

IX. CONFERENCE

EUROPEAN SOCIETY FOR COGNITIVE PSYCHOLOGY
SEPTEMBER 4-8, 1996
UNIVERSITY OF WÜRZBURG



COGNITIVE PSYCHOLOGY IN EUROPE

PROCEEDINGS OF THE
NINTH CONFERENCE OF THE
EUROPEAN SOCIETY FOR COGNITIVE PSYCHOLOGY

J. HOFFMANN AND A. SEBALD
(EDS.)

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**COGNITIVE PSYCHOLOGY
IN EUROPE**

Editors

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FOREWORD

This book comprises the material of the Ninth Conference of the European Society for Cognitive Psychology which was held at the University of Würzburg in September 1996. The material is presented in accordance with the thematic structure of the Conference which has been shaped by the international programme committee: The first chapter presents elaborated abstracts of four invited lectures. Next, the abstracts of five symposia are presented, followed by the abstracts of individually submitted papers, which have been grouped into thirteen thematic sessions. Finally, the abstracts of two poster sessions are presented, whereby we tried again to cluster together posters with related topics. Altogether abstracts of approximately 200 submitted contributions from nearly all European countries, as well as some from North America, are comprised. Furthermore, a last chapter contains selected texts from an exhibition presented during the conference, in appreciation of the 100th anniversary of the foundation of the Würzburg School in 1896 and its contributions to the establishment of Cognitive Psychology. Altogether the book provides a thematically structured overview about present research activities in the cognitive psychology laboratories of Europe, supplemented by a reference to one of the European roots of modern cognitive psychology. This content seemed us to justify the title we have chosen for the book: Cognitive Psychology in Europe.

Würzburg, September 1996

Joachim Hoffmann and Albrecht Sebald

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The Würzburg School

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CHAPTER 1

INVITED LECTURES

Execution of cognitive skills by the human brain

Michael I. Posner

University of Oregon, U.S.A

In his many papers and books Donald Broadbent not only laid out a serious proposal for the study of the way the nervous system performed high level skills, but also defined the empirical spirit he believed provided the basis for progress in our field. Broadbent understood that an empirical approach could allow one to move beyond controversies that can impede progress.

This lecture concentrates primarily upon two contributions first introduced in Chapters 10 and 11 of Broadbent's *Perception and Communication* (1958). His flow diagram of human skill proposed to divide the nervous system into modules (boxes) involved in processing information between input and output. His discussion of speed, practice, anticipation and attention emphasized orchestration of these modules in real time and the influence of control systems and learning.

Methods available for exploring the human nervous system during the learning and execution of skills have expanded dramatically in the last few years with the advent of neuroimaging (Posner & Raichle, 1994; Toga & Mazziotta, 1996). These new methods provide an empirical approach to the observation of mental processes during high level skills. It is now possible to "see" the operation of individual modules as they come on and off line in real time.

Only a few years ago the advent of connectionist models had led many to believe that the time had passed for functional models of the type proposed by Broadbent. Impressive results obtained from simulations based up adjusting connection weights among arbitrary units suggested it was possible to ignore anatomical modules. However, as imaging studies have progressed, empirical facts have favored a modular view as consisting of subroutines (mental operations) localized in particular neural areas. Currently there is considerable interest in attempting to understand the function of areas of increased or decreased neuronal activity shown in neuroimaging studies (Buckner, 1996; Nyberg, Cabez & Tulving, 1996; Shulman, in press). I have suggested that what is localized are the types of mental operations specified as subroutines in many symbol processing models. This level of analysis is somewhat more molecular than the one Broadbent first proposed in *Perception and Communication* and it is also more molecular than views based primarily upon hemispheric lateralization (Nyberg et al, 1996). All of these approaches, however, maintain the close contact between cognitive and neuroimaging experiments.

PET studies have uniformly revealed complex networks of brain areas active during the performance of a task. While the nodes of these anatomical networks provide localization of component operations, the presence of networks requires a strategy for considering of connections between them as they are activated or inhibited in the process of performing the skill. Our approach to the problem has been empirical. We (Abdullaev & Posner, 1996; Posner & Raichle, 1994) have attempted to move from anatomy to circuitry by combining the strengths of blood flow studies such as PET with recordings of electrical potentials to provide precise timing of neural events. This strategy appears to have been quite successful and has allowed us to specify the ordering of mental operations in cognitive skills such as reading and arithmetic. In reading words, for example, early visual processing allows the packaging of letters into word chunks. These operations involve right posterior activation related to visual features

and left posterior activation of visual word forms. These operations can take place automatically in the sense that they do not require attention, but they can be influenced by attention as when subjects are required to search for a visual feature or to make a rapid response to words. It also appears possible to influence these operations by prior information, as in repetition priming (Badgaiyan & Posner, submitted).

At the heart of the Broadbent model was a mechanism analogous to a single limited capacity communication channel. PET data have suggested that this single channel mechanism involves activation of areas of the anterior cingulate (Posner & DiGirolamo, in press) beginning as early as 150 milliseconds after input, when blocks of trials in which subjects derive a word meaning alternate with blocks in which they read the word aloud (Abdullaev & Posner, in press). The cingulate activation occurs whenever higher level supervisory control is needed to organize the mental response to the input. In the case of naming the use of a word, attention leads and probably is required for the activation of a network of areas ending eventually in articulation of a novel use of the stimulus word. Semantic analysis of the input word starts after 200 millisecond in left frontal areas and the process of developing associations to the input continues in more posterior sites over the next second. The posterior activation of the visual word form and the activation of frontal areas related to attention and semantics all occur early enough to be involved in generation of saccades in skilled readers (Seren, 1992).

Although it is possible to lay out a sequence of processing steps in understanding words, a serial view can be misleading. Since attention occurs rather early, it is possible for subjects to reprogram the organization of these steps and thus to carry out a number of different instructions with the same brain network. As attention is released from high order activity during practice of the skill it becomes possible to improve the speed of performance by amplification of early processing steps. Studies of the role of attention suggest that reorganization involves amplification of attended operations in comparison to unattended operations. Increases in overall neuronal activity appear to produce more rapid processing or higher priority for the attended computations.

Broadbent also stressed the importance of short term memory in preserving the component steps needed to execute a skill. Studies conducted in the 1970s suggested several short term memory systems and provided evidence that there could be considerable independence between them. Recent imaging data supports separate anatomy for verbal, spatial and object working memories. There is some evidence, however, that all forms of memory are interfaced to a common executive system that involves the same midline frontal anatomy described previously. There was a dispute within cognitive psychology about whether acoustic or articulatory codes were more important for short term information storage. Recent PET studies (Awh, Jonides, Smith, Schumacher, Koepp, & Katz, 1996) suggest that in verbal memory left anterior areas are related to rehearsal (articulatory codes) while left posterior areas (auditory codes) are related to passive representation of stored items. These findings fit with data from word reading suggesting that both posterior and anterior areas are involved in phonological processing. These also correspond roughly to the concepts of acoustic and articulatory codes as developed in cognitive studies.

Studies of mental arithmetic, visual imagery and other forms of skilled performance using neuroimaging methods seem to support many of the same principles outlined above for word reading. The view of skilled performance arising from neuroimaging is consistent with the flow diagram views first outlined by Donald Broadbent nearly forty years ago. This progress in the last forty years has confirmed the utility of Broadbent's empirical approach. Progress has come more through careful experimental investigation, and development of new tools for

exploring the brain and for synthesizing knowledge in the form of models, than through revolutions marked by radical shifts of paradigm.

In this paper I have stressed correspondence between some of Broadbent's ideas and the findings of recent neuroimaging studies. However, as Broadbent himself recognized, it is as important to reject or modify ideas as to support them. Broadbent ended his William James lectures (Broadbent, 1973) by saying:

"I do rather regret that so much of this lecture has been taken up by conceptual analysis rather than by experimental results: I hope at least you may profit by the horrible example, and go out convinced to prove me wrong by the methods of empirical psychology."

Perhaps that is just the right tone to set to start the paper sessions of this meeting.

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Multinomial measurement models for the process dissociation procedure

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The process dissociation procedure has become popular as an experimental tool to investigate the contributions of consciously controlled and unconscious, automatic processes to performance in a variety of memory tasks. It has been suggested as an alternative to the relying on dissociations between direct and indirect measures of memory which are assumed to be affected primarily, but not exclusively, by controlled and uncontrolled memory processes, respectively. In contrast to such a task dissociation approach, the process dissociation procedure represents an attempt to decompose observable memory performance on one single memory test into controlled and uncontrolled components.

The process dissociation procedure consists of two distinct constituents, an experimental procedure and a measurement model. The *experimental procedure* may be adapted to different memory tasks such as recognition, word stem completion, or fame judgements. Common to all of these procedural variants is that participants respond under two different instructional conditions, the inclusion condition in which controlled and uncontrolled processes are assumed to operate in concert, and the exclusion condition in which the two types of processes are assumed to operate in opposition. A *measurement model* is needed to solve the decomposition problem by relating observable task performance in the inclusion and exclusion conditions to parameters representing the underlying cognitive processes.

Jacoby (1991) suggested both an experimental procedure and a first measurement model. Two assumptions underlying this original measurement model appear to have stimulated much of the recent discussion of the process dissociation procedure. First, it is assumed that controlled and uncontrolled memory processes are stochastically independent. As a response, some researchers have specified alternative assumptions (e.g., Joordens & Merikle, 1993), and others have shown violations of the independence assumption to be problematic for the interpretation of the original model's parameters (e.g., Curran & Hintzman, 1995). Second, it is assumed that guessing and, hence, response bias does not occur. This simply seems unrealistic. In response to these two issues, Buchner, Erdfelder, and Vaterrodt-Plünnecke (1995) developed, within the framework of multinomial modelling, an extended measurement model (EMM). Within the EMM it is possible to integrate various assumptions about the relation between controlled and uncontrolled memory processes. Also, one can dispense with the independence assumption. Finally, the EMM provides for guessing parameters and, thus, takes possible response biases into account.

Jacoby's original model and the extended model were evaluated empirically. In three experiments using a yes-no recognition task, response bias was manipulated in various ways. The original model falsely attributed effects of response biases to either controlled or uncontrolled processes or to both. The EMM, in contrast, resulted in estimates of the contributions of controlled and uncontrolled memory processes that are relatively unaffected by response biases. Buchner and Wippich (1996) have shown that serious response bias differences between conditions may also occur without explicit manipulations, such that one may arrive at misleading results if the response biases are not taken into account.

Jacoby (1991, p. 538) suggested that the use of the basic process dissociation procedure and measurement model could be generalised to many different types of memory tasks. However, there are also important limits. For instance, both the original model and the EMM were introduced as models for dichotomous *old-new* (or *yes-no*) judgements. Thus, these models cannot be used for experiments in which confidence ratings are required after each recognition judgement. Rather than simply responding *old* or *new* to every item, participants in a typical confidence rating experiment also state how sure they are of their recognition judgements on a n -point rating scale, $n > 2$. In other words, participants must not only decide about whether they accept or reject an item, but in addition they must also judge how sure they are of their decision. Before models like the EMM can be applied to confidence rating data, therefore, they need to be generalised to incorporate these additional judgement processes. More precisely, parameters must be included in the model which represent these additional judgement processes. Erdfelder and Buchner (1996a) have presented an extension of the EMM to 6-point confidence ratings as used, for example, by Yonelinas (1994). The extended measurement model for rating-scale data (henceforth referred to as EMM-RS) was applied to the empirical ROC data reported by Yonelinas (1994, Experiments 1 to 3). The EMM-RS was found to fit these data perfectly. Moreover, detailed examinations of the model's parameters showed that the 'behavior' of the model was psychologically plausible.

One aspect of confidence-rating data is that the empirical ROCs derived from these data are often non-linear. This is not a problem because the EMM-RS, which takes the confidence judgements into account explicitly, fits these non-linear ROCs. However, if non-linear ROCs would also result from experimental manipulations of response bias in an *old-new* (or *yes-no*) judgement task, then this would be a problem for the simple EMM because this model predicts linear ROCs. Fortunately, strictly non-linear ROCs as a result of experimental manipulations of response bias seem very difficult to find. For instance, the ROC data reported by Ratcliff, Sheu, and Gronlund (1992, cf. the data pattern in Figure 3 of Kinchla, 1994) as well as by Snodgrass and Corwin (1988, p. 42, Figure 6) agree quite well with linear ROC models. Thus, the least one can say is that linear ROC models provide quite good approximations to ROC data obtained by experimental manipulations of response biases.

However, a critical assumption of the EMM appears to be that distractors are never detected as new and rejected. This may occur, for instance, if a person detects that an item must be new because she or he would have remembered it had it been among the items encountered in the experiment. Excluding the possibility of distractor rejection may be too restrictive in a certain number of applications. Therefore, Erdfelder and Buchner (1996b) have developed a two-high threshold EMM (2HT-EMM) which allows for distractors to be detected as new. As they have shown, the 2HT-EMM appears to be an improvement over the EMM, at least when applied to *yes-no* recognition tasks in the process dissociation framework. It remains to be seen whether this result generalises to other implementations of the process dissociation procedure, too.

Another possibly fruitful extension of the process dissociation procedure lies in an application to implicit learning tasks. In that field, like in implicit memory research, one often wants to know whether the knowledge acquired should be conceived of as available or not available to controlled retrieval. However, the standard EMM or EMM-RS does not seem appropriate for many implicit learning tasks. Taking the sequence learning paradigm as an example, therefore, Buchner, Steffens, Erdfelder and Rothkegel (1996) developed a measurement model for well-formedness judgements about systematic and unsystematic sequences. The model assumes that well-formedness judgements are based on recollection, perceptual or motor fluency, systematicity detection, and guessing. The model and the application of the process

dissociation procedure to the sequence learning paradigm were successfully evaluated empirically.

So far, only extensions and generalisations of multinomial measurement models for the process dissociation have been considered. There is, however, also evidence showing that process dissociation measurement models should perhaps not be applied to paradigms to which they have traditionally been applied. More specifically, Jacoby (1991) introduced the process dissociation procedure using a *yes-no* recognition task. When applied to a recognition memory paradigm, the minimum requirement is that there be at least two classes of items in the acquisition phase. For instance, the acquisition phase could be divided into two phases, and participants read words in Phase 1 and hear words in Phase 2. One item class is often considered critical in that participants' responses to items from this class, but not from the other class, are used for measurement purposes. We assume that the Phase 1 items are the critical acquisition phase items. For brevity, we consider only the *exclusion test condition*, in which participants are instructed to judge an item *old* only if it was presented during Phase 2. In contrast, Phase 1 items must be called *new* (i.e., they must be 'excluded'). The same is true for distractors.

According to Jacoby (1991), the exclusion test condition represents an interference paradigm in which controlled and automatic process are said to be put "in opposition." In this condition, participants try to *reject* the Phase 1 items whenever they can identify them as old. If they nevertheless accept such an item as old, then this is assumed to represent the operation of an unconscious and automatic process contributing to item familiarity that could not be counteracted by a controlled recollection. However, one might also reason that critical acquisition phase items are accepted in the exclusion test condition because, although the item is clearly recollected as an item that had been encountered in the experiment before, one simply confuses the presentation contexts. For instance, one may consciously recollect that a certain word has been encountered in the experiment before, but simply misjudge it as a heard word from Phase 2 whereas it is actually a word that was read in Phase 1. This may be conceived of as a classical example of source confusion. From this perspective, we may wonder if there is any difference between the memory processes involved in recognition judgements in the process dissociation procedure and those involved in typical source monitoring tasks. Buchner, Erdfelder, Steffens, and Martensen (in press) have found empirical evidence supporting the idea that the memory processes in both types of task are identical. They also showed analytically how the parameters of source memory models (cf. Batchelder & Riefer, 1990; Riefer, Hu & Batchelder, 1994) relate to the parameters representing recollection and familiarity as derived from the process dissociation procedure. Based on their empirical and analytical results Buchner et al. (in press) suggested to use standard source monitoring tasks instead of recognition tasks in the process dissociation procedure.

To conclude, it might be necessary to analyse more thoroughly the tasks to which the procedure can be applied and to which it cannot, and to develop increasingly more task-specific process dissociation measurement models.

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The Würzburg School: At the roots of cognitive (neuro-) psychology

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Sometimes scientific "schools" are named after places. The "local eponym" can be motivated in two different ways. The first refers to the place where some important teacher and/or innovative investigator has educated generations of students; take the "Leipzig school" of Wilhelm Wundt as an example. The second is an "origin myth". Here it is sufficient that some innovation has occurred at the place in question, without implying any kind of personal continuity at that place. The Würzburg school received its name in the second way. Oswald Külpe, its "founder", stayed in Würzburg for a couple of years only, and even his doctoral students left town quickly after they had finished their theses. Thus, Würzburg was everywhere, perhaps except in Würzburg itself, where Külpe's successors did not feel obliged to adhere to the principles of his "school". However, this "Gone With the Wind" development had positive effects: it assured the wide dissemination of the Würzburg approach. The aim of the present

talk is to trace the influence of the Würzburgers on the subsequent development of cognitive psychology, including cognitive neuropsychology.

At least in the German context, the Würzburg type of psychology was the first example of a cognitive psychology based on experimentation. Wilhelm Wundt had excluded higher mental processes from the field of experimental psychology, basically for two reasons. On the methodological side, he felt that processes like concept formation, judgment and reasoning could not be subjected to the tight control defining psychological experimentation. Theoretically, he was convinced that higher mental processes could never arise in the individual person, but presupposed a "community of minds". Thus, like language, the arts and moral behavior they were to be studied by *Völkerpsychologie* (his name for a historically-based social psychology) - that is, by recording their products and interpreting them by means of the conceptual apparatus provided by his own psychological "system", i.e., in terms of the apperceptive and associative levels of mental functioning, taking into account their emotional in addition to their cognitive aspect.

