefly enumerate these results and make some conclusions with respect to the hypotheses they are supposed to warrant.

7.2. For the *recall experiments* for complex narrative discourse we found:

- (i) Given a narrative discourse of sufficient length and complexity, subjects will on immediate trial recall about a third of its propositions. On second (one week interval) trial, the average protocol had merely a fifth left of the original set of propositions of the text.
- (ii) The set of propositions recalled by the groups was at least a sixth smaller than the original set, on first trial, and only a bit more than half of it, on second trial. That is, there is a considerable number of propositions which do not occur on any protocol. This number has more than doubled in the second trial.
- (iii) Whereas the number of propositions recalled by less than a third of the subjects (occasional recall) is more than 60% on first trial and 75% on second trial, the number of propositions occurring in most protocols is about 10%. This 'core' of important propositions is much more resistant against forgetting over time: most of them are still recalled on second trial.
- (iv) There are no significant differences between recall for texts which have been orally presented and those presented in print (although in our data

the delayed recalls of the written version were better, which however seems group dependent).

- (v) The propositions having the highest probability of not being recalled, or being recalled by only a few subjects, and which — once recalled on a first trial — tend to disappear from second trial protocols, have the following properties:
- setting descriptions;
 - preparatory action descriptions
 - mental action descriptions, except for a statement about a decision for major actions, providing the purpose of a major action sequence
 - component actions of an action
 - likely consequences of an action
 - all meta-narrative statements, comparisons and stylistic repetitions.
- (vi) The major propositions recalled (i.e. about 10%) have the following properties:
- they introduce the main agent (+ opponents, + helpers)
 - state his major purpose of action + (non-)realization
 - describe his actions which directly lead to/from the realization of this purpose (intended final state)
 - describe the events occurring to the agent which directly lead to/from the realization of the purpose
 - describe the main opposing/helping actions of opponents and proponente (helpers).
- (vii) The recall protocols are no direct 'reflections' of the propositional structure of the input text: at least two-third of the propositions 'recalled' are either only partially recalled and/or combined with other propositions in a 'new' molecular form ('clause').
Furthermore, recall protocols are also discourses in their own right, showing the normal constraints on coherence (e.g. certain repetitions of presuppositions in subordinate clauses, adjectives and sentence adverbials).
Finally, the protocols show certain narrative output constraints in which the subjects inevitably tried to make even their recall protocol interesting as a (mini-)story, e.g. following conventions of exaggeration.
The same holds for the summaries.
- (viii) When abstraction is made from the exact propositions of the original text, and a list of constructed propositions is made covering the major episodes of the story, score with respect to this list is very high: most two-third) subjects 'recalled' at least 90% of such a list.
- (ix) Structural errors made by a subject in the first trial are in general repeated (i.e. not corrected) in subsequent trials.

7.3. For the *summary experiments* we found:

- (x) The total number of propositions selected from by the group was similar to that in second trial (one week interval) recalls, viz. between 50% and 60%. The same holds for the lengths of the protocols: a sixth of the original.
- (xi) When a gradual summary can be made (e.g. in summarizing the main episodes of a story) the results are similar to that of immediate recalls (total number of propositions recalled by the group, lengths of protocols, etc.) but there is more consistency in selecting the more important propositions (20% instead of 10% occurring in most protocols). A total, over-all summary given after partial summaries is significantly shorter (a third) than a 'direct' summary, and only 27% of the propositions (in stead of 50% to 60%) of the original input text is used to construct second order summaries.
- (xiii) The propositions used most in the summaries are the same as those used in the recall protocols, and are in all cases at least a third of the protocol.

7.4. In the *summary-recall experiments* we found:

- (xiv) Given a summary of a story, presented before the story itself, subjects recall, as a group, all propositions of the summary, whereas most subjects recall at least 70% of the original propositions of the summary.
- (xv) A recall of a given summary is shorter than an 'own' summary of the subject, but longer than the summary given. I.e. subjects introduce propositions from the text in their recall of a summary and add the usual output ('production') propositions. The highest probability of retroactive interference from the text have those propositions which are recalled most in the recall experiments, and which denote major events, but which were not used in the previously given summary.
- (xvi) There is hardly any influence of an incorrect, previously presented, summary on 'own' summaries by the subjects of the story, e.g. in terms of length or selection. There are a few cases where the subjects follow the hint of an appropriate summarizing proposition of the given summary in their own summaries.
- (xvii) Subjects have difficulties in reproducing an incorrect summary after presentation of the story itself, especially of those episodes which have been permuted in the incorrect summary, and especially of the proposition 'motivating' the different order. Hence, recalls of incorrect summaries are rarely fully correct, in half of the cases approximately correct, and in average considerably shorter than recalls of correct summaries.

For all experiments a small number of propositions (between 10% and 15%) of the story occurred in any reproduction (recall, summary or recall of summary), whereas 50%-60% of the propositions tend to disappear fully. Variations between subjects hence come from a set of about 30%-40% of the

original propositions. In most cases these propositions denote causes, reasons, auxiliary and component actions, of the major actions/events denoted by the major propositions.

7.5. From these data a certain number of conclusions seem warranted. First of all there is a strong positive correlation between recall and summary behavior/activity. The propositions produced in both recall and summary experiments are roughly the same (when frequency is taken as a first criterion). This is most striking in second trials for recall: these are very similar to immediate summarizing protocols. It seems to follow that summarizing rules and strategies are based on the same principles and conditions also determining storage and retrieval in recall.

There is only a relatively small number of propositions recalled from a longer text. These are not necessarily identical with those of the text, but certain transformations of them. The nature of these propositions can be theoretically predicted by:

- a. the rules of narrative
- b. the logic of events and actions
- c. macro-rules for complex semantic information processing.

The rules of narrative determine which sequences of propositions are most important for the narrative structure, i.e. are directly dominated by obligatory narrative macro-categories. The logic of events and actions, underlying the narrative rules, determines coherence and consistency of the action/event sequence (and their memory representation), and provide the criteria for hierarchies between actions in terms of their structure.