Ironically, it was Wundt's favorite student, Oswald Külpe, who most effectively revolted against Wundt's restrictive approach to higher cognitive processes; and, even more ironically, he did this by a productive misunderstanding of Wundt's tenet that psychology had to be based on "inner observation". For the type of introspection practiced in his "Experiments on Abstraction" (1904) and subsequently refined by his students at Würzburg had almost nothing in common with Wundt's use of introspection. To Wundt, introspection could not be separated from tightly controlled experimentation, and it had to occur at the same time as the mental *contents* (sensations or elementary emotions) that were observed. In contrast, the Würzburg type of introspection consisted in extensive protocols of mental *processes* whose "data base" was no longer present when they were reported. Also, experimental control was rather loose and the time measurements that were being taken were more a kind of "ritual" than a serious data base to be used for testing hypotheses. To the generation of post-Wundtian psychologists, "systematic, analytical self-observation" became the almost exclusive method of psychology, even outside of the circle conventionally known as the Würzburg school. As Karl Bühler put it: "Introspection does not need to be controlled, but it needs to be interpreted". Wundt (though he never expressed it that way) had it the other way round: Introspection was in need of control, but not in need of interpretation, at least not in terms of a "hermeneutic" approach to it.

The initial discovery of the Würzburgers - that thought could be "imageless" - had profound effects on the development of psychology outside of Germany and was hailed as an important breakthrough within the country; but it could scarcely have resulted in the emergence of a "school" of psychology. This poses the question: What were the positive perspectives that provided for a minimum of coherence between the views of the Würzburgers and explained their perception, by outsiders, as a "school" or "group"? The answer seems to have been in the eye of the beholder. For George Humphrey, the British historiographer of the school, the rejection of the associationist approach to thinking and its replacement by a model of thought as a goal-directed process seems to have been most important. While this point was not lost on German observers, they focused on two additional features that were much in line with the German intellectual atmosphere prevailing in the first third of the 20th century.

Other than in most countries where experimental psychology was flourishing at the time, in Germany as its home country it was subjected to severe criticism. Not the least for practical reasons, many people felt that it should be replaced by an approach centering on the "realities of life" rather than on narrow laboratory situations. Support in the pursuit of this aim was rarely sought in more ecologically valid laboratory situations (this approach was taken by

Kurt Lewin and his students), but more frequently in the adoption of a *geisteswissenschaftliche* stance. That is, psychology was to be founded on the humanities rather than on (natural) science. First and foremost, this implied that mental life was conditioned by "objective mental structures" residing (in the manner of Popper's Third World thesis, that's where he got the idea from) outside of individual minds but somehow to be realized by them. The most important result of Bühler's experiments on thought was that his subjects had an "awareness of rules" (*Regelbewußtsein*): individual objects of thought were experienced in terms of the rules exemplified by them. The rules themselves were of a logical nature and as such different from physical causality.

Another trend consisted in taking *expression* as the primary source of psychological data. Behavior and behavioral products such as handwriting were of interest mainly as symptoms of mental states and traits. The Würzburgers were little concerned with what became known as the "psychology of expression" (*Ausdruckspsychologie*), although Bühler in 1934 wrote a book on it. Nevertheless, even before 1910 the verbal output produced in thought experiments was considered as a "manifestation" (*Kundgabe*), rather than a description, of mental states and thus it was assimilated to the categories of "expression" and "communication".

The Würzburgers, in sum, practiced a "new" type of experimental psychology driven by problems and concepts derived from a non-naturalistic approach to the mind and serving the needs of an increasingly *geisteswissenschaftlich* oriented scientific community. In 1927, Karl Bühler proposed a synthetic reconstruction of psychology taking into account its foundation on the humanities as well as on biology. Immediate experience, expressive behavior, and objective mental products were all accepted as psychological data, and every psychological process was to be analyzed according to the dimensions of expression, communication, and representation (*Darstellung*). Bühler's "triangulation" of psychology was also informed by his work on language, for which he is better known, in present-day Germany, than for his more properly psychological work.

Other Würzburgers were more faithful to a naturalistic approach though even they abandoned the type of (quasi-)physiological theorizing that had been prevalent at the beginnings of experimental psychology and was now denounced as "brain mythology". Thus, they effectively promoted the idea of an autonomous psychology dealing with mental processes independent of their physical instantiation - a process to be exemplified on the basis of Otto Selz's work on problem solving and his polemics with the Gestalt psychologists. Narziss Ach expanded the scope of Würzburg-type psychology by moving it into the realm of motivation, where he promoted an analysis of mental architecture taking volitional action, rather than environmental stimulation, as the starting-point. The Würzburg approach was even carried over to the psychology of religion, as witnessed by Karl Girgensohn's experimental work on the "mental architecture of religious experience" supervised first by Külpe and then by Bühler.

Turning to the effects of the Würzburg revolution on the development of cognitive psychology at large (i.e., transcending its German context), we notice a short-range destructive and a long-range constructive influence.

Paradoxically, the rise of Watsonian behaviorism was, in part, motivated by the Würzburg revolution. Two aspects merit consideration. First, Watson's polemics against introspection was directed against what he took as the only form of it, namely, the type of analytical introspection introduced by the Würzburgers and adopted by Edward Titchener, Külpe's roommate in Leipzig and self-appointed spokesman of "Wundtian" psychology. As a result, the difference between Wundt-type and Würzburg-type introspection was unknown to most Americans, including Watson, and the endless controversies known as the "imageless thought

controversy" fostered a well-deserved mistrust in the reliability of introspection. Second, with respect to the subject-matter of the imageless thought controversy, Watson sided with the "imageless" party and even (contrary to his own methodological imperative) offered a piece of introspection, to the effect that he himself never had experienced mental images. Within the behaviorist approach, the mental image remained exorcised as a mentalistic pseudo-concept - a perspective maintained by both Skinner and J.J. Gibson (in other respects somewhat unlikely bedfellows). The exception is, of course, Edward Tolman, who was exposed to second-order Würzburg influences during his stay in Vienna (where Bühler held the chair in psychology) and the collaboration with Egon Brunswik that was started there.

On the long-range side, a first (admittedly remote) influence of the Würzburg approach on the "cognitive revolution" occurred in the New Look promoted, most prominently, by Jerome Bruner. His "Study of Thinking" (1956) is dedicated to Brunswik's memory, contains references to Humphrey's review of the Würzburg school, and proposes a return to a Golden Age before the 1st World War when "Higher Mental Processes" were a "core topic in psychology". A more restricted, but more precise, "revival" of Würzburg happened when Herbert Simon and Alan Newell rediscovered the work of Selz (as mediated by Adrian De Groot's work on the psychology of chess, inspired by Selz during his exile in Amsterdam - to be ended by Selz's murder in the Auschwitz extermination camp). Newell and Simon noted some analogies between Selz's concept of *Mittelfindung* and their own heuristics, his concept of a "reflexoid activation of operations by occasions for responding" and the "if-then" structure of a production system, and his general analysis of problem solving as driven by a goal representation and realized by means of operations "actualized" by the goal representation. At a more general level, one could point out that the type of cognitive psychology advocated by them, resting as it did on an analysis at a "symbolic" level and proceeding independently of the actual brain, was part of the general Würzburg program. A more detailed examination of some neglected aspects of Selz's work, however, shows that he incorporated an associative type of functioning as the "reproductive" substructure of productive thinking and (put anachronistically) wanted to implement a symbol system by means of a network system. Of course, computers were unknown at his time and he, like all other psychologists of his time, had no idea of purely formal symbol processing as envisaged by the Computational Theory of Mind.

Given that present-day cognitive psychology has developed an intimate alliance with neuropsychology, we want to close our review by drawing attention to the little-known influence of the Würzburg school on the neurology of its time. In 1913, Külpe argued for making psychology (which in Germany was part of philosophy and was being threatened with expulsion by "pure philosophers") a subfield of medicine, to the extent of moving it from the philosophical to the medical faculty. In favor of his proposal he quoted the important recent advances in aphasiology made possible by advances in psychology. He was referring to Arnold Pick's work on agrammatism which in fact was informed by the Würzburg approach.

According to Pick, the approach to aphasia exemplified by Lichtheim-type of diagram making misses the true nature of aphasia as much as the associationist approach in psychology misses the true nature of thinking. Instead, an analysis of intact and disturbed language should proceed from the communicative intentions of the speaker. When a complete elaboration of the communicative intention is no longer possible, speech production is adjusted to the communicative intentions. Function words, for instance, are left out in Broca's aphasia not because their "images" have been lost but because they are unimportant in the communicative context. Grammar mediates between thought and its linguistic expression, and it can be disturbed without implying a loss of either concepts or words. In the final version of his theory, Pick proposes a top-down model of speech production that incorporates the stages of thought

schema, intonation schema, sentence schema, word finding, and progressive elaborations of the sentence schema. All this is very modern - although, again, modern in terms of a sequential stages approach which at present seems to be in need of revision.

Perhaps even more densely, the Würzburg type of psychology was accepted by major figures in post-Kraepelin German psychiatry - a development that is less relevant to the present audience but testifies to the very broad reception pattern found by the Würzburgers.

There were, however, two negative aspects to this Würzburg enthusiasm among what today would be neuropsychology and cognitive psychopathology. The "relaxed" style of experimentation propagated by the Würzburgers was enthusiastically received by the medics, but all of them decided to abandon experimentation altogether. Thus, Pick's analysis is derived from the spontaneous linguistic utterances of aphasic patients, without the slightest attempt at experimental control aimed at "carving nature at its joints" that is standard in present-day cognitive neuropsychology. In fact, it was the theories, rather than the methods, of the Würzburgers that were imported by the neurologists and the psychiatrists. As a result, theorizing became somewhat arbitrary and was informed more by argumentation than by scientific data gathering. A second negative feature, prominent more in psychiatry than in neurology, was the complete abandonment of brain-style theorizing, now discarded as "brain mythology". The very idea that schizophrenia is a purely functional disorder without any organic basis was justified, in part, by appealing to the results of the Würzburg revolt in psychology.

Like any other innovation, the Würzburg approach had unintended negative side effects.

Intelligence and human resources: Past, present, and future

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INTRODUCTION

Intelligence, in the sense of individual differences in mental competence rather than its narrower definition as a score on a designated IQ test, is both a social and a biological concept. Psychologists, who should have their feet planted firmly in both social and biological inquiry, have too often jumped up and down on one foot here. Individual variations in human mental capacity are indisputable. They were noted in the Odyssey, given systematic treatment by Juan Huarte de San Juan in the 16th century, and have been the subject of intense psychological scrutiny in the 20th century. Obviously individual differences are biological, since humans can only vary across the range that the human genome permits. However the particular use that society makes of variations in human potential, and the extent to which a society wishes to inquire about that potential, varies a great deal across societies. Some social systems, such as the rigidly structured caste systems of classic India and the equally rigid non-class systems of the Soviet Union, have proscribed asking certain questions about the nature of individual differences (Sternberg & Grigorenko, in press). Our own society has, from time to time, discouraged certain lines of inquiry while encouraging others. For instance, Binet's famous work on intelligence testing can only be understood in the context of a society that has a public school system. The group administered intelligence test, now a standard part of the psy-

chologist's battery of research tools, was a response to a need for rapid screening of military recruits during World War I.

The 21st century, insofar as we can glimpse it, will probably make even more demands on human mental competencies than our present society does. How will our present knowledge of intelligence assist us in responding to these demands, and what further knowledge will we have to seek? In this paper I review our current knowledge of intelligence and, looking forward, I ask what psychologists are going to have to find out about intelligence in order to respond to the social demands of the next century.

THE PRESENT STATE OF KNOWLEDGE

Psychometric research can be looked upon as a quest to locate the underlying dimensions of human intelligence, a sort of Euclidean metaphor for the way in which people vary (Sternberg, 1990). Not surprisingly, how much variation we find depends upon our definition of intelligence itself. The wider the sorts of performance we are willing to accept as being potentially intelligent, the greater the dimensionality of the descriptive space. While a case can be made for including social sensitivity, the ability to control one's emotions, and even bodily movement as important aspects of human individual differences (Gardner, 1983), psychometricians have restricted their inquiries to the actions of rational individuals attempting to solve problems that do not have inherent social or personal consequences. Even within this restriction it turns out that there are many ways to look at the dimensions of mental ability, ranging from an emphasis on a unitary trait of general intelligence (*g*) to identifying over 100 special abilities. At one time there was great controversy over which of these different views of the psychometric evidence was the correct one, but we now seem to have come to the more rational position that these are different perspectives on the same phenomenon, and that the appropriate view depends upon one's purpose in drawing the picture (Gardner, Kornhaber, & Wake, 1996).

Having acknowledged the validity of multiple points of view, it still appears that for many purposes the best distinction to make is Horn and Cattell's distinction between three separate kinds of intelligence (Horn & Noll, 1994). These are *fluid intelligence* (*Gf*), which can be thought of as the ability to deal with new and unusual problems, *crystallized intelligence* (*Gc*), which is the ability to apply previously acquired knowledge and solution methods to the current problem, and *visual intelligence* (*Gv*), which is the ability to manipulate spatial-visual information, as in imagining what an object will look like as it moves into positions different from the current viewing position. Nor surprisingly, *Gf* and *Gc* are correlated, for the way that we acquire information to be applied is to learn something (or how to do something) the first time. *Gv* seems to be a somewhat independent statistical trait, at least in the normal range of abilities.

It is important to remember that the *Gf-Gc-Gv* model is not the only possible way of accounting for the psychometric data, and that for some purposes other models, such as the general intelligence model, may be useful. I advocate it for three reasons. First, no other model has any better psychometric support, and few have as much. Second, the *Gf-Gc-Gv* model connects well to the information processing view of intelligence that provides a needed complement to the psychometric view. Third, and finally, the distinction between abilities to deal with new information and abilities to apply acquired knowledge helps greatly in understanding the role of individual differences in cognition in the workplace.

Psychometric studies are sometimes criticized as being solely correlational; they tell us what the statistical distributions of talents are without telling us why these distributions come

about. This is not an entirely fair criticism. Binet and many psychometricians since him proposed causal theories of intelligence. Nevertheless, these theories are far less detailed than the cognitive psychology approach, which begins with an attempt to study how the mind works, in general, and then treats distributions of abilities as a derivative of a general theory of cognition. While no one in their right mind would claim that we know how that mind works, debates over minor details sometimes obscure the very general agreement on the broad outline of cognitive mechanisms.

Virtually every cognitive psychologist today acknowledges the need to distinguish between cognitive competencies that depend upon temporary memory storage processes; variously designated by terms like *primary memory* and *working memory* and competencies that depend upon the acquisition and use of factual knowledge and problem solving procedures. (After all these years, we may well go back to William James' (1890) distinction between primary and secondary memory!). These processes are highly interactive. A person with a large primary memory capacity has the resources required to work on problems that require attention to many things at once, and in doing so he or she may be able to develop ways of describing problems so that when they are encountered again they will be solved in a more efficient way, by transferring the burden of problem solving from primary to secondary memory processes.

This fact cannot be stressed too strongly, for it may explain certain apparently paradoxical findings. While more data is needed, it appears that in general crystallized intelligence measures, such as measures of vocabulary, are related to information processing tests of long term memory function (e.g. lexical identification), while fluid intelligence measures, such as abstract reasoning tests or tests that require dealing with arbitrary relations, such as a matrix reasoning test, are more strongly correlated with measures of primary memory resources (Carpenter, Just, & Shell, 1990; Hunt, 1987; Kyllonen & Christal, 1990; Palmer et al. 1985). Recent neuroscientific findings indicating that primary memory functions (outside of purely visual reasoning) depend upon prefrontal cortex functioning, while retrieval of information from long term memory depends upon more diffusely distributed cortical processes, suggest that we may soon be able to go beyond correlating gross measures of brain function with test score, to the point of understanding where in the brain particular types of individual differences arise.

Finally, and not too surprisingly, there is now a great deal of evidence indicating that primary memory processing involving visual - spatial information is distinct from primary memory processing involving verbally coded material. This is not surprising, for imagery studies have shown that different regions of the brain are involved in the activation of verbally coded and visual-spatial information (Kosslyn, 1994; Posner & Raichle, 1994).

Synthesis and prospectus

There is clearly a complementarity between *Gc-Gf-Gv* theories and the findings from cognitive psychology. Both sources of evidence indicate the need to distinguish between situations in which a person is learning something, and a situation in which a person is activating previously learned knowledge. This may well account for the well known disparity between accounts of the importance of "intelligence" and of "expertise." However the cognitive psychology approach suggests an amplification. Knowledge can be thought of as being applied in a two step process. First the person has to recognize that a particular bit of acquired knowledge is relevant to the situation at hand, and then the knowledge must be acquired. The pattern recognition stage is too often overlooked. Crystallized intelligence, expertise if you will, applies only to those situations in which a person recognizes that the knowledge applies. Thus

if knowledge has been acquired in a specialized context it is probably not going to be available outside of those contexts. There is ample experimental evidence to support this contention. It suggests a caution for those educators who are ardent advocates of situation-based learning. The situations had better be carefully chosen, and if learning is to be generalized more than one situation should be used.

The distinction between knowledge-based (Gc) and primary memory based (Gf) mental competence is not merely an academic nicety. It is important in both educational and workforce settings. My colleagues and I have found that when high school students learn difficult topics, such as introductory physics, measures of fluid intelligence and measures of prior relevant knowledge make surprisingly independent contributions to performance. Industrial and military studies have shown that intelligence certainly counts in the workplace, but that the contribution is greatest during the learning phase of a job (Hunt, 1995). The argument is not that anyone can learn anything. No matter how efficient a person is, certain minimal primary memory capacities are required for all but the simplest pattern recognition tasks. Also, persons with limited primary memory capacities may well be unable to maintain the disciplined attention required for the acquisition of complex problem solving procedures.

When we look to the future of research on intelligence it is useful to keep two separate goals in mind. One is the goal of understanding how differential mental capacities come to be, by looking downward from the mind to the brain. Establishing that there are correlations between test scores and gross biological variables, including genetic background, only hint at a useful explanation of mechanisms. Progress in the neurosciences is virtually certain to produce great advances in our understanding of the biological mechanisms of intelligence. The second goal is to look upward, to understand how individual differences in mental competence influence educational, social and workplace performance. If anything, this effort will be more important in the 21st than in the 20th century because of two non-psychological factors. Technological changes are increasing the disparity in value between the abstract thinker and the hands-on operator. Most importantly, the pace of technological change produces a shift in the relative marketability of fluid and crystallized intelligence. This poses a social major problem, because the workforces in all the industrialized nations are aging, and that it is well known that Gf and all the information processing functions associated with Gf decrease with age. There is a great deal of talk, today, about teaching people to "learn to learn." In the terms used here, we want people to retain the behaviors associated with fluid intelligence while at the same time we know that the information processing capacities associated with Gf are deteriorating. One of the major problems for applied psychology will be to resolve this paradox. I do not regard this challenge as insurmountable, but I believe that psychologists are fooling themselves and everyone else if they claim that our current theories tell us how to teach someone to learn in any general sense.

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CHAPTER 2

SYMPOSIA

2.1. THINKING WITH AND WITHOUT IMAGES: IMAGELESS THOUGHTS OR THOUGHTLESS IMAGES?

Introduction

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The place of Wuerzburg in the history of experimental psychology is well known, and the choice of it as a venue for the 1996 ESCOP conference is particularly timely. Equally well known is the debate between Kuelpe's group at the Wuerzburg laboratory and Wundt's laboratory in Leipzig over the feasibility of studying thinking. Most notable was the idea proposed in Wuerzburg that much of thinking was 'imageless' and not readily amenable to study by introspection, but that the imageless aspects of thought could be identified with what were termed 'conscious attitudes'. A different slant on the debate is still very much to the fore a century later, where the modern form of introspection, or verbal protocols are accepted by many as a valid data source for revealing aspects of thinking. Moreover many contemporary researchers would argue that mental images are at the core of much of human thinking, and that the study of imagery will reveal a great deal about the higher levels of cognition. This symposium offers a set of presentations by people who are among the most active contemporary researchers in the field of thinking and of imagery. They reflect the strength of the case that thoughts are neither inaccessible to study nor are many of the functional aspects of thinking imageless. After a brief introduction by the symposium convenor, the first three papers will examine different perspectives on reasoning. Gilhooly and Wynn discuss syllogistic reasoning, followed by the Vandierendonck work on reasoning about time. The group of papers on reasoning concludes with Cornoldi's work on children's spatial reasoning. This last paper links with the DeVega and Rodrigo studies on interaction with spatial representation. Logie and Pearson discuss the debate as to whether mental transformations can be carried out adequately in imagery without external stimulus support, and Marschark addresses how modality specific information contributes to imagery in cognition. Mohr and Engelkamp focus on mental comparisons - an interesting link with the original Wuerzburg School who concluded that comparisons for example between physical weights had few accompanying images that were amenable to introspection. Denis presents evidence of neurological correlates of mental imagery derived from the rapidly developing and fascinating technique of Positron Emission Tomography (PET), and Kaufmann concludes the presentations arguing that there may now be a solution to the unresolved 'imageless thought' controversy. The discussant, Richardson, briefly will bring together common themes and puzzles which arise from the papers in the symposium, including pointers to aspects of the original debate between Leipzig and Wuerzburg, and will then lead an open discussion.

Syllogistic reasoning and working memory

Ken J. Gilhooly, Robert H. Logie and Val Wynn

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Results will be reported from experiments in which subjects pre-selected into groups of high and low skill at syllogistic reasoning were tested under a range of dual task conditions (articulatory suppression, verbal random generation, unattended speech, unattended pictures, tapping in a pattern, spatial random generation). Results indicated that higher skill subjects were following a high load strategy which loads central executive, articulatory loop and imagery subsystems but that lower skill subjects were following a less demanding strategy which does not load working memory components heavily.

Visuo-spatial working memory and reasoning about time relations

André Vandierendonck and Gino De Vooght

University of Ghent, Belgium

There is ample evidence that reasoning about spatial relations is based on mental models. Vandierendonck and De Vooght (in press) have shown that reasoning about temporal relations is highly similar to reasoning about spatial relations, and is also based on mental models. If these mental models are coded visuo-spatially during the reasoning process, it may be expected that a secondary visuo-spatial task interferes with the reasoning process. Data from several experiments will be presented showing that visuo-spatial resources are involved in 4-term reasoning tasks with spatial and with temporal relations. Moreover, the visuo-spatial interference is most potent during premise presentation and is weaker in the response-selection phase. These data will be discussed with respect to both the mental models theory and the working memory model.

Individual differences in imagery and spatial thinking

Cesare Cornoldi

University of Padova, Italy

The paper explores differences in visuospatial working memory and imagery tasks in low spatial intelligence children. Children with poorer scores in spatial than in verbal intelligence tests appear to have difficulty with a series of tests requiring the use of visuospatial working memory. Further they also have difficulty in generating complex mental images. These data support the idea that different aspects of spatial cognition are strictly interconnected.

Pointing to objects in imaginary frameworks

Manuel de Vega and Maria J. Rodrigo

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People communicate directions either by pointing to objects or by using direction labels. When subjects were tested for object directions by means of labels they were faster in the front-back than in the right-left dimension (e.g., Franklin & Tversky, 1990; de Vega, 1995). However, when subjects were tested by pointing (pressing to four direction arrow-keys) they were slower in the front-back than in the right-left, with markedly slow times for "back" responses (de Vega, Rodrigo, & Zimmer, in press). Verbal encoding parses space into discrete topological regions whose accessibility is governed by a dimensional organization. In turn, pointing might be associated with a continuous representation of space in which a "visual field" region (an expanded front which subsumes right and left) is highly accessible, whereas the back is less attended. We present data in which subjects learned imaginary environments in a perceptually homogeneous cabin. Later they were tested for object positions using an eight-direction keyboard after rotating "mentally" or physically in the cabin. The pattern of results were interpreted in terms of the mental visual field hypothesis.

Working memory and the role of stimulus support in visuo-spatial transformations

Robert H. Logie and David Pearson

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Visuo-spatial working memory is often considered a core mechanism in the on-line processing of visual mental imagery. However recent studies have suggested that many imagery processing tasks may rely heavily on the central executive of working memory. This paper will describe a series of experiments which address the effect of concurrent tasks on mental synthesis tasks and the effects of providing stimulus support. Results suggest that the visuo-spatial component of working memory serves a role as a temporary storage mechanism. Some forms of stimulus support enhance performance on these tasks. The paper will end with a discussion of whether stimulus support aids the on-line processing in mental synthesis or acts as an external aid to temporary memory for the stimuli and partially constructed images.

What's in an image?

Marc Marschark

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The role of modality specific information in cognition and memory. This paper will consider the issue of how modality specific information is retained in memory and how limiting conditions of such "information storage" influence theoretical perspectives on mental imagery. In particular, the paper will consider evidence for the representation of visual-spatial information by people who are blind versus those who are sighted and the representation of what intuitively appears to be auditory information by people who are deaf versus those who are hearing. In both cases, the mental representations involved appear to be functionally equivalent to mental imagery and yet we are reluctant to give them such status. The reasons for such reluctance will be considered. The link between imagery, language, and thought will be reconsidered as they relate to "special populations" such as those who are deaf or blind.

Modality-specific processing in memory for serial orders

Gilbert Mohr and Johannes Engelkamp

University of the Saarland, Germany

The paper attempts to integrate two different lines of research on memory for serial orders. One line is the study of immediate serial recall with its focus on speech based coding. The other line is the study of the storage and the retrieval of serial information by comparative judgement tasks in which assumptions on imaginal and semantic coding play an important role. A task analysis for both the serial recall and the comparative judgement task is presented with the aim to identify common components and to derive hypotheses on variables that affect performance in both tasks.

Cerebral correlates of mental imagery: Evidence from PET studies

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At least as crucial as the question of whether mental images really contribute to human thinking, the issue of objective correlates of mental processes has motivated a number of empirical efforts on the part of imagery researchers. Physiological indicators like eye movements and pupillary dilation have not proven to be unequivocal attestations of visual imagery. More efforts have been developed to collect signs of the cerebral activity that accompanies

the generation and exploration of visual images. In close conjunction with neuropsychology, EEG studies and the studies based on the technique of evoked potentials have provided converging indications on the role of occipital cortex in visual mental imagery. More recently, the development of neuroimaging techniques based on the measurement of variations of regional cerebral blood flow have contributed to document the involvement of the temporo-occipital and parieto-occipital regions in cognitive tasks calling for visual imagery. Presently, a debate is developing on a crucial issue, namely, the involvement of the primary visual cortex in visual imagery. In particular, while Kosslyn has reported PET data indicating that imagery activates topographically mapped cortex, the data collected in our PET experiments did not reflect the involvement of the primary visual cortex, but only of remote visual areas. Further data will be reported regarding the cerebral activity accompanying visual imagery generated from verbal descriptions.

2.2. JUDGEMENT, REASONING AND DECISION MAKING

Introduction

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Symposia at ESCOP congresses were supported by more than 75% of respondents to the recent ESCOP questionnaire and reasoning, judgment and decision making were amongst the symposia topics explicitly suggested. Further, judgment, reasoning and decision making were suggested as topics for summer schools and workshops (by members from different countries). There is therefore evidence for an interest in such a symposium among ESCOP members. The last SPUDM meeting in Jerusalem attracted around 200 researchers in decision making from all parts of the world but chiefly Europe. The SPUDM meeting increases in size each time it is held thereby demonstrating the increasing interest in this field in Europe. This year there is no SPUDM meeting so a symposium at Wuerzburg offers the opportunity for european decision researchers to present recent work. As a field grows it tends to fragment into a number of specialized areas and consequently, specialist journals. Also at large decision-making conferences such as SPUDM there tend to be a number of parallel sessions each devoted to a particular specialist area. These facts mean that it is difficult for people to keep up with developments in areas of judgment and decision making which are not immediately related to their own. An aim of the proposed symposium is to attract contributions from the field as a whole, including the related field of reasoning, so that participants have the opportunity to hear about a variety of problems, approaches and findings which may inform their own research in new ways.

Gender specific differences in attitudes towards risk

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Economists and psychologists become more and more aware of the relevance of gender specific differences. With respect to attitudes towards risk gender specific differences seem highly plausible. In this paper, different procedures to generate knowledge on such differences are discussed. Furthermore, men's and women's attitudes towards risk are analysed in detail. Finally, the differences' implications for economic behavior and results are pointed out.

Reasons for choices: Processing risk, regret, disappointment, and norms in decision making

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It has often been demonstrated that expected utility theory is insufficient to account for choices under uncertainty. In regret and disappointment theory it is assumed that people anticipate states evoked by counterfactual outcomes. The notion of regret serves as an explanation of omission/commision and status quo biases, demonstrating that people prefer omissions to avoid possible regret, especially if outcomes are negative. Conditions eliciting regret or disappointment are often confounded with different degrees of risk. Two experiments, employing several binary non-monetary choice problems, tested the assumptions of regret and disappointment theory, especially, whether people actually take emotional considerations into account. Additionally, interactions with the options being described either as normal action (as an omission or status quo), or as an exceptional action (commision), and either being a risky or a safe option were examined. Analyses of preference ratings show that most choice patterns are consistent with expected utility; regret and disappointment theory could not generally be confirmed. Analyses of verbal reports indicate that to avoid disappointment, but not to avoid regret, is a major emotional factor influencing preferences. Although anticipated emotions do not seem to play a significant role in making choices, postdecisional emotions are highly consistent with the assumptions of regret theory. A further analysis of decision times support a simple process model, called norm-acceptance model. It claims that people have a default preference for the normal option, and only if some acceptability thresholds such as risk or potential regret are violated, the exceptional option is evaluated.

A study of food risk perception and its relation to purchasing behaviour

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Studies of risk perception have found two main factors by which people appraise risk: the degree of "knowledge" regarding a hazard and its "severity". However, it is not known whether these dimensions play a role in choice behaviour. In the present study information search, preferences and choices are recorded during a simulated shopping trip based on an information-board design. This method, plus concurrent verbal protocols and post-experimental interviews, are used to capture the policies people follow when buying food. The degree to which policies can be represented as linear models will be investigated. Half the food products have a risk factor (e.g. heart disease or salmonella infection) indicated in an associated list of attributes (e.g. nutritional information: percent saturated fat; or ingredients: fresh eggs), and half the products do not. Also half the products have been the subject of food scares within the last few years. On the basis of findings from qualitative research it is hypothesized that unless a risk is particularly salient (e.g. due to a food scare) factors other than risk (e.g. taste and appearance) will dominate preference and choice. It is anticipated that for the salient risks there will be greater information search than the less salient risks as well as changes in processing manifest in preferences, choices and verbal protocols. Finally, the relationship between individual differences in risk orientation and purchasing behaviour will also be examined.

Reasoning about beliefs, obligations, decisions, and plans: A unified approach to modelling cognitive processes and representing knowledge

John Fox

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Lola Lopez (University of Iowa) has observed that psychological research on judgement and decision making is dominated by quantitative or "algebraic" models (e.g. expected utility theory, prospect theory). She observes that such models neglect potentially important aspects of decision making, such as an individual's knowledge and understanding of the decision domain, and the information processing mechanisms which underpin decision making. Jane Beattie (Sussex University) has similarly remarked that JDM research is pursued in a kind of behaviouristic tradition, eschewing mentalistic ideas like "experience" and "cognitive functions". A comprehensive theory of judgement, should accomodate all these aspects but to date there have been no satisfactory theoretical and methodological frameworks for achieving this integration. The paper will outline recent theoretical developments in formal knowledge representation and systematic cognitive modelling which have the potential to bring the different traditions together in a rigorous way. These will be illustrated by means of a knowledge-

based model of decision making, and a computational model of cognitive processes in a medical decision making task.

Focusing in inductive reasoning and decision making

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On the basis of a general theory of deductive reasoning (the mental model theory), it is possible to investigate other domains of thinking. In particular, it has been established that people's tendency to focus on only one representation (model) of the premises elicits some erroneous deductive inferences, as well as a non-normative consideration of only one branch of a decision tree in information-seeking before deciding. In this paper we present new evidence of focusing phenomena. We discuss the results of two series of experiments on hypothesis testing, the first one is about the classical 2-4-6 problem; the second one concerns the Bayesian inference problems which elicit the so-called pseudo-diagnosticity bias - i.e. the tendency to neglect the likelihood $P(D/\text{not-}H)$. In both cases, the results corroborate our model theoretical interpretation. Finally, we discuss the results of a new series of experiments in which we have tried to reduce the focusing effects in decision-making.

The effects of format change on the calibration of subjective probabilities: Unconfounding response scale and type of question

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In this paper we investigate the effects of changing the response scale format (full-range vs. half-range) and question format (a or b vs. true/false) on performance in a subjective probability calibration task. Recently Juslin, Olsson and Björkman (1995) presented simulated data from two models of the probability judgment process; in one random error was introduced at the formation of belief stage (belief-error model) and in the other at the response stage (response-error model). They found that the random error model was „format dependent“ in that at a given level of performance it predicted a different pattern of over/underconfidence for full- and half-range formats. The belief-error model was found not to be format dependent. They also reported empirical findings which they claimed were consistent with the response-error model. However, in the Juslin et al. Study, the change in the response scale format was confounded with the change in question format, and the overall performance level for full-scale format was not reported. A partial replication of their study is reported here, where response-scale and question type were unconfounded. We found that performance level was higher in the half-scale format, but there was no effect of either scale or question type on overall confidence. Neither variable affected over/underconfidence, although there

was a significant effect of response scale on measures of calibration and resolution. We discuss the implications of these results for models of probability assessment.

Actor-observer differences in estimates of the probability of the effectiveness of plans

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Executives often need estimates of the probability that plans will be effective so that they can decide whether to commit additional resources to the development of alternative strategies. Should these estimates be provided by the person who devised the plans (the "actor") or by an independent consultant (the "observer")? Koehler and Harvey have already shown that when plans are difficult to formulate, both actors and observers are overconfident. However, this bias is greater in actors. Thus observers are more appropriate for making effectiveness assessments. People are underconfident in estimating the probability that they have correctly answered easy general knowledge questions. Will the bias also be in this direction when plans are easy to formulate and, if so, will it be greater in actors or observers? To find out, our first experiment used a computer-based interception task. Actors saw a target start to move across the screen and selected one of ten differently positioned guns to fire a missile to intercept it. They then estimated the probability this plan would be successful. Observers saw the target start to move and the gun the actor had selected. They then estimated the probability this selection would be effective. Interception performance was high and estimates of it showed the expected underconfidence. However, this bias was greater in observers. Thus when plans are easy to formulate, the person devising them is the more appropriate for assessing their effectiveness. Results from additional experiments designed to discover the reasons for this difference in bias will also be reported.

An associative approach to base-rate neglect

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The present research will try to explain base-rate neglect from an associative perspective. The Rescorla-Wagner model (1972) will be used as a prototype of associative learning models. Three predictions of the model will be tested. First, the RW-model predicts that a probability problem that elicits base-rate neglect when presented summarized, will not do so if presented sequentially. The model states observers form on-line associations between stimuli and effects in the sequential format, on which they base their judgment. The weights of these associations incorporate the base-rates of the effects. This can be verified by (1) presenting equivalent probability problems in a summarized and sequential format and by (2) letting the subjects rate the associations between symptoms and diseases directly in the sequential format. Second, the model predicts subject's direct ratings of the base-rates shouldn't improve in

the sequential presentation, which can be easily tested. Third, the RW-model predicts that by manipulating the contingency between stimuli and effects base-rate neglect can be induced in a sequentially presented probability problem. Normally, the association between a stimulus and an effect in a sequential presentation is diminished by trials on which the effect appears without that particular stimulus. However, if we associate the effect with an alternative stimulus, the weight of the association between the stimulus and the effect will decrease less. As a result, base-rate neglect should occur. Preliminary results are promising, and I hope to discuss the final results at the conference.

Do subjects discard data relevant to estimation of base rates?

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The proposition of base rate neglect has been challenged both theoretically (e.g., Gigerenzer) and empirically (e.g., Koehler). In a series of investigations using a novel data selection method of assessing whether people are sensitive to base rate information, 362 subjects were presented frequentistic information, some of which was incomplete but relevant to estimating the base rates. Virtually no subjects performed optimally, strongly supporting the original proposition of base rate neglect.

Diminishing sensitivity of event outcomes as a function of time and distance from a reference point

Johanna H. Kordes-de Vaal

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A combination of predictions of the quasi-hedonic editing model (Thaler & Johnson, 1990) and the phenomenon of diminishing sensitivity over time (Loewenstein, 1988) was tested. Subjects were asked for 12 different pairs of financial outcomes to rank the attractiveness of these outcomes when they occurred on the same day, on different days, or integrated into a single outcome. The results support the quasi-hedonic editing model in three respects: (a) A diminishing sensitivity with distance from a reference point was found in the preference of a majority of subjects for integration of pairs of losses and pairs consisting of a small loss and a large gain, and for segregation of pairs of gains and pairs consisting of a small gain and a large loss; (b) the "different day" scenario was ranked highest on attractiveness more often for a loss following another loss than for a loss following a gain, which suggests a loss sensitization mechanism; and (c) the majority of the subjects who preferred a single loss to two segregated losses did not prefer the "same day" scenario to the "different day" scenario, which might suggest that people have difficulty in mental integration of two losses that occur close

in time. A diminishing sensitivity over time was found as well: Subjects preferred to postpone losses as much as possible. The seize, order, and closeness in time of two outcomes as well as the individual value functions might stipulate whether the sensitivity of outcomes will diminish more strongly over time or with distance from a reference point.