The macro-rules operating on well-formed narrative action discourse, reduce the information within the constraints of the narrative rules (the resulting macro-structure must be narrative) and the logic of action (reducing only lower' or secondary actions and events). They map sequences of propositions on propositions entailed by these sequences, by abstraction, generalization, deletion and construction. The propositions recalled most in the experiments are the same as those predicted by the theoretical macro-rules, whereas those forgotten or abstracted from are those which do not remain under macro-operations.

In summarizing behavior this macro-structure, gradually built up in comprehension, can be 'read-off' directly from the semantic store in which it is retrieved. In recall, the macro-structure is retrieved and then serves as a 'clue' for re-production. Propositions are derived from it by probabilistic and deductive inferences and checked with what is left in the processing stores for the propositional sequence. That is, the macro-structure is, following the converse macro-rules, expanded in a recall protocol, such that the detail-propositions are reproduced if recognized in the processing stores. False recognition and added propositions in recalls demonstrate that this process is indeed based on probabilistic inferences from the macro-structure: a proposition directly fol-

lowing from a macro-structure will tend to be 'recognized', whether in the original text or not. This is a well-known fact." Errors in the reproduction of macro-structure are rare. Thus, in our data, it sometimes happened that the agent, instead of going home rich with his jewels, stayed on the island marrying the woman who had helped him. This can be predicted by narrative conventions, rules and functions, in which a resolution and/or final reward is often in the form of a marriage. That is, the actual macro-structural content here interferes with certain universals of simple (folk-tale) narratives.

The fact that structural errors (in the macro-structure) persist in subsequent recalls further demonstrates that a macro-structure is directly constructed during input (comprehension), and that it further organizes the storage and retrieval of more detailed information.

In subsequent recalls it is mainly the macro-structure which determines reproduction, since the processing stores are gradually losing the detail-propositions abstracted from by the macro-rules. Then, the macro-structure itself is submitted to further macro-rules, if possible, and prepared for integration in the incidental fact store and the systematic knowledge store. The processes involved here are yet unknown.

7.6. Although the main macro-structure hypotheses seem to be confirmed by the experimental results, and appear to provide serious explanation for most of the comprehension, storage and recall experiments for discourse reached in the Bartlett tradition, there are still a number of important problems.

As we have just remarked at the end of the previous section, we do know little about the further fate of constructed macro-structures in episodic and epistemic memory. It has been demonstrated (especially by Bartlett) that macro-structures themselves do not survive either: they are integrated into our fact- and knowledge-systems, at least if they provide further information about facts and objects about which we have acquired information from other discourses. Secondly, we still have the problem of the individual differences both in recall and in summaries. Although it may be assumed that the macro-rules and their conditions are the same for each language user, the rules may be applied in different ways by different subjects. Stylistic differences, as discussed by Paul (1959) provide only part of the insight into these differences. Other differences are based on differences in the underlying fact- and knowledge stores of the subjects: what is a 'striking detail' for one subject may be

¹⁹ See the results obtained, for sentences, by Bransford & Franks (1972).

We interpret our treatment of macro-structures as a formal account of the notion of 'abstract idea' used by these authors. The same holds for such notions as 'theme', 'topic', etc. used in the literature on memory for discourse.

As we have remarked in the beginning of this paper, we did not want to discuss in this paper the results of previous psychological work on discourse, although they are partly relevant for our theoretical and experimental treatment. We think of work by such scholars as Bower, Carroll, Cofer, Clark, Frase, Pompi, Lachman, Dooling, Sachs, Schank, Slamecka, Gomulicki, Rothkopf, Freedle, Crothers, and others not referred to in this paper.

less striking for another subject. How there 'personal' factors interact with the macro-strategies is still obscure. We have observed that the macro-rules for the comprehension and organization of narrative discourse, depend on semantic, logical and pragmatic properties of narrative. In order to fully understand the processing of complex information in general, we would need data about the operation of macro-rules-for different types of discourses. Thus, in descriptive discourse, descriptions will of course not simply be deleted, whereas in argumentative discourse motivations, reasons, etc. will become the major 'states' of the discourse. Similarly, in order to acquire insight into the integrated nature of cognitive operations, we would have to know more about the relations between macro-structures determining the production and comprehension of narratives and the processes determining the planning and execution of action. Although we have primarily studied processes of comprehension, organization and retrieval, it seems certain that macro-structures also organize production of complex discourse. Similarly, macro-plans must be postulated in order to explain our ability to execute a long series of linearly ordered actions to which a hierarchical structure may be assigned.

Most previous models for discourse memory are word or proposition based, either assigning linear structure or assigning conceptual and/or rhetorical hierarchical structure to the input string. We have seen that these models do not adequately account for the relevant data. The rules of comprehension and organization require macro-processes which are constrained by the principles of the type of discourse and their underlying logic. Instead of constructing enormously complex hierarchical structures for the discourse (in which each proposition has its place) such that the 'top' of this structure is stored, the comprehension process rather seems to be based on systems of inference based on rules of narrative natural logic and world knowledge. Thus, interpretation strategies first must reduce the complex informational structure to a small number of macro-propositions which are then assigned to some narrative category. Only in that case, is the resulting hierarchical structure simple enough to be further processed.

Appendix A

Text of the Story

From: Giovanni Boccaccio, *The Decameron*. Translated by G. H. McWilliam (Harmondsworth: Penguin Books, 1972) pp. 136-141.

N. B. A short summary of the story and the presentation of the story by one of Boccaccio's narrators has not been reproduced here, since it has not been used in the experiments.

This English version and the Dutch version have some minor differences, as can be seen in the proposition list in Appendix B.

Few parts of Italy, if any, are reckoned to be more delightful than the sea-coast between Reggio and Gaeta. In this region, not far from Salerno, there is a strir

of land overlooking the sea, known to the inhabitants as the Amalfi coast, which is dotted with small towns, gardens and fountains, and swarming with as wealthy and enterprising a set of merchants as you will find anywhere. In one of these little towns, called Ravello, there once lived a certain Landolfo Rufolo, and although Ravello still has its quota of rich men, this Rufolo was a very rich man indeed. But being dissatisfied with his fortune, he sought to double it, and as result he nearly lost every penny he possessed, and his life too.