Effects of multiple anchors on judgement and recall

Rüdiger F. Pohl

University of Trier, Germany

The term "anchor effect" refers to the finding that an experimenter-provided value (the anchor) may distort the subsequent estimation of an unknown quantity (or the recall of an earlier generated estimate). This paper explores the following questions: (1) How can the anchor effect be quantified? (2) Is the size of the effect independent from the anchor value used? (3) How are double and triple anchors combined? Can their joint effect be predicted from the single-anchor effects? (4) Is the anchor effect identical for judgment and recall? Two experiments were conducted to provide answers to these questions. In both experiments, participants had to estimate the solutions to difficult knowledge questions. One experiment was run in a judgment, the other in a memory design. The anchors presented to the participants varied in distance and number. The results showed strong anchor effects that were linearly related to the anchors distance. Double and triple anchors behaved like their mean single anchor, that is, the effects of multiple anchors could easily be predicted. Moreover, both designs (i. e., judgment and recall) led to similar results. The implications of these findings will be discussed within the framework of a cognitive model that was devised to explain the observed effects.

Decision making in diagnostic situations: New heuristics and biases

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In the usual base rate experiment on diagnostic decision making the subject is confronted with the base rate (prevalence) of a certain disease, the sensitivity and specificity of a diagnostic instrument, and a (fictitious) patient of whom nothing is known, except that s/he has a positive diagnosis on the instrument. The subject is then asked to estimate the probability (the predictive accuracy of the diagnosis) that the patient indeed has the disease. In this presentation the results will be presented of a study in which this paradigm was expanded in two ways, in order to increase its ecological validity. First, subjects had to estimate the prior probability of a certain patient having the disease, on the basis of relevant information about this patient presented to them in writing. Second, they received information about the results of two independent diagnostic instruments (each with its own diagnostic qualities), and were requested to combine this information into a probability estimate of the patient having the disease. Subjects performed several of these diagnostic tasks, and were requested to think

aloud concurrently. Analyses of the verbal protocols and the probability estimates revealed, apart from the usual confounding of conditional probabilities heuristic, a variety of ways in which subjects tackled the diagnostic problem, most of them not entirely irrational, but normative incoherent.

2.3. MEMORY FOR SENSORY FEATURES AND ITS IMPLICATIONS FOR MODELS OF EXPLICIT AND IMPLICIT REMEMBERING

Introduction

Hubert D. Zimmer and Johannes Engelkamp
University of the Saarland, Saarbrücken, Germany

It is often postulated that recognition as an explicit memory test depends on conceptual information. As a consequence, recognition performance should not depend on the repetition of sensory aspects of the study material during test. This is different for implicit perceptual memory tests, which are thought to be datadriven. Performance in these tests should therefore depend on sensory congruity. Several experiments, however, yielded exactly the opposite results. The results were always similar: in summary, it was recognition which depended on sensory congruity, not the implicit test. These effects are incompatible with the original assumption. There are especially problems with monohierarchical models which postulate a hierarchy of stages starting with a unique pictorial token and ending with a concept. An alternative may be the conception of multiple tokens and the postulation of heterarchical models. However, these models have to make structural assumptions to avoid circular explanations, and to specify in advance which sensory features will be effective in implicit tasks and which will not be effective. In the symposium, experiments will be presented and discussed in which memory for sensory aspects of pictures, objects, etc. were investigated in explicit and implicit tasks. We will especially focus on the consequences of these results upon the conception of a model for implicit and explicit memory.

Attentional and structural constraints on short-term memory encoding

Pierre Jolicoeur
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Subjects made speeded responses to the first (S1) of two critical stimuli embedded in a stream of letters shown using a rapid serial visual presentation paradigm (RSVP, 100 ms SOA). Performance in a two-alternative forced choice (2AFC) discrimination (unspeeded) on the second (S2) critical stimulus was impaired when processing of S1 was required - a result often called the attentional blink (AB). The nature of the task required for S1 modulated the magnitude of the impairment for S2. Worse performance on S2 was found for Go than for Nogo trials, for 2AFC than for simple RT, and for 4AFC than for 2AFC in a series of within subject manipulations of the response-selection requirements of the task associated with S1. The deficit on S2 was also found when S1 was a tone requiring a 2AFC frequency discrimination. Within each experiment and each condition, worse S2 performance was associated with slower responses to S1 - results consistent with a central single-channel capacity limitation. Several additional results from my lab will be described and used to constrain a new theory designed to account for the deficits observed in such RSVP tasks and other similar paradigms. Key points in the theory are masking, single-channel capacity limitations on response selection, capacity limitations on memory encoding, and a hypothesized pipeline channel involved in the transfer of information from maskable (iconic/echoic) to non-maskable (STM) memory.

Unconscious perception of meaningful and meaningless information: Evidence for two forms of episodic representations

Walter J. Perrig
University of Bern, Switzerland

The research to be presented is based on the assumption that in a perceptual experience episodic information is extracted in two forms: (1) as conceptual meaning, that represents the subjective phenomenal identification of objects, and (2) as perceptual representations, that do mirror the physical characteristics of the input stimuli, or the process of perception itself on a basis that is not accessible by conscious interpretation. The data of two series of experiments demonstrate that both kind of representations can be effective outside of the awareness or the reportability of the observer, thus representing two forms of implicit memory. In one paradigm the unconscious activation of meaning is demonstrated by the use of concurrent measurement of stimulus identification and a forced-choice discrimination. Words that had to be identified were presented followed by a backward mask. Immediately following each identification subjects had to select response alternatives that were semantically similar to the target word. Dissociations can be demonstrated in that correct stimulus discrimination exceeds a chance level of performance following both hits and misses. In the other paradigm complex geometric-like and meaningless line drawings were used. These figures were distorted by five

different mathematical functions. Subjects were then presented with six drawings, five of them distorted by the same, one by another function. The data show that subjects correctly select the drawing with the least perceptual correspondence, without reference to meaningful discriminative features.

How to enhance perceptual priming

Ulrich Olofsson

Umea University, Sweden

Explicit recall and recognition benefits from different types of conceptual elaborative processing at study, assumed to produce more distinctive and accessible "traces" in memory, and is little affected by perceptual manipulations. Perceptual priming, in contrast, is generally not affected by conceptual manipulations, and often affected negatively by changes in perceptual information. Compared to explicit memory, priming is a remarkable stable form of memory, and few conditions are known that increase priming effects. The question addressed in the present paper is whether it is possible to enhance priming by "perceptual elaboration" at study, similar to explicit memory? Speaking against this possibility are evidence that priming does not benefit from increased exposure durations and massed repetition (Jacoby & Dallas, 1981), indicating that "normal" priming requires only a minimum of perceptual analysis. On the other hand, by a transfer-appropriate-processing view (e.g., Graf & Ryan, 1990), perceptual priming tests, requiring identification of perceptually degraded information, should benefit from extensive processing that focuses on the visual details of stimuli. In support of this view, data from self-generation, context effects, spaced repetition, and von Restorff (isolation) manipulations is presented and discussed as examples of how extensive visual processing at study enhances perceptual priming. It is concluded that priming benefits from "perceptual elaboration" in a manner similar to how explicit memory benefits from conceptual elaboration.

Visual/spatial properties of memorial representations of objects

Lynn A. Cooper and H. John Hilton

Columbia University, NY, USA

Recent research (e.g., Cooper, 1994; Cooper & Schacter, 1992; Schacter, Cooper, & Delaney, 1990; Schacter & Cooper, 1993) suggests the existence of multiple systems for the representation and retrieval of information from novel visual objects at both functional and neuro-anatomical levels. One system - termed the structural representation system - codes abstract, axis-based perceptual information that is invariant over selected transformations in object attributes including size, parity, and colour; the operation of this system is revealed by priming effects on various implicit memory tasks. The other episodic system codes object meaning and function, as well as visual attributes that contribute to an object's distinctiveness in memory; the operation of this system is revealed by performance on explicit tests of recognition

memory. Of particular importance are visual attribute manipulations that produce opposite effects on, or dissociations between, these hypothesized underlying memory systems. In the experiments to be reported, well-defined transformations of object shape (including scaling along a single axis, or transformation in axis ratio, as well as skew and shear transformations) were introduced from the time of object encoding or study to the time of implicit or explicit memory testing. In certain cases, predictable dissociations were observed, thereby highlighting the abstract nature of structural representations of objects. Results are discussed in terms of their contribution to an evolving theoretical characterization of both structural and episodic systems for object representation.

A Paradox: Some sensory matching effects are larger in explicit than implicit memory

Joan Gay Snodgrass

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One important distinction between implicit perceptual tasks, such as fragment completion and perceptual identification, and explicit tasks such as recognition and recall is that the former are more sensitive to the match of sensory information between study and test forms of stimuli. For example, cross-modality priming effects are much smaller than within-modality priming effects in implicit tasks, whereas cross-modality recognition memory is often equally as good as within-modality recognition memory. We have re-examined this distinction for a very subtle change in sensory information, namely whether a studied fragmented picture is tested with exactly the same fragments or a complementary set of fragments. Across five experiments which varied the absolute level of fragmentation, we found that priming in fragment completion was impervious to whether fragments matched or were complementary, whereas recognition memory showed a substantial decrement to changed fragments. Thus, the explicit task of recognition memory showed greater sensitivity to sensory matching than the implicit task of fragment completion. I recently extended these findings to the implicit task of categorization and the explicit task of cued recall, and found comparable effects. I will argue that memory for sensory features provides a potent retrieval cue in explicit memory, and that it is the difference in retrieval demands between the two types of memory tasks which accounts for this paradox.

Implicit memory for colour and for size information

Werner Wippich and Silvia Mecklenbräuer
University of Trier, Germany

Recent investigations of implicit memory failed to find effects of colour and of size information on test performance. In 4 experiments, we found priming effects of colour information with a conceptual implicit measure, but not with conventional perceptual tests (e.g., picture fragment identification). In a conceptual test, subjects were asked to choose a colour for each object at testing. The colour-choice task demonstrated reliable preferences for the previously seen colours. Comparable priming effects were observed with black and white pictures of objects and with object names at testing, corroborating the conceptual nature of the measure. Dividing attention at study did not influence conceptual priming. Similarly, priming was found even when subjects were not obliged to attend to color at encoding. Thus, colour may be processed more or less automatically at a conceptual level. We conclude that some effects of perceptual information can be detected at a conceptual level of processing. Colour may be integrated at a higher-level object representation that is not accessible via perceptual cues. Two further experiments were dedicated to another perceptual attribute, namely the size of pictures of objects or their names. We failed to find effects of size information on implicit test performance. In a size-choice task, subjects did not show reliable preferences for the previously seen sizes. These results may be due to size being a relative rather than an absolute perceptual attribute. Or they may indicate that size is not represented at a conceptual level of processing.

Size and colour of objects in implicit memory tasks and in recognition

Hubert D. Zimmer and Johannes Engelkamp
University of the Saarland, Germany

A series of experiments is reported in which we investigated the influence of size and colour on implicit and explicit tests. Subjects studied pictures of different size and/or colour and participated in an explicit test (recognition) and in different implicit tests (either object decision, tachistoscopic perception, naming or word-picture matching). From study to test the sensory congruity was manipulated. The pictures of the objects were either of the same size or colour as during study, or they were of a different size and colour as during study. If this variation influenced performance, sensory congruity from study to test was effective in recognition, but not in the implicit tests. A heterarchical multi-token model is suggested to explain these results.

2.4. THE CENTRAL EXECUTIVE: THE GHOST IN THE MACHINE OR THE MACHINE IN MAN?

Introduction

Koen Van der Gooten¹ and Bernhard Hommel²

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The concept of a Central Executive, that is, an instance or module that deals with how information is processed throughout the cognitive system, has (again) become increasingly popular in cognitive psychology. Does this reflect the ultimate victory over behaviorism by re-introducing the "real" psychological issues in information processing psychology? Or is it a relapse into mentalism? Do we really gain something, theoretically and/or empirically, by using this concept or does it rather prevent us from addressing the essential questions? Although we feel that it is about time to enter a broad discussion on these issues, we do not yet expect final answers from this symposium. As the concept of a central executive does not refer to a particular field or research domain but to a highly controversial theoretical issue, we do not even expect the contributions to combine to a homogeneous picture. Rather, the symposium is intended to raise questions and stimulate further theoretical and empirical developments.

Working memory's central executive: Always just at the end of the rainbow?

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The concept of a central executive in a working memory system can be interpreted in a number of ways. One view holds that the central executive plays an important role as a general purpose processor which can act as a storage medium when other systems are occupied (e.g. Baddeley & Hitch, 1974; Case, 1985). There is also the notion that the executive is a limited-capacity device which takes a primarily supervisory role in guiding lower-level processes towards appropriate and goal-directed ends (e.g. Baddeley 1986; Baddeley, Bressi, Della Sala, Logie & Spinnler, 1991). The present paper will consider two aspects of the central executive construct. The first is its heuristic value in marking and identifying the need to explain certain aspects of cognitive activity, which cannot legitimately be assigned to other systems within working memory. For example, in a multi-component system, some account will be required of how information is transferred, integrated and coordinated. A second aspect involves the characterisation of the executive specifically as a single, limited capacity and general device. Experimental evidence from adults on a task thought to reflect executive

processes - random generation - and from children performing working memory tasks - requiring both processing and storage operations - will be reported. These data will be used to specify executive functioning.

Cognitive and motivational determinants of switching costs in the task-switching paradigm

Ritske De Jong

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In the task-switching paradigm, an instruction signal, that signals which one of several alternative reaction-time (RT) tasks is to be performed on the trial, is followed after a variable preparation interval (PI) by a stimulus that requires a speeded response. From the resulting PI-RT function, and from comparison with control single-task RT, both the speed and efficiency of preparatory processes can be estimated. A recurrent finding in the recent literature is that even for very long PIs, the level of task performance in switching conditions remains substantially below that in single-task control conditions. The fact that switching costs are present even at long PIs might indicate a fundamental limitation in top-down cognitive control of task performance, but alternative interpretations of these findings are possible. I will present results of detailed analyses that strongly suggest that such remaining switching costs have in many cases a motivational rather than a cognitive basis. These analyses also show that very long PIs may in fact be counterproductive as they require people to actively maintain task sets over prolonged periods of time. I will argue that further progress on these issues will require not only a careful distinction between cognitive and motivational causes of switching costs but also due consideration of the possibility that such causes may be strongly interrelated.

The origin of mixing costs: Endogeneous or exogeneous?

Sander A. Los

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People usually respond faster when the levels of an independent variable are presented in isolation, that is in pure blocks, than when they are presented randomly intermixed, that is in mixed blocks. These mixing costs have widely been interpreted as reflecting the subject's uncertainty about the level of the independent variable to be presented on the forthcoming trial. Due to higher uncertainty, subjects are not as well prepared for processing in mixed blocks as they are in pure blocks. In this view, the origin of mixing costs is endogeneous, since a central executive should be postulated that takes care of preparing the mental system for forthcoming processing. An alternative view derives from the observation that block type (pure vs mixed) confounds uncertainty and intertrial variability. Due to higher intertrial variability, switching among processes for the benefit of events occurring on subsequent trials takes on the average

more time in mixed blocks than in pure blocks. In this view, the origin of mixing costs is exogeneous, since mixing costs are assumed to reflect the extent to which previous processing aids or impedes actual processing. In this talk I will discuss methods that aim at dissociating endogeneous and exogeneous contributions to mixing costs. Based on these methods, the origin of mixing costs is examined at several stages of information processing, including perceptual, central and motor stages.

Exploring the dynamics of short-term memory storage

Marc Brysbaert

University of Leuven, Belgium

The span task and the Sternberg task are usual procedures to assess short term memory storage. A common characteristic of these procedures is that the items are presented at a fixed pace. Using a variant of the Sternberg task in which the observer has control over the presentation duration of the individual items, Brysbaert (1995) found that the time needed to store the items in short term memory reflected important characteristics of the processing. In particular, he found that the magnitude of Arabic numbers influenced processing time, as well as syllable-length, and priming. In a new experiment, this technique is used to study the effect of serial position and control over action on processing times.

The elusive executive: Can we measure cognitive control processes?

Louise Phillips

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Cognitive psychology has traditionally shied away from the study of executive control processes, influenced by an aversion to homuncular ideas of conscious control. Recently, executive function has been called upon to explain an ever-increasing number of psychological phenomena, particularly the behaviour of patients with frontal lobe lesions. Despite the widespread interest in such processes, investigation into executive function is hampered by problems of assessment. The most common tests of executive function are those proposed to be selectively sensitive to frontal lobe lesions. This paper will highlight theoretical issues and empirical evidence which question the widespread use of such 'frontal lobe tests' to assess executive function in both clinical and normal populations. Some of the issues discussed include: (1) difficulties in ensuring novelty of both contents and format, (2) the bizarreness, unpleasantness and incomprehensibility of some frontal tests, (3) the impossibility of assessing executive function in isolation from representational domains or response modalities. Evidence suggesting contrasting reasons for poor performance on an executive test in frontal lobe as opposed to Alzheimer's disease patients is presented. Also, problems in establishing the reliability and construct validity of executive tests are discussed in relation to data on age and individual differences in fluency performance. It is hoped that evaluating methods of ex-

ecutive assessment can highlight some problems with current theories of the control processes of mind.

The central executive: What is it good for? Comments and open discussion

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Empirical data and theoretical viewpoints from different domains within cognitive psychology regarding attentional control have been presented in this symposium. As an introduction to the discussion we will try to orient the discussion towards some communalities over the domains and their consequences for further research and theorizing.

2.5. COGNITION AND INTENTION

Introduction

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The role (and function) of intentions in cognition has been widely neglected so far in cognitive psychology and it seemed us to be worth to shed some light on it, especially on the occasion of this conference because this topic was at the core of the special approach of the Würzburg School to acting and thinking. First, it needs to be explored how the cognitive processes which underly perception, attention, imagery, memory, and learning are modified by the goals of the behavior in which they are embedded, i.e. how far they are modified by intentions. Second, the mechanisms by which the employment of mental routines and operations is controlled needs exploration, i.e. (at least in some sense) the mechanisms of the intentional control of thinking. Finally, the cortical structures which mediate intentional influences are of interest.

Intention as representational modifier in apperception

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All of the contents in human representations are seldom reducible to immediately perceivable physical stimuli. We cannot perceive „tomorrow“ or „possible“, for example, though we are quite able to represent issues related to them. Therefore it is necessary to assume a stimulus independent representation construction process, which is apperception. Apperception constructs representational contents. It selects which content elements are relevant and which are not. It also integrates the elements to each other in a sense-making manner. Some content elements in representations are relatively independent and very general. Typical examples could be epistemic and alethic quantifiers. These kinds of representational elements can be called representational modifiers, because they can be used very freely to modify representational contents. Intention is a content-element of this type, i.e. a representational modifier, because it is a highly general content element it is very hard to find any representation which would not entail some intention. Of course, the reason for the generality of intentionality is caused by its relatedness to human action. Actions are intentional and people are practically always doing something and thus they have to apperceive and represent intentions. In this paper I have worked to develop empirical methods based on protocol analysis for investigating the functions of intentionality in apperception. This is why subjects were presented with artistic paintings. The skill level and the types of intentions were systematically varied to receive information about, how intentions modify their mental representations.

Attention, expectation, and intention. From responses to actions

Alexander H. C. van der Heijden

University of Leiden, The Netherlands

The information processing psychology is a laboratory psychology. The registration of symbolic responses in simple artificial laboratory settings is its method, the quantitative summaries of aspects of these responses form its data, and the construction of a hypothetical information processor, whose internal structure and function can explain the data, is its theoretical goal. Van der Heijden (1992) presented such a hypothetical information processor that can account for the accuracy and latency of instruction-induced selective responding in simple visual information processing tasks. In that hypothetical information processor the simultaneous operation of attention, expectation and intention, in interaction with the stimulus information, leads to the required selective responding. The real human information processor spends most of its time outside the laboratory within a complex real world where it has to engage in a meaningful interaction with a hostile environment, i.e., where it has to act in order to survive. A critical evaluation of some selected recent literature concerned with aspects of the relation between perception and spatial actions shows that, for meeting this action challenge, the information processor has to be armed with attention, expectation, and intention for

channeling environmental information. In other words, for meaningful spatial actions in a meaningful world, the human information processor requires an internal structure and functioning similar to the structure and functioning of the hypothetical information processor derived from the response data collected in the artificial laboratory experiments.

Intentional constraints of response outcome learning

Joachim Hoffmann and Albrecht Sebald

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Control of behaviour requires the ability to predict its consequences. However, consequences often depend on the situation in which we act, i.e. the same actions can produce different outcomes in different initial situations. Therefore, there have to be learned not only covariations between our actions and their outcomes, but also the dependencies of these covariations on the initial situations. In a series of experiments, the acquisition of this „dependency knowledge“ was investigated by means of a computer game. Subjects could rotate different wheels of fortune using buttons on a keyboard, whereupon hits or blanks were displayed. In principle, the probability of scoring hits with particular buttons depended on the initial situation. In different experiments, the situation-depending probabilities of hits, the value of hits and blanks, and the behaviourally relevant characteristics of the initial situations were varied. The results indicate that there are at least three constraints which impair learning about the effectiveness of acting: First, covariations between actions and outcomes are only recognised if the respective outcomes are intended. Second, only those outcomes seem to be taken into consideration that were, at least for a certain period of time, experienced as being deterministic. Third, characteristics of the initial situation are considered as relevant only if they correspond to subjective theories of causal connections. Overall, the results suggest a learning process, in which mechanisms of reinforcement interact with an intentional search for rules.

Intentional switching between tasks

Alan Allport

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The performance of subjects, when they are required to shift voluntarily from one speeded task to another, may provide insights into the mechanisms of intentional task control. This paper reports a series of experiments in which subjects switched, from trial to trial, between two mutually incompatible tasks (e.g. add 3 vs subtract 2 from a number; name an object in German vs French). In such cases, a shift of task results in a substantial increase in reaction times (RTs), referred to as the switch cost (SC). Even with fully predictable shifts of task, and with long inter-trial intervals (ITI), the SC remains large and, in some cases, can be unaffected by ITI. In previous studies (Allport, Styles & Hsieh, 1994, *Attention & Performance* 15) we have found that SC is (paradoxically?) greater in switching to the relatively stronger of the two tasks / two languages. In the present series of experiments we investigate this

finding further. The experimental questions to be addressed are the following: (1) How far is SC affected by the relative vs absolute levels of practice/strength of learning? a) over an hour of differential practice? b) over years of practice? (2) Can these global effects of task practice be reproduced by local, item-specific priming? (3) Can practice at task A (alone) affect the shift cost also for task B? Is the cost of shifting from task A to task B related to the amount (and/or asymmetry) of (Stroop) interference between A and B?

Shifting task set

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Intentional control of cognitive activity takes different forms. One experimental paradigm studied recently by Allport et al. (1994) refers to intentional shift task set. Subjects are required to shift between tasks compared to a condition under which a given task set is maintained over many trials. The observed efficiency of task-shifted performance is analysed in terms of time costs, which are assumed to indicate cognitive effort due to intentional control. Allport et al. (1994) among others reported results according to which the time costs of a shift set are not affected by task variables. Concurrent shifts in task set on two different task dimensions caused no greater shift costs than did shifts on a single task dimension. Our interest is in the mechanisms of control and in the factors affecting shift cost. We designed three experiments, in order to examine two hypothetical determinants of shift cost: (1) The distinctiveness of tasks, which could have been effective under the condition of concurrent shift of two dimensions in the first experiment of Allport et al. (1994); (2) The anticipation of tasks, which is possible when the shift between task dimensions follows a regular sequence that is known in advance. Essentially the same experimental setting was applied as described by Allport et al. (1994). In Experiment 1 significantly higher shift costs were found for shifting between stimulus dimensions compared to shift of judgment mode, and compared to concurrent shift of task set as well. The latter did not differ significantly from shift of judgment mode. These results were also obtained for a condition with random sequences of tasks where a shift of task set could not be anticipated by the subjects. Experiment 2 and 3 applying slightly changed conditions clearly confirmed these results. The same picture is obtained under self-paced as well as under fixed conditions: Costs are high for shift of stimulus dimension, low when shifting judgment mode, and low for concurrent shift of both, too. However, the highest shift cost was observed in all three experiments under a so-called mixed condition originally not included by Allport et al. (1994). Here concurrent shift between both task dimensions was implemented, providing all possible combinations of stimulus dimension and response mode. The results suggested that a shift of stimulus dimension causes high time costs, presumably due to the required switching between local (number) and global processing (set). Costs are significantly lower for a shift of judgment mode. Despite concurrent shifts in task set of two dimensions, the resulting time costs are lower; this can be explained by the increased distinctiveness of tasks when a shift of stimulus dimension is combined with a shift of judgment mode. This assumption with regard to the effect of distinctiveness is also supported by the significant increase of time costs under the mixed condition of concurrent shift. Distinctiveness is reduced under the mixed condition, because there are concurrent shifts between tasks where one of the two dimensions is kept. It can be assumed that this makes it

more difficult to inhibit the preceding task set and to adopt the new task set. This causes time costs until the new task gains priority. The lack of any effect of random sequences is explained with regard to the decreased number of shifts between task set under this condition: this requires further research. Also, it is of interest to examine if increasing the distinctiveness of tasks experimentally will decrease the observed shift cost.

Ideo-motor action

Wolfgang Prinz and Lothar Knuf

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A hundred years ago ideo-motor actions played a prominent role in the theoretical debate on the linkages between volition and cognition. At this time, there were, however, no attempts to analyze how ideo-motor movements are related to the pattern inherent in stimulus motion. Later on, the study of ideo-motor movements fell into oblivion after Thorndike had banned it as unscientific. We have taken a new look at this old phenomenon and have developed a paradigm that allows us to study how the kinematics of induced ideomotor movements depend on both the kinematics of the stimulus in events (i.e. what actually happens) and the observer's intentions (i.e. what he/she wants to see happening). Our experiments suggest that ideo-motor movements are intention-controlled rather than stimulus-controlled. They seem to be organized in accordance with intended events rather than ongoing events (intention vs. imitation hypothesis).

The role of frontal lobes in executive functions

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A distinction has been proposed between an anterior attentional system and a posterior attentional system (Posner & Dehaene, 1994). The posterior attentional system subserves various aspects of spatial attention. The executive functions are among the functions subserved by the anterior attentional system (Shallice, 1994). In closed head injury (CHI) patients, the prevailing anatomo-pathological lesions are localized in the fronto-orbital cortex. One group of severe CHI patients, one group of mild CHI patients, and two groups of matched control patients were studied. The mild CHI patients did not show any signs of the frontal syndrome. All subjects performed in a dual-task test and a task-shifting test, which tap executive functions, and in a global-local test, which taps visuo-spatial selective attention. Both severe and mild CHI patients showed a deficit in the dual-task test and in the task-shifting test in comparison to controls. In contrast, there were no differences between CHI patients and controls in the global-local test. The results are discussed in terms of the distinction between the anterior and the posterior attentional systems.

CHAPTER 3

THEMATIC SESSIONS

3.1. WORD PROCESSING

Segmentation and access in spoken Italian

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In order to understand discourse, listeners must recognize the words occurring in it. This is a difficult task, as in fluent speech word boundaries are not clearly marked. One influential hypothesis is that listeners perform segmentation, relying on language-specific, perceptual strategies: While English speakers may rely on prosodic cues, speakers of Romance languages may use syllables as basic units to access the lexicon. The present study explores the role of syllables in Italian. Experiments 1 to 3 test the hypothesis that the sensitivity of Italian listeners to syllables is comparable to that observed in speakers of Spanish. Spanish, in fact, unlike other Romance languages, share with Italian phonological parameters which are known to be relevant in determining syllabic effects. In particular, both languages have a variable, contrastive stress, have neither ambisyllabicity nor reduction, and have only five vowels. The findings indicate that, like in Spanish, syllabic effects can be found. However, they are less consistent than the effects initially observed in French, and attentive mechanisms must be engaged for the effects to appear. But granted that Italian speakers are sensitive to syllables, what evidence is there that they rely on these units to segment speech and access the lexicon? This issue is addressed in Experiment 4. Here, the activation of words in spoken sentences is explored as a function of length and structure of the initial fragments of the words. In the light of the results, the viability of the syllabic hypothesis is discussed.

Frequency of morphemes as a determinant of parsing

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The relationship between the frequency of a word and the frequency of its morphological constituents may affect the likelihood that the word is morphologically parsed during lexical access: Words of a lower frequency than their included morphemes are likely to be accessed via activation of the constituent morphemes. In a first visual lexical decision experiment, we contrasted four sets of Italian suffixed derived words having the same (low) frequency but differing for the frequency of their morphemes. Words in the four sets included: 1) high-frequency root, high-frequency suffix; 2) low-frequency root, high-frequency suffix; 3) high-frequency root, low-frequency suffix; 4) low-frequency root, low-frequency suffix. If words are parsed morphologically, decision times should reflect the frequency of the constituent morphemes, with words including higher frequency morphemes being recognized more

quickly than words including lower frequency morphemes. By contrast, if no morphological parsing takes place, the whole-word frequency, which is constant across the four sets, should affect lexical access, with words of all the sets giving rise to analogous recognition times. Results suggested morphological parsing for derived words: Both the root frequency and the suffix frequency had an effect, with words in set 1 being decided more quickly and accurately than words in sets 2 and 3, and words in set 4 being the slowest and less accurately recognized. In a second experiment, we assessed possible costs and benefits of parsing with respect to whole-word processing, by comparing suffixed words with underived words of analogous (low) frequency. Results confirmed morphological parsing for derived words, with frequency of constituents affecting lexical decisions. With respect to whole-word processing of underived words, parsing resulted in quicker reaction times only for words in which both constituents were high frequency. By contrast, parsing was not advantageous when only one constituent was high frequency, and it implied even larger processing costs when both constituents were low frequency.

Morphemic frequency effects in visual word recognition: Evidence from masked morphological priming

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Three experiments are reported that examine the effects of lexical and morphemic frequency (the cumulated frequency of all derived words that share the same base; e.g., LAITIER + LAITERIE + LAITAGE...) in the masked priming paradigm. Experiment 1 demonstrated that the prior presentation of a morphologically related root having a lexical frequency superior to its morphemic frequency facilitates suffixed word processing compared to an orthographic control. No facilitation is observed when the root prime has a lexical frequency inferior to its morphemic frequency. In Experiment 2, the morphemic frequency effect was estimated using both an unrelated and an orthographic control. As in Experiment 1, facilitation was obtained only when the prime has a lexical frequency superior to its morphemic frequency. A third experiment was conducted using only pairs with a higher lexical than morphemic frequency, while varying in terms of their morphemic frequency (high or low). The results suggest that priming effects depend on morphemic frequency rather on the relation between the lexical frequency and morphemic frequency. An interactive activation model, including a supra-lexical representational level of morphemic nodes, is proposed to account for the present results.

Form and meaning contribution to word recognition in Catalan/Spanish bilinguals

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Using the masked priming technique and English/Spanish bilinguals, previous studies (Sanchez-Casas, Davis, García-Albea, 1992) have shown that cognate words (e.g., rich/rico) produce priming effects not different in magnitude from those found when prime and target are the same word. Moreover, these effects are obtained even when the form similarity of the cognate pairs is low (e.g., tower/torre). However, no priming effects were found with non-cognate words (e.g., moon/luna). These findings have been interpreted as evidence to support the claim that only cognate words are stored under the same lexical representation, both their form and meaning similarity being responsible for such a common representation. The two experiments that we report in this paper explore further the form and meaning contribution to priming effects, examining now Catalan/Spanish bilinguals. In both of them, we use the lexical decision task and the masked priming procedure of Forster and Davis (1984), manipulating the prime and target language. The first experiment used cognate words (with similar form and meaning, e.g., tarde/tarda), noncognate words (with different form and similar meaning, e.g., jaula/gabia), and false cognates (similar form and different meaning, e.g., fleco/fleca). The results showed evidence of priming effects only for the cognate cases, suggesting that form and meaning by themselves are not sufficient to produce priming effects. In the second experiment, we used cognate words which could differ either in just one letter (e.g., astro/astre) or in two or more letters (e.g., deber/deure) in order to examine the influence of form similarity for these cases. The findings of both experiments are discussed in relation to current models of bilingual processing.

Conceptual representation in bilingual memory: Effects of concreteness and cognate status in word association

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How are the meanings of words in the two languages of a bilingual organized in memory? Do the words of a translation pair share a conceptual representation (common storage view), or are they represented in separate, language specific stores (separate storage view)? This question has elicited considerable debate in the bilingual memory literature over the past few decades. Currently, the dominant view is that conceptual representations, as tapped by tasks that involve the retrieval of word meanings, are shared in bilingual memory. However, most studies that support the common storage view of bilingual memory have used concrete, easily imaginable nouns as their stimulus materials. It remains to be seen to what extent results obtained with concrete nouns generalize to words with other characteristics, e.g., abstract nouns, or verbs. In a word association experiment we examined the conceptual representations of

words with different characteristics in bilingual memory. Words (i.e., nouns, verbs and adjectives) were varied on concreteness and cognate status. Dutch-English bilinguals were asked to associate twice on the same series of stimulus words: Once in the same language as that of the stimuli (within-language), and once in the other language (between-language). The within- and between-language associative responses on each stimulus word were subsequently compared to see whether they were the same (i.e., translations, in line with the common storage view) or different (in line with the separate storage view). The results indicated that the within- and between-language associative responses on concrete words and on cognates were more often translations than those on abstract words and cognates. This suggests that conceptual representation in bilingual memory depends on word-type.

Bilingual organization of spoken and literary Arabic in native speakers

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Arabic has two forms. One, the literary Arabic, is universally used in the Arab world for formal communication and writing. The second, spoken Arabic, is a local dialect which has no written form. Yet, the spoken dialect is the native language of the absolute majority of native speakers of Arabic while the written form is taught in school in parallel with learning to read and write. Although sharing a limited subgroup of words, the two languages are phonologically and syntactically different. Therefore, these two forms of the Arabic language can be considered as first and second language and each literate Arabic speaker a bilingual (at least). On the other hand, because of the absence of any written form of the spoken dialect, these two languages are inter-twined in every-day life, particularly so in school. Consequently, it is possible that for the native Arabic speaker, literary Arabic is not a second language but an enhancement of the same lexicon. We have examined this possibility comparing semantic priming and repetition effects within L1 (spoken Arabic) with the effects found when the primes were in literary Arabic (L2) or Hebrew (L2) and the targets were in spoken Arabic and vice-versa. In a pilot test we have verified that for both visual and auditory presentation, lexical decision performance for words and nonwords in literary Arabic and Hebrew is equivalent. Using lexical decisions for auditory presented words we found that the semantic priming effect was 4 times as big when both the prime and the target were in spoken Arabic (185 ms) than when the prime was in literary Arabic (45 ms) or Hebrew (54 ms), whereas the targets were in the spoken dialect. When the primes were in spoken Arabic and the targets in the different language conditions the across-languages priming effects were doubled but were still smaller than within-language priming. Repetition effects at lags between 9 and 12 were found only within language (140 ms). We conclude that, despite its intensive every-day use and psychological proximity, spoken and literary Arabic entertain two different lexica in the cognitive system of the native Arabic speaker.

Orthographic priming: Effects of relative letter position

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In this work the role of individual letters in visual word recognition is investigated. An orthographic priming paradigm is used in which targets are six letter French words formed by four consonants and two vowels (e.g., BALCON) and primes are strings of four consonant. In the first experiment two prime lengths were used. Primes could be either six or four letters long. The six-letter prime contained the four consonants of the target word plus two further consonants placed in the same position as the vowels (e.g., bslcrn BALCON). The four consonants had the same relative and the same absolute position in the prime and in the target. Performance in this condition was compared to a condition in which primes were formed by six unrelated consonants (e.g., tspvrf BALCON). The four-letter prime was formed uniquely by the consonants of the target. No further letters were included so that the consonants had the same relative but not the same absolute position in the prime and in the target (e.g., blcn BALCON). Performance in this condition was compared to a condition in which primes were formed by four unrelated consonants (e.g., tpvf BALCON). In a second experiment the same six-letter target words were primed by four consonant primes. The first condition was the same as in the previous experiment in which the prime contained the same consonants as the target word in the same relative position (e.g., blcn BALCON). In another condition the two lateral letters of the prime were scrambled so that the first letter of the target word was the last letter of the prime (e.g., nlcb BALCON). In another condition the two middle consonants of the prime were scrambled (bcln BALCON). Effects of these primes were compared to a condition in which the prime contained four unrelated letters. Results obtained are discussed in relation to models of visual word recognition and mechanisms involved in the coding of letter identity and position.