This Rufolo, then, having made the sort of preliminary calculations that merchants normally make, purchased a very large ship, loaded it with a mixed cargo of goods paid for entirely out of his own pocket, and sailed with them to Cyprus. But on his arrival, he discovered that several other ships had docked there, carrying precisely the same kind of goods as those he had brought over himself. And for this reason, not only did he have to sell his cargo at bargain prices, but in order to complete his business he was practically forced to give the stuff away, thus being brought to the verge of ruin.

Being extremely distressed about all this, not knowing what to do, and finding himself reduced overnight from great wealth to semipoverty, he decided he would make good his losses by privateering, or die in the attempt. At all events, having set out a rich man, he was determined not to return home in poverty. And so, having found a buyer for his merchantman, he combined the proceeds with the money he had raised on his cargo, and purchased a light pirate-vessel, which he armed and fitted out, choosing only the equipment best suited for the ship's purpose. He then applied himself to the systematic looting of other people's property, especially that of the Turks.

In his new role, he met with far more success than he had encountered in his trading activities. Within the space of about a year, he raided and seized so many Turkish ships that, quite apart from having regained what he had lost in trading, he discovered that he was considerably more than twice as wealthy as before. He thus had enough, he now realized, to avoid the risk of repeating his former mistake, and once he had persuaded himself to rest content with what he had, he made up his mind to call it a day and return home with the loot. Being wary of commercial ventures, he did not bother to invest his money, but simply steered a homeward course, at breakneck speed, in the tiny ship with which he had collected his spoils. He had come as far as the Archipelago, when he found himself sailing one evening directly into the teeth of a southerly gale, and his frail craft was barely able to cope with the mountainous seas. So he put into a cove on the leeward side of a small island, with the intention of waiting for more favourable winds. He had not been there long, however, when two large Genoese carracks, homeward-bound from Constantinople, struggled into the bay to escape the same storm from which Landolfo had taken shelter. The crews of the Genoese ships recognized Landolfo's vessel, which they already knew from various rumours to be loaded with booty. And being by nature a rapacious, money-grabbing set of people, they blocked his

way of escape and made their preparations for seizing the prize. First they put ashore a party of well-armed men with crossbows, who were strategically placed so that no one was able to leave Landolfo's vessel without running into a barrage of arrows. Then they launched cutters, by means of which, aided by the current, they drew themselves towards Landolfo's little ship. This they captured without losing a man, after a brief and half-hearted struggle, and they took her crew prisoner. Landolfo was left wearing nothing but a threadbare old doublet and taken aboard one of their ships, and after everything of value had been removed from his vessel, they sent it to the bottom.

The next day, the wind changed quarter, and the two ships hoisted their sails and set a westerly course. For the whole of that day they made good progress, but in the evening a gale began to blow, producing very heavy seas and separating the two carracks from each other. By a stroke of ill-luck, the ship in which the wretched, destitute Landolfo was travelling was driven by the force of the gale on to the coast of the island of Cephalonia, where she ran aground with a tremendous crash, split wide open, and like a piece of glass being flung against a wall, was smashed to smithereens. As is usually the case when this happens, the sea was rapidly littered with an assortment of floating planks, chests and merchandise. And although it was pitch dark and there was a heavy swell, the poor wretches who had survived the wreck, or those of them who could swim, began to cling to whatever object happened to float across their path.

One of their number was poor Landolfo, who had in fact been calling out all day for death to come and take him, for he felt he would rather die than return honre poverty-stricken. But now that he was staring death in the face, he was frightened by the prospect, and like the others he too dung to the first spar that carne within his reach, in the hope that by remaining afloat for a little longer, God might somehow come to his rescue.

Settling himself astride the spar as best he could, he dung on till daybreak, meanwhile being tossed hither and thither by sea and wind. When dawn came, he cast his eyes around him, but all he could see was clouds and water, and a chest floating on the sea's surface. To his great consternation, this chest floated every so of ten into his vicinity, causing him to fear Test it should collide into him and do him an injury. So whenever it came too near, he summoned up the meagre strength he still possessed, and pushed it away as best he could with his hands.

But as luck would have it, the sea was struck by a sudden squall, which sent the chest hurtling into Landolfo's spar, upending it and inevitably causing Landolfo to lose his grip and go under. When he re-surfaced, he found that he was some distance away from the spar, and was afraid that he would never reach it, for he was exhausted and only his panic was keeping him afloat. He therefore made for the chest, which was quite close at hand, and dragging himself up on its lid, he sprawled across it and held it steady with his arms. And in this fashion, buffeted this way and that by the sea, with nothing to eat

and far more to drink than he would have wished, not knowing where he was and seeing nothing but water, he survived for the whole of that day and the following night.

By the next day, Landolfo had almost turned into a sponge when, either through the will of God or the power of the wind, he arrived off the coast of the island of Corfu. Clinging grimly to the edges of the chest with both hands, just as we see a man in danger of drowning attaching himself firmly to anything within reach, he was sighted by a peasant woman, who happened to be scouring and polishing her pots and pans in the sand and salt-water.

At first, being unable to make out what creature it was that was approaching the shore, she started back with a cry of alarm. He said nothing to her, for he was quite unable to speak and scarcely able to see. But as the current bore him closer to the shore, she could make out the shape of the chest, and peering more intently, she first of all recognized a pair of arras stretched across its lid, after which she picked out the face and realized it was a human being. Prompted by compassion, she waded some distance out into the sea, which was now quite calm, took him by the hair and dragged him to the shore, chest and all. There, with an effort, she unhooked his hands from the chest, which she placed on the head of her young daughter who was with her, whilst she herself carried Landolfo away like a baby and put him into a hot bath. She rubbed away so vigorously at him and poured so much hot water over him, that eventually he began to thaw out and recover some of his lost strength. And when she judged it to be the right moment, she took him from the bath and refreshed him with a quantity of good wine and nourishing food. After she had nursed him to the best of her ability for several days, his recovery was complete and he took stock of his surroundings. The good woman therefore decided it was time to hand over his chest, which she had been keeping for him, and to tell him that from now on he must fend for himself. And this she did.