Prelexical phonologic computation in a deep orthography: Evidence from backward masking in Hebrew

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Prelexical phonological computation of print was examined in the deep unpointed Hebrew orthography using backward masking. Target words were masked by nonwords which were homophonic, phonologically similar, or phonologically dissimilar to the targets, yet preserving an identical graphemic overlap with them. Phonological similarity was manipulated by replacing consonant letters by other consonant letters, or by vowel letters. The results demonstrated that the phonological similarity of the nonword masks to the word targets affected detection rate in a non-linear fashion: No differences were found between homophonic

masks, phonologically similar masks, and masks in which a consonant letter was replaced by a graphic pound sign. In contrast, nonwords which were graphemically similar but phonologically dissimilar to the targets, reduced identification rates dramatically. These results suggest that prelexical computation of phonology is a mandatory process even in deep orthographies. However, the representations computed in brief exposures are coarse-grained and not detailed enough to capture fine phonetic differences between masks and targets.

The A in AMEN is different from the A in ALBUM: Phonologic effects in normal-reading and reading-disabled Dutch children

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We will present the results of two experiments investigating the role of phonology in printed word perception in Dutch children with normal reading skills, and in Dutch children whose reading skills are impaired. The experimental task was first-letter naming, which requires naming the first letter of a word or word-like letter string. First-letter naming was faster in the congruent condition than in the incongruent condition. In the congruent condition the pronunciation of the first letter coincides with the pronunciation of the letter in isolation, but in the incongruent condition the pronunciation of the first letter in the word deviates from the one in isolation. For example, in Dutch as well as in American English the phonology of the A in Amen is similar to the letter A in isolation, whereas the A in ALBUM is dissimilar from an isolated A. The performance of the children in the reading-disabled group and of those comprising the normal-reading group (an age-match control group and a reading-match control group) were remarkably similar. The results of both experiments indicated that phonology is a fundamental constraint in printed word perception of readers of all levels and all skills. We will discuss the 'apparent' paradox in the reading behaviour of disabled or dyslexic readers, that is, in some tasks (i.e., first-letter naming) dyslexic readers appear to be affected by phonology, whereas in other tasks (i.e., pseudoword naming) phonologic knowledge seems to be deficient or absent.

Visual word recognition: An experimental evaluation of the dual-route cascaded processing theory

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A nonword prime can sound like a target word or one of its associates, and it can look like either without sounding like either. These pseudohomophones and pseudohomographs can vary in the number of the letters distinguishing them from either the target or its associate. In an associative priming experiment in which targets were named and SOA = 250 ms, pseudohomophones primed and pseudohomographs did not, with the pseudoassociative priming independent of spelling differences. In further experiments at SOAs of 250 and 34 ms, in which homophony and homography were defined with respect to the targets, the superior priming by pseudohomophones was independent of spelling differences. Discussion focussed on dual-route cascaded processing theory and a leading role for the nonlexical route.

3.2. VISUAL ATTENTION

Selection processes in primates: A new look at „task combination and selective intake of information“ in vision

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Attention research of 60's to the 80's was dominated by the topics of „task combination and selective intake of information“ (Broadbent, 1982). In the last decade, the focus of attention research shifted towards selective intake, especially towards selective visual attention, and away from dual task work. In this presentation, a new theory will be introduced that attempts to cover both topics in one model. Two separate attentional processes, namely visual attention and modality-unspecific action attention, are specified at the level of neuro-cognitive information processing in primates. Reference to the „object file“ framework and the idea of a „central executive“ will be made. Dual task combination findings, especially for visual-based activities, will be reanalysed, e.g. the probe stimulus paradigm (Posner), the working memory interference data (Logie), and data on the relationship between spatial-motor actions (saccades, reaching) and perceptual discrimination (Deubel & Schneider).

Global-to-local expectancies in visual search

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Recent models of visual object-identification (Kosslyn, 1994; Hoffmann, 1993) assume that objects are recognised by a sequential global to local analysis of their properties. In most cases, processing global properties suffices in order to identify an object, at least at its basic level. But there are situations where global processing does not suffice to indicate a basic-level-object or where a more specific identification is required. It is assumed that under such circumstances the present visual configuration will be tentatively attached to an object, which mostly resembles its global appearance. The hypothetical attachment then serves to control a guided search for local details. If the details are detected as they were expected, the tentative object-hypothesis is validated. A guided search for details presupposes knowledge about contingencies between global and local properties of objects. Experiments will be reported which studied the acquisition of such knowledge and its use in visual search: Subjects performed a visual search task. They had to decide which of two target-letters was respectively presented among a set of distractor-letters. The letters were arranged such that they formed different global configurations on the screen. Covariations between global and local properties of the configurations were varied. Consequently, the local properties become predictable by the global ones, if the corresponding covariations were really acquired. The results of two experiments revealed that subjects easily acquire knowledge about where at the configurations which details are to be expected. They seemed to form configuration-centred reference systems, which render predictions of details even when the configurations were displaced or rotated. A third experiment indicated that subjects acquire knowledge not only about locations, but also about orientations of details. Again, configuration-centred reference-frames seem to be used, i.e. subjects expect the orientation of details relative to the orientation of the global configuration, in which they are embedded.

Effects of similarity on the search of within-dimension conjunctions

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In a series of experiments, Wolfe et al. (1989) have shown that it is possible to guide attention to a target which is defined by a conjunction of simple features belonging to different dimensions (e.g. colour x orientation). But, it is not possible to guide it to targets defined by conjunctions of two colours or two orientations. Following Duncan and Humphreys' Similarity Theory (1989), we tried to find which similarity relationships are the most suitable to produce an efficient search. We ran an experiment with two conditions: a) High inter-alternative and within-display similarities; stimuli were red, green and blue colours (target: red-green, distractors: red-blue and blue-green). b) Low inter-alternative and within-display similarities; stimuli were the combination of three different hues of red: R1: X=0.58, Y=0.34, luminance=26.8 cd/m²; R2: X=0.56, Y=0.39, luminance=18.5 cd/m²; R3: X=0.62, Y=0.35, lumi-

nance=24.4 cd/m² (target: R1-R2 and distractors: R1-R3 and R3-R2). Subjects took part in four experimental sessions with 320 trials each one. Only the last session was analyzed. Results showed that when the similarity was low (condition a), subjects detected the target in parallel, independently of the set size, and reject negative trials automatically. On the other hand, when similarity was high (condition b), search functions were linearly increasing, that is, the bigger the set size, the higher subjects' reaction time (RT). These results reveal the relevance of similarity relationships for the search of targets defined by within-dimension conjunctions.

The effect of the requirement to identify a peripheral precue on the time course of visuo-spatial attention

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We investigated the effects of the requirement to identify the peripheral precue on the time course of spatial attentional focusing in two experiments. The "precue" (S1) and the "target" (S2) that belonged to the same set of stimuli were successively exposed with varying SOAs at one of the four alternative peripheral positions and identification of both stimuli was required. In one of the conditions S2 was exposed simultaneously with three irrelevant distractors, in the other condition S2 was exposed alone. S1 and S2 were either spatially overlapping or adjacent; also the intensity of S1 was varied in order to control the internal speed of processing and conspicuity of the "precue" so as to decrease its spatial uncertainty in case of short SOAs and overlapping S1 and S2. The efficiency of S2 identification increased with SOA as in the typical peripheral precuing studies in all conditions (and exceeded that of S1 beginning with intermediate SOAs) regardless of the requirement of precue identification both with spatially overlapping and nonoverlapping S1 and S2. The "target" (S2) identification in the target-alone condition was systematically better than in the target-with-distractors condition even with longest SOAs (150 ms and 190 ms). This result refers (1) to the prolongation of the supposedly automatic spatial-attentional focusing in the case of higher processing load on the abrupt-onset, peripheral precue at identification levels (and hence refers to the nonautomatic nature of this type of focusing) and/or (2) to the spontaneous defocusing or zooming out of the spatial-attentional focus if - in addition to location detection - the processing of the identity of the physical cue is performed at levels compatible to those of parallel, although unattended processing, of the distractor letters that are exposed in the succeeding stimulus frame.

Spatial attention and the Simon effect

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The relationship between spatial attention and the Simon effect has been explored in this set of experiments. A discrimination task between letters X and O with a cost and benefit paradigm (Posner, 1980) was used. Target eccentricity (4° or 6°, left or right from fixation point) and type of spatial cue before target presentation (central -an arrow with 75% validity- and peripheral -an asterisk 1° above the target location with 50% validity-) were manipulated between groups. SOA values for central cues were 75, 125, 175 msec. SOA values for peripheral cues were 50, 100, 150, and 200 msec. The measure for spatial attentional effects was the difference between valid and invalid trials. The Simon effect is defined as the difference between the condition where stimulus location and response position are congruent (left-left or right-right) and the condition where they are incongruent (left-right or right-left). An interaction between spatial attentional effects and Simon effect was observed, for central and peripheral cues at 4° of eccentricity (the Simon effect was significant only for invalid trials), but for 6° no Simon effect and no interaction were obtained. The temporal courses of the Simon effect and spatial attention were different. These results are discussed in the context of the theoretical polemic between the temporal decay of irrelevant stimulus location information theory of Hommel (1993) and the attentional frame of reference explanation of the Simon effect of Umiltà and Stoffel (in preparation).

Detecting gaps with and without attention: Further evidence for attentional receptive fields

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In two experiments subjects were instructed to detect and localise a gap on a small vertical line with and without attention. When the line was presented in the visual periphery, inattention produced a tendency to report broken lines as solid ones and it also produced a substantial increase in coarse localisation errors. The results support the hypothesis (Tsal & Shalev, 1996) that the unattended visual field is composed of large attentional receptive fields (ARFs) within which there is no spatial resolution. Perceptual closure of the gap may be produced by partial stimulation of such an ARF by the inner ends of the lines.

The Stroop effect: Robust in some conditions and weak (at best) in other conditions

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One of the best known findings in cognition is the congruency effect obtained in the Stroop task. Literally hundreds of studies have demonstrated this Stroop effect in numerous versions. The essence of the standard Stroop effect is the interaction between the content of the word (which is presumably derived from perceptual analysis of the word's shape) and its physical colour. Another well-known task, the flanker task, is often perceived as a variant of the Stroop task. Recent work in my lab, however, has demonstrated that when the stimuli in the flanker task are composed of colours and shapes, no interaction is observed between the colour stimuli and the shape stimuli. In this talk I will present a series of experiments that explore the sources of the congruency effect in the standard Stroop task. The experiments demonstrate that the causes of the congruency effect in the Stroop task are different from those of the flanker task. There appear to be three separate sources that contribute to the Stroop effect. When these sources are controlled, the interaction between the colour and shape stimuli is not observed. These findings may have strong implications for the nature of the connections between perception and action and for the role of spatial attention in the execution of responses to visual stimuli. These implications will be discussed.

Interactions between colour and word processing in a flanker-Stroop task

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We examined interactions between colour and word attributes in a series of experiments. Subjects responded either manually or vocally to a central target (colour patch or word) flanked by a Stroop stimulus. Colour and word attributes of the flanker affected responding to color patches regardless of the response mode. Colour and word attributes of the flanker also affected manual responding to word targets but only word flanker affected vocal responding to word targets. These results do not support models suggesting no interactions between colour and word processing systems (e.g., translational models), and have important implications for explanations of the Stroop effect.

Is visual attention automatically attracted by one's own name?

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Subjects were presented with briefly exposed visual displays of words, which were common first names with a length of 4-6 letters. In the main experiment, each display consisted of 4 words: 2 names shown in red and 2 shown in white. The subject's task was to report the red names (targets), but ignore the white ones (distractors). On some trials the subject's own name appeared as a display item (target or distractor). Presentation of the subject's name as a distractor caused no more interference with report of targets than did presentation of other names as distractors. Apparently, visual attention was not automatically attracted by the subject's own name.

3.3. PERFORMANCE AND CONTROL

Monitoring and learning: Same or different cognitive resources?

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The relationship between monitoring and learning has been investigated in several investigations. A comprehensive model on the interplay between monitoring and control during learning (Nelson & Narens, 1994) recently proposed a theoretical distinction between the level of cognitive processes, also called the object level, and the level of the monitoring processes, i.e. the metalevel. Are these two levels independent? From a logical point of view, monitoring and cognitive processes can be independent; however, they might be psychologically dependent. As an example, consider that our cognitive system is limited in terms of cognitive resources. Monitoring, although theoretically independent from cognitive processes, might draw upon the same cognitive resources used for learning. In that case, asking people to monitor the ongoing acquisition of the items would slow down or impair learning. This hypothesis has been addressed in three experiments, where monitoring has been measured as aggregate memory predictions. Results have shown that monitoring does not impair if time is long enough to allow learning followed by monitoring, whereas learning is impaired when time is reduced, so that learning and monitoring have to be carried out at the same time.

Executive processes in task-shifting

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Executive processes affect behaviour indirectly through elementary processes which take part in task execution. Therefore, a-priori criteria must be used. In task shifting, two criteria may be employed in identifying executive processes: (1) Specificity to task shifting (because executive involvement is not predicted under routine performance but is predicted when new routines are implemented), and (2) executive processes must precede task-execution because commands precede the resultant performance. In a set of experiments, subjects performed choice reaction time (RT) tasks on two dimensional stimuli such that each task was based on one stimulus dimension. A cue preceded the target stimulus and instructed the subject which (randomly selected) task to perform. Shifting between tasks was associated with a RT cost, which was larger when the (randomly varying) cue-target interval was short as opposed to when it was long. Cue-target interval was not confounded with the remoteness from the previous trial. Hence, it affected the task-shift cost through preparation rather than by allowing carry over effects to dissipate. Similar results were obtained for two location tasks and for the object-based tasks (colour and shape discrimination). They indicate a time/effort consuming process that operates after a task-shift precedes task-execution, and is therefore compatible with the criteria regarding executive control processing. The results support Norman and Shallice's (1986) model which suggests that task-selection processes ("schema activation") precede and are distinguishable from task execution processes.

Do mental transformations combine independently and additively?

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The ability to imagine compositions of mental transformations is a source of potential cognitive limitations (Kosslyn, 1994). One question concerns the degree to which the executive functions (Baddeley, 1993) are required to process compositions. Based on former results (Hagendorf & Sá, 1996) we explored whether combinations of mental size scaling and rotation require such a general processing device. A separate control demand for compositions was found. Compositions of transformations took different time to perform in dependence on the ordering of their elements. This is evidence that mental rotations and size scaling are considered to require distinct processing mechanisms (Kosslyn, 1994) such that their execution can be partially overlapped. There was no evidence for this ordering effect in another experiment with combinations of reflections and rotations. Therefore the control demand is independent of transformation mechanisms. One possible explanation of this control demand results from the assumption of additional reconfiguration operations (Rogers & Monsell, 1994). This explanation can be excluded because it was shown that advance information on the number of transformations (0, 1, or 2) to be executed does not reduce the control demand as expected. Results are discussed in relation to current views on executive functions.

3.4. SENTENCE PROCESSING

Eye guidance when reading: Interactions between foveal load and parafoveal processing

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There is a controversy about the question of "how do readers know where to look next?" Evidence in favour of a parafoveal processing hypothesis of eye guidance suggests that readers can make use of information from the word to the right of the current fixation. In turn, this evidence has been supported, challenged and supported. The critical effect is of within-word information distributions upon the position of the first fixation on the word. Readers have been observed to locate their first fixation nearer to an informative group of letters (or away from a relatively common group of letters). This effect comes and goes, and one of our purposes will be an attempted explanation for its inconsistency, suggesting that the landing position depends on what was happening last, as well as upon the information within the word. Readers' eye movements were monitored in an experiment in which sentences were read for comprehension, and in which a target word had an orthographically informative beginning (eg, "irksome") or uninformative beginning (eg, "cordial"). When informative word beginnings attract fixations we can conclude that some information has been processed prior to their fixation, using parafoveal vision. The fixation prior to the target provides a clue to the inconsistent appearance of the landing position effect, and evidence will be presented to suggest that landing positions vary according to the amount of visual attention given to the words immediately prior to the target word.

Effects of case marking and word order on syntactic parsing in Finnish: An eye fixation analysis

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Syntactic parsing was examined in Finnish by registering readers' eye movements while they read single sentences for comprehension. The study investigated to what extent lexical constraints in the form of morphological case marking and more coarse-grained syntactic constraints in the form of word order influence on-line parsing as reflected in readers' eye fixation patterns. Target nouns appearing toward the sentence beginning took one of three grammatical roles: subject, object or adverbial. In one experimental condition, the grammatical role of the target noun was signalled by a case inflection attached to the preceding word; in the second condition this was not the case. The relative ambiguity of case inflections in marking the grammatical role of the target noun was also varied, from totally unambiguous through fairly unambiguous to moderately ambiguous. The results showed an immediate ef-

fect of case marking on sentence parsing; the effect was more pronounced for unambiguous than ambiguous morphological cues. Moreover, there was an immediate effect of word order, where the canonical SVO (subject-verb-object) order was associated with greater processing ease than non-canonical word orders. Similar effects were also observed as spill-over effects, reflected in the number of regressive fixations back to the target noun. The results are consistent with frequency-based, probabilistic approaches of syntactic parsing that assume multiple sources of constraints, both lexical and more coarse-grained, to be exploited in on-line parsing.

Subject-verb-agreement in production and comprehension

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Syntactic agreement processes have originally been investigated in speech production (e.g. Bock & Miller, 1991; Bock & Eberhard, 1993; Schriefers & van Kempen, 1993). Agreement errors on the verb are frequently made when the head noun and the local noun of sentence fragments like „The key to the cabinets was/were...” differ in number. Comparable effects have been found in reading by Perlmutter et al. (1995), but they are not as consistent as in speech production, shown by Branigan et al. (1995). Verb agreement effects in reading would have important consequences for the architecture of the human language processing drive. Our study focuses on interlingual differences in agreement effects between English and German. MacWhinney et al. (1984) have shown that German and English readers differ substantially in their reliance on agreement cues. Verb morphology in German is more complex and -unlike English- the verb is always marked for number. Additionally we suspect that the syntactic agreement effect in the aforementioned experiments is in fact contaminated by plausibility differences in the materials used. Therefore, the plausibility of our material was first assessed in an online rating procedure and then systematically controlled for the following experiments. We report results of both a written sentence completion experiment and an eyetracking experiment with German subjects. Subjects in the completion experiment were to complete sentence fragments like („The girl with the books...“). The number of the head noun and the local noun was varied. The results are discussed with respect to parallel and serial models of human language processing. Consequences for symbolic parsers and linear association based mechanisms are compared.

Sentence parsing and competition: The processing of ambiguous relatives in French

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Two different tasks were given to French adults in order to determine closure preferences in the processing of locally ambiguous relative sentences in French. The linguistic material was composed of sentences including complex NPs („the X of the Y who was...“) in which the two possible antecedents of the relative pronoun (X and Y) were contrasted on semantic (animacy) as well as lexical (gender) features. In the first (off-line) study, subjects were required to provide an ending for the relative clause. The second study involved an on-line RT measure (speeded grammaticality judgement) on target adjectives bearing a disambiguating morphological cue (gender inflection). On the one hand, the data provide evidence for a (high) attachment preference to the head of complex NPs in both off-line and on-line tasks, a result challenging what is generally observed in English. Moreover, the data are compatible with an interactive view of sentence parsing, in which the immediate outcome of processing is claimed to reflect the interaction between the different information sources (semantic, syntactic, morphological) available in sentences. These results, analysed and discussed in terms of convergence and competition of linguistic cues, are interpreted in the frame of the competition model.

The role of lexical and contextual processes in the interpretation of pronouns

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In order to understand a sentence containing an anaphoric pronoun, the reader must correctly assign an antecedent to the pronoun. However, very little is known about the cognitive processes which are immediately involved in the interpretation of pronouns. The current research is designed to track the loci of both morphological and contextual effects on anaphoric processing. The method adopted here consists of presenting the potential referent of the pronoun as a test word for the lexical decision task after the presentation of a clause containing it. Each clause occurs both in a pronoun version and in a version which has no anaphor (e.g. While the actor rehearsed (it),). The activation of two potential referents was tested: a morpholexical candidate (ACT) vs. a semantic candidate (ROLE) which was considered as the more predictable and the more prototypical word. We consider that reaction times on test words would reflect the time taken to reinstate the referent. The results show that reaction times observed for the morpholexical candidate are facilitated in the pronoun version over those obtained with the semantic candidate (Experiment 1). By contrast, when extra material was inserted between pronoun and referent (e.g. While the actor rehearsed (it), the stage-manager exam-

ined...), only lexical decisions for semantic candidates were facilitated (Experiment 2). The results are consistent with the theory that a modular process, determined by lexical units, is immediately activated to provide an initial interpretation of a pronoun by default, which can then be confirmed or overridden by contextual processes.

Noun-pronoun agreement in Dutch

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We investigated the processing and production of Dutch demonstratives. According to reference grammars, the appropriate demonstratives are "dat" for nouns whose grammatical gender is neuter and "die" for non-neuter nouns. On linguistic grounds we expected that demonstratives would usually agree with a preceding phrasal head. However, native speakers suggested that "die" and "dat" are largely interchangeable and can be used to refer to phrasal heads or adjuncts. A rating experiment on utterances such as "kijk, er zit een eend naast een varken, die is klein" (look there is a duck next to a pig, it is small) showed that the utterances were judged as more natural when a) the demonstrative agreed with one of the preceding nouns than when it did not agree with either of them, and b) the agreeing antecedent was the head of phrase rather than the adjunct. The strength of these effects was modulated by a semantic variable (whether the adjective applied more naturally to the head noun or the adjunct). A forced choice experiment in which the participants specified the antecedent of the pronoun yielded compatible results. Finally, in two elicitation experiments participants provided the pronoun in the second clause given the first clause and the adjective. There was a strong tendency to select a pronoun that had at least one agreeing antecedent. However, the preferred antecedent was not the head, but the adjunct. The implications of these findings for theories of establishing pronominal reference in sentence comprehension and production will be discussed.

3.5. TEXT PROCESSING

Perspective-shift effect: Eye movements investigation in text processing

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Text understanding requires the reader to construct a coherent mental representation of the information in the text. Sometimes, the coherence process becomes more complex when the text introduces a new discourse topic, a new episode or a change in perspective (i. e. change in point of view) and consequently the current representation must be updated. The updating

process has been shown by on-line studies showing more processing times on these kind of sentences but few of which have been done using an eye tracking paradigm. In the present paper, we are interested in analyzing eye movements data of readers encountering a perspective shift in texts. Perspective shift has been manipulated by shifting a 3rd person paragraph to a 1st person paragraph. The shift to the 1st person paragraph involved from the reader to notice that the narrator and the character shared the same identity. We will hypothesize that the updating of the mental representation involved in this perspective shift will be more complex as a function of the number of referents (i. e. number of protagonists) that such representation already contains and as function of the gender cues present in the text. The perspective shift should be easier whether the character is explicitly noted in the text rather than implicitly. Moreover, eye movements analysis (progressive and regressive fixations duration) should provide precise data on the locus of intervening processes during a perspective shift.

Tonicity effects in understanding pronouns

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The present research investigates which is the preferred antecedent for a pronoun that has more than one grammatically possible interpretation. A full (non-reflexive) pronoun, whether singular or plural, may have an anaphoric or an exophoric antecedent; furthermore, plural pronouns may have an antecedent matching for number with the pronoun, or a 'reconstructed' antecedent consisting in the plural antecedent plus other possible antecedents in the sentence. In this work we investigate whether, for all kind of pronouns, the choice of the anaphoric antecedent equals the choice for the exophoric one. Similarly, in the case of plural pronouns, we want to see whether the preferred antecedent is the one matching for number with the pronoun or a 'reconstructed' one. Furthermore, we want to see if the tonic/clitic character of pronouns influences these choices. Using questionnaires, we tested pronoun interpretation in two-clause sentences, manipulating the singular/plural feature and the tonic/clitic feature of the pronouns. The results show that the choice of an exophoric antecedent and that of a reconstructed antecedent are highly marked choices. Furthermore, only the choice of the exophoric antecedent is affected by the tonic character of pronouns. Finally, we found that in the 80% of the cases participants preferred as antecedent a closely preceding noun, which would be excluded on the basis of grammatical principles. This result (which mimics production errors, cf. Bock and Miller, 1991; Bock and Eberhard, 1993; Vigliocco, Buttleworth and Semenza, 1995) can be interpreted in favour of a model of language processing that allows general processes to go along in parallel to linguistic driven ones.

Demonstrative noun phrases and class-membership inferences

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Inferences serve to construct a coherent representation of the text. At least two aspects of coherence can be distinguished: relational coherence and referential coherence. Relational coherence concerns the way in which sentences are meaningfully related to each other in terms of conceptual relations such as causal or concessive relations. Referential coherence concerns the way in which entities in one sentence are related to entities in other sentences. Referential coherence is achieved by means of e.g. pronouns, definite noun phrases, demonstrative noun phrases. These expressions have the function to identify the intended referent, but they serve other functions as well, that have to do with discourse structuring. Demonstrative noun phrases have, beyond their identificatory function, a function in the relational coherence of the text. This paper deals with one of these relational functions of demonstrative noun phrases. From a parsimonious point of view one may assume that the function of a demonstrative noun phrase is indeed the identification of the referent designated by the demonstrative. However, it will be shown that in understanding demonstrative noun phrases a model is constructed that reflects class membership relations, and that members of the class other than the intended referent are activated as well. This will be demonstrated in experiments in which a particular kind of demonstrative noun phrase is compared to its definite counterpart. Results of different tasks, such as a production task, lexical decision, and a reading time task, indicate that the demonstrative indeed creates a class, the construction of which requires additional processing time, but once it has been constructed it facilitates subsequent processes.

3.6. PERCEPTION

Ultra-precise quantal timing in long-range apparent movement

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Downward simultaneity thresholds were determined for beta motion on a millisecond level as a function of ISI for three angular separations (3.5, 7 and 14 degrees), with exposure durations varying blockwise in a range from 3 to 250 ms. The distribution of critical ISIs collapsed over 46 Ss shows sharp maxima at regular distances and a gap between 0 and 5 ms. Particularly prominent peaks were found at 9 and 108 ms ISI. A more detailed analysis revealed stability of the main preferred points of motion break-down under shifts of the mean critical ISI and a periodic modulation of the performance under identical conditions, with a period as short as 4.5 ms. All findings agree well with the basic tenets of a system of quantal timing (TQM) previously advanced by the author. In particular they support TQM claims about smallest relevant units of timing, temporal coherence limits and the hierarchical organi-

zation of human cognition in the time domain. To account for the discovered temporal fine structure, the precision of timing must be assumed to reach the millisecond level which represents a major challenge to physiological research. Consequences for sensory real-time dynamics are discussed in the context of apparent motion.

Location-based IOR: A different time course for detection and discrimination task

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It has recently been argued that inhibition of response (IOR) is limited to detection and localization tasks (Neill et al., 1994). In this work we used a cue-target paradigm and compared detection vs discrimination tasks. Location-based IOR is shown with both detection and discrimination tasks, but at different SOAs. Two boxes are displayed on the screen, one of them being flashed for 50 ms. After the flash, at different SOAs, a target is displayed for 33 ms either on the cued or the uncued box. Subjects were to respond to the target either detecting or discriminating it. Tasks and different SOAs were manipulated across experiments. In the first experiment 100 and 600 ms cue-target SOA were used and subjects were to detect the target. Facilitation effect at the shorter and IOR at the longer SOA were obtained. The same SOAs were used in the second experiment but now subjects were required to discriminate the target. A facilitation effect was obtained at both short and long SOAs. Three SOAs (100, 600 and 1000 ms) were used in the third experiment with discrimination task. In this case, results showed facilitation at short SOA, no effect at medium SOA and IOR at long SOA. These results suggest that IOR is a robust effect, which shows a general principle of information processing. However, the time course of the effect is different depending on the experimental task. That could imply that inhibition take place at different representations (location-, environment-, object-based...) each one presenting different time courses.

The microgenesis of the perceptual organization of multi-element visual patterns

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Palmer and Rock (1994) have recently proposed a new theoretical approach to perceptual organization in which the principle of uniform connectedness plays a fundamental role. According to their theory, uniform connectedness as applied to image properties such as luminance and colour, defines regions which constitute the initial, entry-level units of visual stimuli. Once entry-level units are established, grouping and/or parsing processes operate on these units, creating superordinate and/or subordinate units. The present research examined this hypothesis by studying the microgenesis of the perceptual organization of hierarchical,

multi-element patterns. The primed matching paradigm and the visual search paradigm were used to examine the progressive development of the perceptual representation of multi-element patterns as a function of number and relative size of the elements. The results suggest that the entry-level units of few-element patterns are the elements, and the global configuration is created later via attention-demanding grouping processes, whereas the region defined by homogeneous texture constitutes the entry-level unit of many-element patterns, and the individual elements are identified later via attention-demanding parsing processes.

Local and relational aspects of face distinctiveness

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Distinctiveness contributes strongly to the recognition and rejection of faces in memory tasks. In three experiments we examined the role played by local and relational information in the distinctiveness of upright and inverted faces. In all experiments subjects saw one of three versions of a face: Original faces, that had been rated as average in distinctiveness in a previous study (Hancock, Burton & Bruce, in press), a more distinctive version in which local features had been changed (D-local), and a more distinctive version in which relational features had been changed (D-rel). An increase in distinctiveness was found for D-local and D-rel faces in Experiment 1 (complete faces) and 3 (face internals only) when the faces had to be rated in upright presentation, but was smaller or even vanished for the D-rel version when the ratings were given to the faces presented upside-down. Moreover, when faces were presented as targets or distractors in a recognition test, False-Alarm-rates showed a corresponding pattern: Presented upright, both, D-local and D-rel gave lower False-Alarm-rates compared to the originals but in upside-down presentation, the D-rel versions lost their distinctiveness advantage. This effect was clearest when the internal features of faces were used (Experiment 3), but was not found in the Hit-rates. The results suggest that at least two dimensions of facial information contribute to a face's apparent distinctiveness, but that these sources of information are differentially affected by turning the face upside-down. These findings are in accordance with a face processing model in which face inversion effects occur because a specific type of information processing is disrupted, rather than because of a general disruption of performance.

Facial recognition: Is face processing encapsulated?

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The ability to recognize people face is present very early in human development and it is a very efficient ability. Bruce and Young (1986) propose a model that explains the different steps of face processing ability, but the first level of this process takes place in modules. This means that the components, such as facial decision and structural encoding are encapsulated. However some arguments from many studies in visual perception seem to go against this conception: Gregory (1970,1974) and Ramachadran (1988) suggest that the understanding of perceptual phenomena should include some effects of cognitive elements. According to these authors the interpretation of such phenomena cannot only be based on retinal messages. The aim of this study was to test the existence of such an integration of top-down information into the low level processing using the pop-out paradigm. In this paradigm subjects have to say if a certain target is present among distractors. The results partially confirm the non-encapsulation of these components.

3.7. KNOWING AND CONSCIOUSNESS

On knowing that intentional processing is automatic

Joseph Tzelgov and Vered Yehene

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While it is agreed that prolonged training results in automatization, it is much less clear how one knows that a given process, being a part of intentional behaviour is automatic. It is rarely the case for all features that define automaticity, in the feature-list approach, to hold simultaneously. Furthermore, construct-oriented definitions of automaticity (e.g., Shiffrin & Schneider, 1977, Logan, 1988) provide the sufficient but not the necessary criteria for automaticity. Following Bargh (1992), we propose to define automaticity in terms of Ballisticity; i.e., a process is automatic if once started it runs to completion, without conscious monitoring. However ballisticity is hard to show under conditions of intentional processing, i.e., when a given process is a part of the task definition. Yet automatic processing can also be autonomous, i.e., it can appear not being a part of the task's definition. Consequently, we propose to define a given process as automatic if and only if it can be shown to be active in the autonomous automatic mode. We also propose that one can argue that a given process acts automatically in a specific situation of intentional processing when, in addition to the above, it is part of the task's definition, but it is not the definition of the task (see Vallacher and Wegner, 1987). Empirical examples of our approach will be provided.

To know and to understand

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Knowing a fact A requires a cognitive representation \hat{A} of A and \hat{A} has to be true by correspondence: the „adequatio rei et intellectus“ truth; if A is a theorem proved in a consistent theory, then \hat{A} is true by coherence. There exists also a „psychological truth“ (Fries, Popper, see also Bolzano's „Wissenschaftslehre“) which is a (tacit) assent or a firm belief in the mind of a subject of the truth of \hat{A} . This last kind of truth may be prominent in the process of understanding. An understanding of a fact A impel a more or less complex mental activity in order to produce a cognitive meaning of \hat{A} : inclusion in a semantic net of related representations, recognition of causes or reasons, of inferred or expected consequences, ascription of an intention, formation of reflexive representations (representations of representations) etc. Thus, in order to understand, the mind performs several processes depending on the operational competences and the aims of the subject. There exist transformations of particular importance: transfers of representations like metaphors, analogies, transductions (Piaget), decentrations etc., the use of peculiar logical links in reasoning and the impact of intentional functions like beliefs, desire, etc. Past experience, world-knowledge and assents of the subject provide other components into these processes. Consequently, the resulting cognitive meaning is strongly dependent on the properties of these different operations. This investigation raises problems concerning mutual understanding in dialogues, in arguing or in teaching, and also of cogent relations to reality.

The function of consciousness

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This paper proposes an answer to the title question on the basis of the analysis of empirical data - a large corpus of what I call thought sequences, namely, trains of verbal-like expressions that spontaneously pass through people's minds. The ideas presented here are based on the systematic analysis of this corpus. They reveal several patterns that could not have occurred had thought not been conducted in a conscious manner. The key feature that makes these patterns possible is the concreteness resulting from the articulation of thought in a particular medium. In all standard models of cognition today this feature is deemed to be irrelevant. I show that it is of highly significant functional benefits. Specifically, three such benefits are indicated. First, the local de-coupling of medium and content opens the possibility for thought to progress along lines not planned or envisioned by the thinker beforehand, and thus it is a key for the generation of novelty. Second, articulated thought creates a medium for activities carried out in the internal theatre of the mind that are analogous to activities carried out in the real world. Third, articulation provides for concreteness and the quality of entityhood, hence for compartmentalization and enhanced control as well as for reflection and meta-observation. The presentation is grounded in a general critique of the conceptual foundations of cognition. In particular, I maintain that action in the world, not computational op-

erations applied upon abstract underlying symbolic representations, are the basic capability of the human cognitive system. The three patterns indicated are of functional advantage because they all tie with this basic capability.

3.8. PERCEPTION-ACTION COMPATIBILITY

S-S associations and response selection

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Weeks and Proctor (1990) reported a compatibility effect of orthogonally coded S-R dimensions: Right responses are faster to top stimuli, while left responses are faster to bottom stimuli. In order to explain this mapping effect I suggest an association hypothesis. It assumes that individually learned S-S associations determine response selection in an automatic fashion. First evidence supporting this idea will be presented.

Automatic stimulus-response translation in dual-task performance

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According to the received view, the translation of stimulus codes into response codes represents one - if not the - bottleneck in dual-task performance. I present findings from several manual-verbal dual-task experiments that challenge this assumption. These findings strongly suggest that stimuli of the secondary task are translated into secondary responses long before the primary response is selected - even before the primary stimulus is fully identified. Nevertheless, considerable dual-task costs were obtained. This means that if there is a response-related bottleneck it is confined to genuine response selection, hence to deciding between response codes activated by automatic S-R translation.

Detection and identification of response-compatible stimuli

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The relationship between perception and action is tested by using an experimental design that requires a motor action during a presentation of a stimulus: Subjects reacted by pressing a 'right' or 'left' key, and were presented masked 'right' or 'left' arrows shortly before the reaction. The findings of several detection and identification experiments are reported. We found that the both detection and identification probability of the arrow is reduced when the to-be-executed reaction is compatible with the presented arrow. For example, if a 'right' reaction is intended, the perception of a 'right' arrow are impaired compared with a 'left' arrow in the same condition. This influence is interpreted within the framework that stimulus processing and action control share some common features, as this may produce specific interference.