He could remember nothing about any chest, but he nevertheless accepted it when the good woman offered it to him, for he thought it could hardly be so valueless that it would not keep him going for a few days. His hopes were severely jolted when he discovered how light it was, but all the same, when the woman was out of the house, he forced it open to see what was inside, and discovered that it contained a number of precious stones, some of them loose and others mounted. Being quite knowledgeable on the subject of jewels, he realized from the moment he saw them that they were extremely valuable, and his spirits rose higher than ever. He praised God for once again coming to his rescue, but since Fortune had dealt him two cruel blows in rapid succession, and might conceivably deal him a third, he decided he would have to proceed with great caution if he wanted to convey these things safely home. So he wrapped them up as carefully as he could in some old rags, told the woman that if she liked, she could keep the chest, since he no longer had any use for it, and asked her to let him have a sack in exchange.

The good woman gladly complied with his request, and after he had thanked her profusely for the assistance she had rendered, he slung his sack over his shoulder and went on his way, first taking a boat to Brindisi and then making his way gradually up the coast as far as Trani, where he met some cloth-merchants who hailed from his native town. Without mentioning the chest, he gave them an account of all his adventures, and they felt so sorry for him that they fitted him out with new clothes, lent him a horse, and sent him back with company to Ravello, whither he was intent on returning at all costs.

Secure at last in Ravello, he gave thanks to God for leading him safely home, untied his little sack, and made what was virtually his first real inspection of its contents. The stones he possessed were, he discovered, so valuable and numerous, that even if he sold them at less than their market value, he would be twice as rich as when he had set out. So that, having taken steps to dispose of his gems, he sent, by way of payment for services received, a tidy sum of money to the good woman of Corfu who had fished him out of the sea. And likewise, he sent a further sum to the people at Trani who had given him the new clothes. He was no longer interested in commerce, so he kept the remainder of the money and lived in splendour for the rest of his days.

*Appendix B***List of Propositions of the Story with Their Frequencies in Tests I–IIA, IVA, III–VI**

Semi-bold = $k \geq 3N$	N =	32	32	21	28
	Exp.		I–IIA	IVA	III–VI
1. A pirate is punished [title of dutch version]		12	11	14	11
2. There is a coast between Reggio and Gaeta.		4	2	0	4
3. This coast is reckoned to be one of the most beautiful of Italy.		16	13	13	11
4. There is a region, near Salerno, overlooking the sea.		5	4	0	1
5. This region is called Amalfi by its inhabitants.		1	0	0	1
6. This region is dotted with small towns.		3	4	4	1
7. This region is dotted with gardens.		0	0	0	1
8. This region is dotted with fountains.		1	1	0	0
9. This region is inhabited by rich people.		9	7	4	3
10. These people are enterprising merchants.		5	4	0	0
11. One of these small towns is Ravello.		16	6	6	9
12. (There) lived a rich man.		27	21	16	27
13. He was called Landolfo Rufolo.		23	18	16	13
14. He was dissatisfied with his fortune.		11	6	4	13
15. He wanted to double (his fortune).		12	15	3	19
16. Therefore he nearly lost both his fortune and his life.		0	0	0	2
17. He made the usual calculations.		2	0	1	1
18. He purchased a large ship.		19	17	16	18
19. He loaded it with a cargo of goods.		24	21	15	17
20. He paid for it out of his own pocket.		7	6	4	6
21. He sailed to Cyprus (with it).		16	16	14	17
22. He discovered there that several other ships had docked (there).		17	17	6	15
23. They carried precisely the same kind of goods.		16	18	5	14
24. Therefore (he) had to sell his cargo at bargain prices.		14	13	14	15
25. And he had to give the stuff away.		14	9	9	7

Semi-bold = 2/3 N	N =	32	31	21	28
	Exp.	I—IIA	I—IIB	IVA	III—VI
26. He was thus brought on the verge of ruin.		9	7	5	4
27. He was reduced overnight from great wealth to semi-poverty.		8	1	10	7
28. This all distressed him very much.		5	3	0	1
29. He decided either to die,		9	0	3	5
30. or to make good his losses by privateering.		19	8	3	6
31. He had set out as a rich man.		4	2	1	3
32. So he did not want to return home in poverty.		8	7	6	11
33. He found a buyer for his ship.		18	16	0	8
34. He combined the proceeds with the money he had raised on his cargo and bought a ship		23	22	16	11
35. This was a light pirate-vessel.		18	15	7	12
36. He armed it and fitted it out, with the equipment best suited for the purpose.		7	5	3	8
37. He then applied himself to the systematic looting of other people's property,		11	11	7	5
38. especially that of the Turks.		11	4	0	1
39. In this role he had far more success than in trading.		8	4	2	9
40. During a year he thus seized and looted many Turkish ships.		16	10	11	10
41. So that (after that period) he had regained what he had lost in trading,		11	5	17	11
42. and he had doubled his fortune.		22	16	16	16
43. He saw that he had enough.		12	4	4	3
44. He wanted to avoid his former mistake.		0	1	2	0
44 a. He persuaded himself to rest content with what he had.					
45. He decided to return home (with the loot).		22	18	15	22
46. He did not invest his money.		3	0	0	0
47. He was wary of commercial adventures.		1	0	0	0
48. He thus returned home with the same ship with which he had collected his spoils.		3	3	7	2
49. The ship was rowed by vigorous rowers.		5	1	4	1
50. He came to the Archipelago.		3	2	2	3
51. In the evening there was a south-easterly gale.		30	27	20	22

Semi-bold = $_ > 2/3N$	N =	32	32	21	28
	Exp.	I–IIA	I–IIIB	IVA	III–VI
52. The seas were to high for his little ship.	6	2	3	1	
53. So he put into the bay on the leeward side of a small island.	27	28	20	18	
54. There he would wait for better weather.	2	0	0	3	
55. He had not been there long.	4	1	1	2	
56. Then two large Genoese carracks also took shelter.	26	23	20	15	
57. They carne from Constantinople.	2	1	0	1	
58. They struggled into the bay.	4	0	0	0	
59. They blocked his way of escape.	3	2	0	0	
60. They recognized L's vessel.	11	7	6	2	
61. They heard who was on it.	18	17	11	3	
62. They knew from rumours that he was loaded.	14	12	7	6	
63. They are by nature rapacious and money grabbing people.	0	0	2	1	
64. They decide to seize the ship.	13	13	10	4	
65. They put ashore a party of men.	13	8	2	0	
66. These were well-armed.	6	1	0	0	
67. They had cross-bows.	9	4	0	1	
68. They had weapons for defense.	1	0	0	0	
69. They were strategically placed	4	2	3	0	
70. So that nobody could leave the ship without being shot.	11	7	7	1	
71. They launched cutters.	8	4	0	1	
72. These drew their ships, with the current, to L's ship.	5	1	2	0	
73. They captured the ship.	18	16	12	4	
74. They were helped by the rowers.	0	0	0	0	
75. Nobody escaped.	5	2	1	1	
76. They took L. prisoner on one of their ships.	22	23	17	19	
77. They fully robbed his ship.	11	13	6	13	
78. They sent it to the bottom.	17	8	8	3	
79. L. was left wearing but a threadbare old doublet.	4	2	1	4	
80. The next day, the wind changed quarter.	7	6	6	2	

Semi-bold = $\frac{\text{?}}{N}$	N =	32	32	21	28
	Exp.	I–IIA	I–IIB	IVA	III–VI
81. The merchant hoisted their sails and set a westerly course.		9	7	13	2
82. The whole day they made good progress.		2	0	0	0
83. In the evening a gale began to blow producing very high seas.		23	20	18	13
84. It separated the two carracks from each other.		16	8	8	1
85. The storm threw the vessel on which poor L. was onto a sandbank.		29	30	21	26
86. It crashed like a bottle thrown against the wall.		6	1	0	1
87. This happened before the coast of Cephalonia.		0	0	0	0
88. The sea was directly full of planks		5	1	0	0
89. and full of chests		4	1	0	0
90. and full of spars.		5	1	0	0
91. Anyone who could swim, and had survived, tried to grab something.		9	4	11	2
92. and would cling to it,		1	0	4	0
93. although it was pitch dark		0	0	0	0
94. and the seas were high.		0	0	0	0
95. L. did the same.		11	7	4	0
96. He was frightened by the prospect of death,		3	1	3	1
97. although he had called for death all day because he had decided to die rather than to return home as a poor man.		1	1	4	0
98. He too clung to the first spar within his reach [in the hope that by remaining afloat for a little longer, God might somehow come to rescue him].		27	24	20	18
99. He set himself astride the spar.		5	1	2	0
100. He was tossed hither and thither by the sea and the winds.		2	1	7	2
101. This lasted until day-break.		6	1	7	1
102. Then, looking around, he only saw a chest except for clouds and water.		23	15	19	8
103. The chest floated every so often in his vicinity.		4	1	5	0

Semi-bold = . 2/1 N	N =	32	32	21	28
	Exp.	I--IIA		IVA	III--VI
104. He was afraid that the chest would collide into him and harm him.	11	8	9	2	
105. So every now and then he pushed it back with the meagre strength he still possessed.	19	14	11	4	
106. But a sudden squall sent the chest hurtling into his spar.	22	16	20	9	
107. The spar turned and L. went under.	17	14	16	4	
108. He came to the surface	1	0	1	0	
109. He was swimming kept afloat by his panic more than by his strength.	5	1	0	0	
110. He swam to the chest, because the spar was too far.	21	24	15	5	
111. He dragged himself up on its lid.	24	22	20	21	
112. He sprawled across it and held it steady with his arms.	5	4	0	1	
113. In this way he survived the whole day and the following night.	11	3	9	4	
114. He had nothing to eat.	10	4	1	0	
115. He had more to drink than he wished.	8	4	1	0	
115. He had more to drink than he wished.	8	4	1	0	
116. He did not know where he was.	3	0	0	0	
117. He only saw water.	3	0	0	0	
118. The next day he arrived of the beach of the island of Corfu.	29	29	21	25	
119. He had almost turned into a sponge.	5	1	0	0	
120. This happened through the will of God or the power of the wind.	3	1	2	0	
121. He was clinging with both hands to the edges of the chest like anyone drowning clinging to anything within reach.	3	0	1	0	
122. There a woman was polishing and scouring her pots and pans with sand and salt water.	18	16	18	2	
123. She saw him and had never seen something like that.	4	2	4	1	
124. She was alarmed.	10	4	3	1	

Semi-bold = ?_ . /3 N	N =	32	32	21	28
	Exp.	I--IIA	I--IIB	IVA	III—VI
125. She started back.		5	5	2	0
126. She cried.		2	1	0	0
127. He could scarcely see.		1	0	2	0
128. He could not speak, so he could not address her.		1	0	2	0
129. [But as the current bore him closer to the shore, she could make out that it was a chest, and peering more intently, she recognized a pair of arms stretched across its lid, after which she picked out the face and realized That it was a human being]		12	4	5	9
130. Prompted by compassion she waded into the sea, which was quite calm now, took him by the hair and dragged him to the shore.		10	8	8	2
131. She unhooked his hands from the chest.		2	1	1	0
132. She placed the chest on the head of her daughter who was with her.		10	8	4	0
133. She carried L. to the village		14	14	15	2
134. as if he was a baby.		2	2	1	0
135. She put him into a hot bath and rubbed him with hot water		15	8	4	2
136. He began to thaw out.		8	2	1	0
137. He recovered some of his strength.		7	2	1	0
138. When she judged it to be the right moment she took him out of the bath.		1	1	0	0
139. She gave him wine and sweet food.		9	7	2	1
140. She nursed him to the best of her ability for severa) days.		22	21	18	25
141. He recovered his strength.		10	12	8	10
142. He began to realize where he was.		0	0	0	0
143. Now the woman decided it was time to hand over his chest which had saved him.		16	13	20	9
144. and to tell him he should now find his own way, which she did.		2	2	1	2
145. He did not remember the chest.		5	2	3	0

Semi-bold = >2/3~	N =	32	32	21	28
	Exp.	I—IIA	1-II13	IVA	III—VI
146. He nevertheless accepted it.		3	3	2	0
147. He thought it could hardly be so valueless that it would not keep him going for a few days.		6	3	0	0
148. His hopes were severely jolted		4	2	2	0
149. when he discovered how light it was.		8	4	2	1
150. Nevertheless he forced it open		26	24	17	15
151. while the woman was not at home		13	10	8	4
152. He discovered that it contained a number of precious stones.		31	29	21	26
153. Some of them were loose.		3	2	1	0
154. Others were mounted.		3	1	0	0
155. He was quite knowledgeable about jewels.		5	5	3	0
156. As he saw them he understood they had much value.		4	2	10	2
157. His spirits rose high.		4	0	8	1
158. He praised God,		0	0	3	0
159. for having come again to his <i>rescue</i> .		9	9	1	9
160. Fortune had dealt him two cruel blows in succession, and might deal him a third he decided that he had to deal with great caution, if he wanted to convey these things safely home.		5	2	0	1
161. He wrapped them up in old rags.		12	6	12	9
162. He propped the woman to exchange the chest for a sack.		19	16	15	8
163. The woman gladly complied with his request.		3	1	2	0
164. He thanked her profusely for the service she had rendered.		6	4	3	2
165. He slung his sack over his shoulder, and went on his way.		0	0	0	1
166. He took a boat to Brindisi.		8	6	2	1
167. Then he made his way along the coast to Trani.		3	1	19	0
168. There he met some cloth-merchants.		10	9	16	4
169. They were from his native town.		8	7	7	3

Semi-bold = 2/3 N	N =	32	32	21	28
	Exp.	I--IIA	I--IIB	IVA	III--VI
170. He gave them an account of all his adventures.	14	8	4	6	
171. He did not mention the chest.	10	5	3	2	
172. They felt sorry for him and gave him new clothes.	17	15	14	11	
173. They lent him a horse.	15	13	9	8	
174. They sent him back with company to Ravello.	2	1	1	1	
175. There he wanted to return at all cost.	3	3	15	1	
176. Where he felt secure, thanking God, he untied his sack and inspected its contents.	3	2	6	2	
177. The stones he possessed were so valuable and numerous that even if he would sell them at less than their market value, he would be twice as rich	20	19	10	16	
178. as when he had set out.	5	4	4	3	
179. He sold the jewels.	17	13	16	17	
180. He sent a tidy sum of money to the good woman who had fished him out of the sea, by way of payment for her services.	26	22	18	22	
181. Similarly, he sent a sum to the people at Trani who had given him the new clothes.	19	19	17	14	
182. He kept the remainder of the money.	5	1	5	0	
183. He was no longer interested in commerce.	6	8	3	6	
184. And he lived in splendour for the rest of his days.	16	11	18	17	

E l.)	ii <S en	es1 rs1 <M ,	1 d ni /t .	1- N 06 ..- 1-4 1- 01
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Appendix C

List of Macro propositions of the Story with their frequencies in the protocols

Remarks: The list consists of sentences expressing molecular propositions, and is as such one possible interpretation of one of the possible macro-structures of the story.

Since in tests V and VII recall for a summary and not for the story was tested, we have not matched these data with the macro-structure list.

The percentages at the end of each row indicate by how many subjects (of a total of 134 in the tests) each proposition was somehow expressed.

The percentages at the end of each column indicate the macro-proposition score for each group/test, where $23 \times N = 100\%$ for each test.

Parentheses mark those parts of propositions which were not necessarily present for scoring.

Exp. nr.	AI	B	AII	B	III	AIV	B	VI	All
N =	17	17	15	15	15	21	21	13	134 (%)
1. (In [a beautiful part of] Italy) lived a (rich) merchant	17	15	15	15	15	21	17	13	128 (95.52)
2. He wanted to double his fortune	6	3	12	13	14	8	4	12	72 (53.73)
3. Therefore he set out (with catgo) to trade	13	13	14	15	13	16	5	11	100 (74.63)
4. Heavy competition caused that he was (nearly) ruined	14	13	14	13	12	21	14	12	113 (84.33)
5. He did not want to return home as a poor man	3	3	10	5	7	6	0	7	41 (30.60)
6. So he became a pirate	15	16	14	14	13	17	15	13	117 (87.31)
7. This made him (twice as) rich	14	13	13	14	9	19	10	13	105 (78.36)
8. On his way honre, there was a storm	13	13	15	14	12	21	1	12	101 (75.37)
9. So he took shelter in a bay	11	13	15	13	12	20	1	12	98 (73.13)
10. There he was raided by merchants	13	12	15	13	10	20	13	10	106 (79.10)
11. He was taken (prisoner) by them	13	10	12	12	8	18	8	12	93 (69.40)
12. There was a storm	16	13	13	15	12	21	6	13	109 (81.34)

Exp.	IA	IB	IIA	IB	III	IVA	IVB	VI	AB %
13. He was shipwrecked	16	15	14	15	13	21	13	13	120 (89.55)
14. He (saved himself) on a spar	15	14	14	14	9	21	1	11	85 (63.43)
15. Then he kept himself afloat on a chest	17	17	15	15	14	21	9	13	121 (90.30)
16. He was washed ashore (on an island)	17	16	15	15	14	21	13	13	124 (92.54)
17. A woman cared (for) him	17	17	15	15	15	21	17	13	130 (97.01)
18. He found (valuable) jewels in the chest	17	17	15	15	14	21	11	12	122 (91.04)
19. he returned honre	16	14	13	15	13	21	9	12	113 (84.33)
20. He was helped by (landsmen)	15	14	11	12	6	21	3	10	92 (68.66)
21. He sold the jewels (and was twice as rich)	10	10	11	7	10	17	3	12	80 (59.70)

Exp.	IA	IB	IIA	IB	III	IVA	IVB	VI	All %/0
22. He sent a reward to his helper(s)	16	14	11	11	11	19	3	10	95 (70.90)
23. (He was now twice as rich) and lived in splendour for the rest of his days (without going back in commerce)	15	13	14	15	10	20	16	12	115 (85.82)

Mean recall frequency of a macro-proposition (N = 134) 108.48 (80.96%)
 Percent recall macro-propositions (mean tests) 79.88%
 idem, without 2nd order summary (IVB) 85.64%

Appendix D

A Partial Narrative Grammar

A. Base Rules

- 1. Narrative Story (C) Moral
- 2. Story Plot (9 Evaluation)
- 3. Plot Episode (C) Episode"
- 4. Episode -> Setting O Happening
- 5. Setting Circumstances O Introduction
- 6. Circumstances -> World (C) Context)
- 7. Context -> Bio-physical
Socio-historical

- 8. World Time @ Place
- 9. Introduction -> Actor(s) 'nidal State
- 10. Happening -3 Complication **e**) Resolution
- 11. Complication

Event	(O Event)" 1	((O Event)"	9 NEG Result
Action	(O Action)"	((O Action)"	
Event	(O Event)" 1	((C) Event)"	
- 12. Resolution

Action	(O Action)"	(O Action)"	POSResult fNEGResult
Event	(O Event)"	(O Action)"	

 C) Res

- 13. Event

Event (C) Event)"	Action (C) Event)"
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- 14. Event -3 State, Change O State₁₊₁
- 15. Action -3 Action (C) Action)"
- 16. Action --3 (Mind 9) Doing
- 17. Mind Motivation O Plan

18. Motivation	Desire Reason
19. Plan	Purpose O Intention
20. Doing	Attempt @ POSResult NEGResult}
21.0+	{ ⁰⁻¹ ;
22. p	cp(O Qual.) (where is any category, except e)
23. φ	(p,(p,+1,•••,pi,-))

B. Transformation Rules

Since the story has a canonical narrative structure no transformation rules will be formulated.

C. Some Specific Constraints (see also the remarks below)

1. The 'Complication' category in rule 10. is optional only if:
 - a. the initial state is negative
 - b. the final state of a previous episode is negative
2. Rule 12. must apply recursively until a positive result has been reached (at least for a certain type of story).

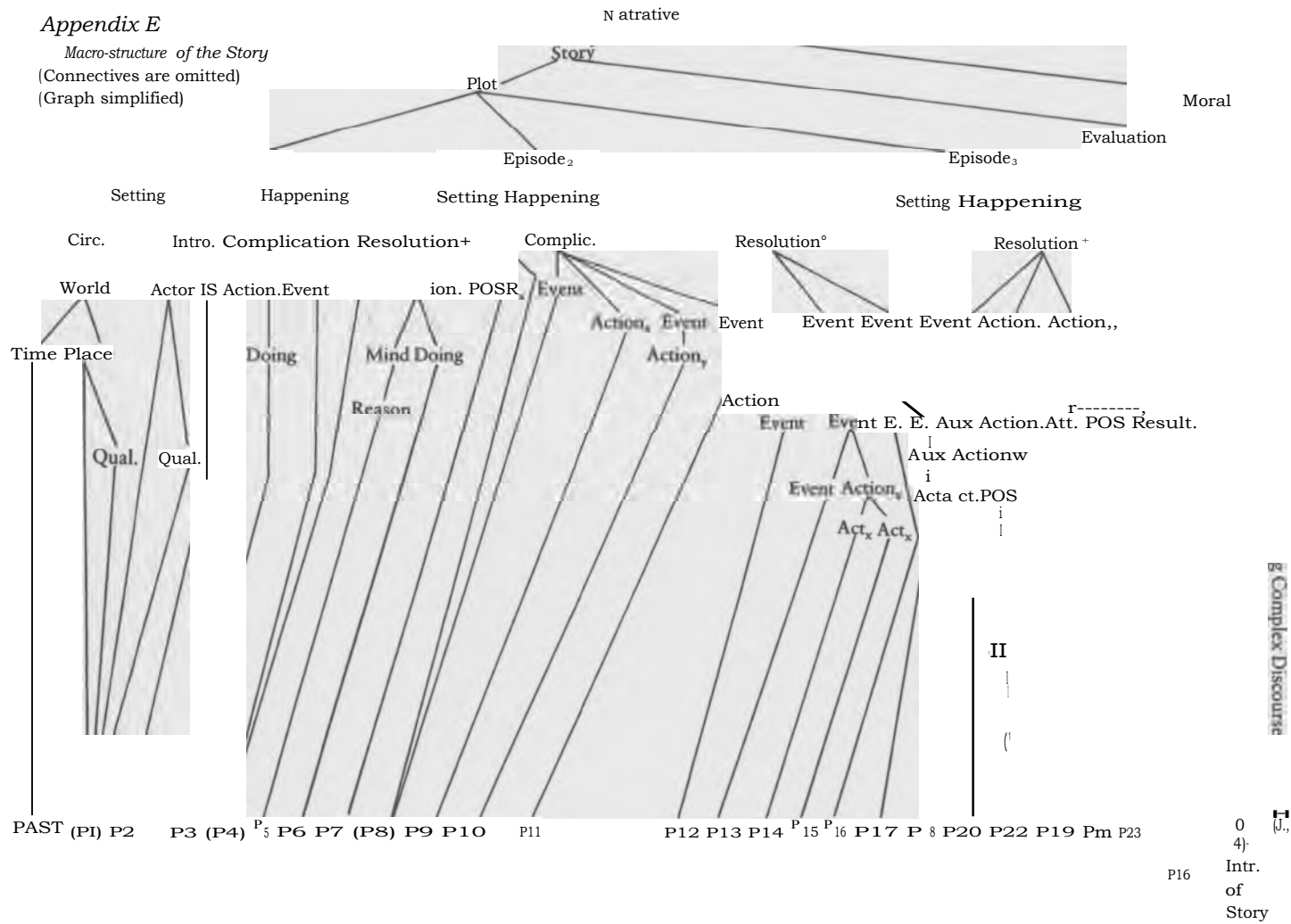
Remarks

Although the rules are very straightforward and thus speak for themselves, the following remarks may be added. For details, see the theoretical work on narrative cited in the footnotes.

1. In the first rule it is assumed that the 'Moral' or 'coda' belongs to the narrative discourse, but is not part of the story told 'about', which has its own 'Evaluation' as indicated in rule 2.
2. A number of categories, viz. Action, Event and Resolution are recursive, i.e. an action or event in which an action or event are embedded are also an action and an event respectively. In our rules we have also 'linear' recursion. The variable n indicates how often a category repeats.
3. Curled brackets indicate options in the usual way. Parentheses enclose optional categories. Square brackets enclose optional, non-exclusive categories. There are story types in which some of the categories are either optional or implicit, i.e. deleted by — contextually determined — transformations. Example: we need not explicitly introduce agents of the story (or other parts of the setting) if these are known by the hearer. This is a more general (context-)grammatical constraint.
4. The connective O has been expanded by two sets with each three members, indicating 'necessary', 'possible' and *condition for*, and *consequence of*, respectively. These connectives thus define 9 complex connectives, abstractly defining the connectives of natural language. For definition and formal interpretation, see van Dijk (1974c).
5. Rule 21 is a meta-rule, indicating, provisionally, that each category may be connected with a 'qualification' of some sort.
6. All categories are finally replaced by (sequences) of propositions of which the 'meaning' fits the category. I.e. 'Purpose' must be substituted by a purpose description, etc.

Appendix E

Macro-structure of the Story
 (Connectives are omitted)
 (Graph simplified)



*Appendix F*Table 1: *Frequencies and Proportions of Recall in Protocols*

N =	17		15		15	21		18	13	13
Exp.nr.	AI	B	AII	B	III	AIV	B	V	VI	VII
Total number of different propositions used by group	150	105	164	131	108	144	51	23 (of 23)	100	22 (of 23)
idem: never used by group	34	79	20	53	76	40	133	0	84	1
Number of different propositions occurring in most (i.e. 2/3) protocols	15	10	18	13	10	38	0	16	21	16
Number of propositions rarely recalled (5/3)	110	140	119	133	148	123	169	0	139	4
Average protocol length (without imposed prop.)	50	35	53	42	31	55	12	17	37	16
Standard deviation in protocol lengths	18.0	14.4	14.4	12.6	8.7	8.6	4.4	3.7	7.2	2.4

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"Causality and Reasoning" (Istituto per gli Studi Semantici e Cognitivi, Castagnola, Switzerland, Technical Report 1).
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Postscript, June 1978

Since this paper was written, in early 1975, the developments in the field of discourse processing have been very impressive: many articles and books have appeared in the meantime, and many experiments have been carried out in cognitive psychology. In artificial intelligence, theoretical work has been done on discourse (and story) comprehension. The results of all this work are consistent with the provisional theoretical and experimental results reported here. The reader is requested to consult the following books in this area, where further references to other work can be found:

Marcel Just & Patricia Carpenter, eds. *Cognitive Processes in Comprehension* (Hillsdale, N. J.: Erlbaum, 1977)

Roy O. Freedle, ed. *Discourse Production and Comprehension* (Norwood, N. J.: Ablex), and other books following in the same series, and in the journal of the same name *Discourse Processes*, published by Ablex.

Roger Schank & Robert Abelson, *Scripts, Plans, Goals and Understanding* (Hillsdale, N. J.: Erlbaum, 1977).

Similarly, mainly together with Walter Kintsch, I have since this early paper carried out much further research on the cognitive psychology of discourse processing, cf. e.g. (also for further reference):

Teun A. van Dijk, "Complex Semantic Information Processing". in: D. E. Walker, H. Karlgren & M. Kay, eds. *Natural Language in Information Processing* (Stockholm: Skriptor, 1977) 127-163.

Teun A. van Dijk & Walter Kintsch, "Cognitive Psychology and Discourse", In: W. U. Dressler, ed. *Current Trends in Textlinguistics* (Berlin: de Gruyter, 1977) 61-80.

Walter Kintsch & Teun A. van Dijk, "Towards a Model of Discourse Comprehension and Production", *Psychological Review* (1978, in press).

For the more general text-theoretical background, the reader is also requested to consult my more recent books, e.g.

Text and Context (London: Longmans, 1977).

Studies in the Pragmatics of Discourse (Lisse, Holland: de Ridder, 1978).

The Structures and Functions of Discourse. Introduction to Textlinguistics and Discourse Studies (University of Amsterdam, 1978).

Macrostructures. An interdisciplinary Study of Global Structures in Discourse, Cognition and Interaction (in preparation).

N.B. On some points I have revised the positions in this paper in later work: more attention is paid to the role of world knowledge (frames) in discourse comprehension; a difference is made between semantic macrostructures and

schematic (e.g. narrative) *superstructures*; the differentiation between different memory working and data stores has been reduced; there is less emphasis on the fact that (long term) memory *only* has macropropositions, but also many kinds of micro-information (as our experiments suggested for immediate recall), although this is not always accessible; there is more emphasis on several *transformations* both on micro- and macro-propositions; there is more emphasis on the description and explanation of new, personally variable information in comprehension and recall protocols; narrative grammar and action theory have been separated as two kinds of knowledge; and finally, more attention is being paid to various other cognitive factors determining comprehension and macrostructure formation, such as beliefs, interests, tasks, attitudes, etc. together forming what I call the personally and contextually variable, *cognitive set* of the comprehension process. The interaction of this cognitive set and discourse comprehension is fundamental in further work in cognitive social psychology on discourse influence in communication, to which I am turning in my work for the coming years.

For much of this later work I am indebted to Walter Kintsch, and, for theoretical and experimental research now being carried out in Amsterdam, to Joost Breuker, Nico Frijda and others of the projects on Text Processing and Learning.