Perception-action compatibility: The role of dynamic and static features

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In a typical compatibility experiment subjects react faster when at least some stimulus features correspond to that of the response as compared to situations where they do not correspond. Compatibility effects occurring with static spatial stimuli and spatial responses are well examined. But, comparable effects are also observable in dynamic stimulus-response sets and the question arises, which features of the stimulus-response ensemble do cause that phenomenon. Therefore, the influence of static and dynamic components should be separated in such sets. The present study was designed to put this issue to test: Hand postures (*static features*) as well as hand movements (*dynamic features*) like grasping and spreading were presented on a computer monitor. During each trial the colour of the hand changed to red or blue. Subjects were instructed to respond by grasping or spreading apart their right hand depending on the colour of the hand on the screen. These experiments that resemble the Simon-Paradigm showed the following pattern of results: Both static features such as single hand postures and dynamic features such as movement direction caused compatibility effects. In dynamic stimulus-response sets only an interaction between those components can explain that phenomenon completely. Moreover, the size of the compatibility effect was determined by the number of features that stimulus and response shared.

Compatibility phenomena with dynamic stimulus-response configurations

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Compatibility phenomena are usually studied with respect to static, spatial properties of stimulus-response configurations: In the case of spatial correspondence between stimulus and reaction (e.g. a right-hand stimulus requires a right-hand reaction) faster reactions are observed compared to when the position of the stimulus and the position of the reaction do not correspond (e.g. right-hand stimuli require left-hand responses). The existence of the so-called Simon effect shows that spatial stimulus characteristics can influence the planning of actions even when they are actually completely irrelevant to the task at hand. This is illustrated in tasks which subjects react to the meaning of a stimulus (e.g. respond to a blue stimulus with a right-hand reaction). Here as well, reaction time advantages can be observed when the blue stimulus appears on the right-hand side. Can compatibility effects also be observed when dynamic stimulus-response configurations are used? To study this question, a Simon-like paradigm was used: Subjects were required to monitor a spot-like stimulus moving from left to right or from right to left on a display. At some point in time the spot would change its colour (from white to red or blue). Subjects' task was to move a stylus on a digitizing tablet as quickly as possible to the left or right when the stimulus changed its colour. The critical question then was whether effect of the correspondence between the direction of the seen and the to-be-executed movement could be observed. Result: The stylus movement was initiated more quickly when the direction of the seen stimulus movement agreed with the direction of the movement to be executed. Interestingly, this was only the case when the imperative signal continued to move (for 200ms). When it stopped moving when being coloured (and disappeared from the screen after 200ms) a spatial compatibility effect was obtained: The stylus movement was initiated more quickly when the direction of the to-be-executed movement corresponded to the spatial location of the imperative signal.

The relationship between goal specificity and whether learning is implicit or explicit

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We describe two experiments that investigate the importance of goal specificity in determining whether learning is implicit or explicit. We hypothesised that a specific control goal would lead to implicit learning, while a non-specific search goal would lead to explicit learning, even though the pattern to be learnt was non-salient. Subjects were required to learn a dynamic systems control task (Berry & Broadbent's, 1984, 'Clegg' version of the person interaction task). One group of subjects was given the standard, specific control goal while the other group was given a non-specific pattern search goal. Measures of learning (control performance measures, general and prediction questions) showed that, as expected, the former

group learnt implicitly. However, the latter group learnt explicitly. Experiment two investigated the possibility that explicit learning occurred with the non-specific pattern search goal because subjects with this goal explored a wider range of interactions during the learning phase than did subjects with the specific control goal. Using Berry's (1991) observation paradigm we ruled out this possibility. As long as the observer had a non-specific pattern search goal, then learning was explicit, even when the model had a specific control goal and only learned implicitly. We discuss these results in terms of the nature of the learning fostered by specific and non-specific goals and suggest that the use of a method in which subjects learn the same information implicitly or explicitly is potentially useful for drawing clearer distinctions between implicit or explicit modes of learning.

3.9. SEMANTIC PRIMING

Effects of proportion of related pairs on semantic priming at short SOAs

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There is growing interest concerning the locus/loci of semantic priming effects in word recognition (e.g., Moss et al., 1995; Williams, 1994). The intent of this study was to shed light on that issue. By using the masked priming technique, Experiment 1 shows reliable effects of associative priming at the 67- and the 83-ms stimulus-onset asynchrony (SOA) in the lexical decision task. However, associative strength correlates significantly with the magnitude of priming at the 67-ms SOA, but not at the 83-ms SOA. Further, in Experiment 2 semantic (nonassociative) priming effects were found at the 83- but not at the 67-ms SOA. In order to assess whether or not the priming effect at the 83-ms SOA was due to post-lexical familiarity, we manipulated the proportion of associatively related pairs (.18 vs. .82) in lexical decision and naming. The results with the lexical decision task show stronger effects of associative priming at the 83- rather than at the 67-ms SOA. The results will be interpreted in terms of current models of semantic priming.

Priming for new associations

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In semantic memory tasks such as lexical decision, priming is found for associatively related word pairs (grass-green) compared to unrelated word pairs (sugar-green). This priming effect is the result of the structure and of processes in semantic memory. Consequently, the priming effect can be used to study how new information is added to semantic memory. In a series of experiments, word pairs were presented first for studying. After a study phase priming for

those word pairs was investigated. The relation between two words of a pair was manipulated by including associated word pairs, unrelated word pairs, and pairs of words that were semantically but not associatively related (black-green). Three different priming tasks were used: Lexical decision, perceptual identification, and animacy decision.

Casting a spell with a sleeping princess: Lexical priming of non-word spelling in a shallow orthography

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Despite neuropsychological indications of their independence, there may be a real-time interaction of lexical and sub-lexical procedures during spelling. Evidence for such interaction comes from lexical priming effects in non-word spelling, where the orthography of a lexical item can, directly or via association, influence how a particular phonological segment of a non-lexical item is to be represented. Demonstrations of this influence have been based within the English language, and the extent to which the effect derives from the depth of English orthography, with its inevitable emphasis on lexical procedures, is not known. The present study seeks to answer this question by exploring lexical priming of non-word spelling in Polish, whose shallower orthography may allow sub-lexical procedures to enjoy greater prominence. The findings are considered in terms of their implications for modelling the nature of the spelling lexicon and spelling procedures in Polish, as well as in terms of a cross-linguistic comparison with English.

Processing of affect-loaded concepts

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In this paper the interaction between cognition and emotion is examined. According to the Component Process Theory of Scherer (1983, 1993) emotions are considered as episodes of temporary synchronisation of all major subsystems of organismic functioning (cognition, physiological regulation, motivation, motor expression, monitoring/feeling). Cognition plays the leading role in this synchronisation. Cognitive appraisal process consists of 5 major stimulus evaluation checks (e.g. checks regarding stimulus novelty, intrinsic pleasantness, coping potential etc.). These checks can be performed on at least three different levels (sensomotoric, schematic, conceptual, cf. Leventhal & Scherer, 1987) and can influence subsequent cognitive processes. The paper focuses on the question whether intrinsic pleasantness of concepts (the evaluation of mentally represented environmental events as „good“ or „bad“ for the self) may be activated automatically from memory or may be due to controlled processes (cf. Murphy & Zajonc, 1993; Hermans et al., 1994; Klauer et al., 1996). In addition we have examined whether there is an interaction with the content and complexity of emotionally

evaluated conceptual structures. A variant of the standard sequential priming procedure was used. We manipulated: (1) the kind and complexity of semantic relation between prime and target, (2) the SOA (200 vs. 1000 ms), (3) the emotional evaluation of prime-target-pairs (positive, negative, neutral). The prime stimulus could be either a semantically related, emotionally evaluated cue (e.g. MURDERER) or a semantically and emotionally neutral cue (ATTENTION). It was presented for 200 ms (exp. 1) or for 1000 ms (exp.2) followed by the target. The target consisted of two concepts (e.g. FOREST-DARK). Subjects had to decide whether the target concepts were meaningfully related or not by pressing one of two keys as quickly as possible. Response latencies and error rates were analysed. Specific priming effects were observed. These results as well as their implications for theories on the interaction of emotion and cognition are discussed in detail.

3.10. SKILL AND SERIAL LEARNING

Preference for human or computerized rhythmic performance: Research on determining factors and attempt at modelling

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The expressive transformation distinguishing rhythm from metre appears to have particular relevance for the correct processing of a musical message, helping to reduce ambiguity as the temporal microstructure adapts to phrasing, metre and harmonic progression. Given this premise, we set out to examine how any differences in the preference for rhythm in human (irregular and expressive) or computerized (absolutely regular) performance relate to temporal-structural features of the pieces (metre, tempo) and personal characteristics of subjects (sex, competence, aptitude for music). As stimuli we used 3 pieces of contemporary music with binary rhythm and 3 with ternary rhythm, respectively displaying slow, medium and fast tempos. Moreover, two versions of each piece, performed respectively with human and computerized rhythm, were produced for the purposes of this research. Three groups of subjects (10 males and 10 females each) were tested; high and poor musical expertise characterised respectively the first group and the second one; the third group included musically naive Ss. Analysis of the deviations from isochronism in the human version showed how departure from mechanical regularity can transform the entire event, the tendency being to bring out the gestalt configuration more forcefully. Data analysis (including analysis of the principal components) shows that preference for the human version was more marked among women, subjects with sound musical expertise, and towards the pieces with ternary rhythm. Results are interpreted as confirming the link between grouping structure and rhythmic structure. This link emerges more forcefully in the more structurally complex pieces and determines variations in choice frequencies according to sex, music grounding and the specific aptitudes that enhance the processing of information relating to the particular nature of the rhythmic event. The modelling of this discriminative learning by means of neural nets with internal binary or ternary rhythm shows better performance: 1) in nets with internal rhythm than in nets without

rhythm; 2) in nets while categorizing pieces with the same rhythm as their own; 3) in nets categorizing computerized rhythm.

Tapping with peripheral nerve block: Evidence for a threshold model

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In synchronization tasks subjects are instructed to synchronize taps with a regular sequence of clicks. Usually, a response pattern is found where the tap precedes the click by about 30-50ms. One hypothesis to explain this negative asynchrony assumes synchrony to be established at a central level. According to the original version of this hypothesis the reason for the asynchrony lies in different nerve conduction times between the effector and the brain on the one hand and the ear and the brain on the other hand. The point in time when the code representing the tactile/kinesthetic feedback is available at a central level therefore depends on the anatomical distance between effector and brain (Aschersleben & Prinz, 1995). An alternative version of the hypothesis that has been recently put forward by Gehrke (1995) claims that the relevant factor is not the conduction time but the amount of feedback information that is available at a central level. The more information about the tap is available the earlier a critical threshold is reached and the smaller the asynchrony should be. Both versions of the hypothesis were tested in an experiment where the tactile feedback component was eliminated by using a peripheral nerve block. As according to the threshold model the amount of feedback is reduced under conditions with peripheral nerve block this should lead to an increase in asynchrony. The nerve conduction hypothesis would however predict that the asynchrony decreases because the slower component of the feedback is eliminated, e.g., only the faster kinesthetic feedback remains. The results are in favour of the threshold model.

Constraints of response-effect learning in sequential learning tasks

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Learning of event sequences provides an advantage for behaviour control. It allows one to predict the next event and to prepare the next response. Up to now it is rather unclear which are the processes behind sequence learning. Given the present evidence, it is unlikely that sequential learning consists in pure associations of consecutive events. Rather it seems to depend also on the behaviour connected with the event sequence. My own experiments with a serial reaction task support the view that sequence learning is based on response-stimulus relations. Apparently, subjects do not learn which stimulus will follow a first one, but which stimulus will follow the response to the first stimulus. To investigate this kind of response-effect learning in more detail a dual task paradigm was used. A serial reaction task was combined with a counting task (counting of a stimulus colour). The overlap between both tasks was varied: The counting task was presented before the response to the given stimulus

(Condition 1) or after the response during the response-stimulus interval (Condition 2). Sequence learning should be impaired especially under Condition 2: The counting should disturb the association between the responses and their effects. The results were contradictory. Whereas sequence learning was nearly unaffected under Condition 2, under Condition 1 no sequence learning was found. It can be speculated that an associative mechanism is not sufficient for response-effect learning. Possibly, the effects of a response have to be considered already in response planning to become effective in task performance.

S-R compatibility and sequential learning in SRT tasks

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The serial reaction time (SRT) task is a preferredly used paradigm to investigate implicit learning. In most studies the conditions originally introduced by Nissen & Bullemer (1987) are replicated, i.e. subjects respond on a visuo-spatial sequence of stimulus locations by pressing spatially compatible arranged keys. The present experiment was designed to explore to what degree the sequential learning observed under these conditions depends on the use of the very specific locational sequences. Under otherwise identical conditions first, the S-R compatibility was reduced by using symbols as stimuli instead of locations and second, the „connectibility“ of consecutive stimuli into coherent chunks were varied. Effects on reaction times in the SRT task and on explicit memory in a generation task were evaluated. The results indicate that the „connectibility“ of the stimuli has no effect at all and that S-R compatibility influences only the general RT level, but does not seem to modify the learning process itself. This is in agreement with the notion that learning in SRT tasks can be mainly based on the acquisition of redundancies in the response sequences and keeps therefore rather uninfluenced by the type of stimuli used. Moreover, a post hoc classification of subjects with regard to the amount of explicit sequence knowledge they have acquired reveals a striking modification of the general result: The RT difference between responses to locational and symbolic stimuli vanishes in the course of learning for the full knowledge group. In order to account for this interaction it is suggested that sequential learning in SRT tasks is partly mediated by a shift of response control from stimuli to motor programs.

Connectionist vs. rule-based accounts of sequence learning

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This study reviews three different accounts of the sequence learning produced in paradigms using deterministic rules to generate the stimulus material (e.g., Lewicki, Hill and Bizot, 1988). In this task, participants see a target stimulus appearing at one of several locations on a computer display, and they are required just to indicate its location by making a keypress. Unknown to them, the series of locations follows a set of rules that may be used to predict three out of each five elements, and this fact is exploited by participants as inferred by their performance, which shows a significant decrease in response times to predictable locations, as well as a sudden extinction of this effect when these rules are inverted. This pattern of results has been explained by Lewicki et al. (1988) by assuming that subjects may implicitly acquire and apply rules that are analogous to the ones employed by the experimenters in generating the sequence. However, subsequent studies have suggested that this account could be inadequate (e.g., Perruchet, Gallego & Savy, 1990), and that subjects may be basing their responses on the consideration of simpler rules, based on the relative frequency of different types of movements. A re-analysis of new results from Ferrer-Gil (1994) shows that none of these mechanisms could underlie these learning effects. As an alternative, it is proposed that learning could arise from the action of some connectionist mechanisms of learning (Cleeremans, 1993). The simulation of the main results reported by Ferrer-Gil (1994) on a simple recurrent network reinforces this conclusion.

Incremental sequence learning

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When confronted with a choice reaction time task in which the material is sequentially structured, participants' reaction times to the successive stimuli exhibit an increasingly detailed sensitivity to the sequential contingencies contained in the material over training. An important and somewhat neglected issue in this context is to determine how complex the contingencies that participants can learn about may be, and what factors influence the processing of such complex contingencies. Elman (1993) explored these issues through simulation studies based on the Simple Recurrent Network model of sequence processing. An important limitation of this model, which has otherwise been very successful in accounting for human sequence learning, is that it has difficulty learning about sequential contingencies for which the contingent elements are separated by other, irrelevant elements. Elman showed that the learning of such disjoint contingencies can be improved by training the network incrementally, that is, by introducing complex contingencies only gradually over training. Elman's incremental learning concept was introduced in the context of a developmental theory. In this

paper, I explore whether it also applies to learning within a single task. I report on the results of three experiments designed to test the network model's predictions.

3.11. MEMORY PERFORMANCE

Spontaneous recognition in prospective remembering

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We investigated whether factors known to affect spontaneous recognition (see Ste-Marie & Jacoby, 1993) influence performance in an event-based prospective memory task. Subjects memorized a list of words and then performed an old/new recognition task while, at the same time, they had to remember to read aloud those words beginning with the syllable "CA". At test, each word was flanked above and below by two new words. Subjects had to make the recognition decision about the middle word, while ignoring the flanking words. In one condition, the "CA" words appeared as flankers before they appeared as targets. In a control condition, no "CA" word appeared among flankers. The task was performed under either Full (FA) or Divided Attention (DA) conditions. Results showed that spontaneous recognition, which is commonly observed under DA conditions, does not influence prospective memory performance. In addition, it appears that attentional demands play an important role in prospective remembering. Performance was significantly lower under DA than under FA conditions. Finally, under FA conditions, prospective remembering appears to benefit from presentation of the prospective memory target among flankers, suggesting a possible role of the target in capturing attention.

Interference in implicit and explicit memory performance

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It has been speculated that implicit and explicit memory tests are differently affected by interference. For example, Jacoby (1983) presented subjects with different word lists on each of five successive days. Although such conditions may exert powerful interfering effects on explicit memory performance for the various lists, no evidence was found of either proactive or retroactive interference effects in a word identification task. This should not come as a surprise, however, because in such a task there is hardly any overlap between the cue information given and the interfering stimuli. If interference is defined as any decrease in performance due to the presence of an interfering episode, both presence or absence of interference in implicit memory tests can readily be shown. Studies will be presented showing that presence or absence of interference in implicit memory completely depends upon whether or not the interfering stimuli fit the

cues given in the implicit memory test. Similar findings showed up in a study varying list length but using words that all had different stems. Implicit and explicit memory were determined using the process dissociation procedure. The explicit memory component was affected by list length, but the implicit memory component was not. Finally, some studies are reported in which various aspects of interfering stimuli were systematically manipulated. Again these experiments show that amount of interference is completely determined by the amount of overlap between the retrieval cue information in the implicit test and the nature of the interfering stimuli and encoding task. It is concluded that interference is a general process occurring both in implicit and explicit tests of memory. In data-driven implicit memory tests, interference effects are pure measures of response competition, i.e., interference is completely determined by the amount of simultaneous activation of target and interfering memory representations by the cue information presented.

Repression as successful intentional forgetting: A comparison of methods

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Intentional or directed forgetting (i.e. a motivated attempt to limit the future expression of a specific memory content) was investigated by three methods. Depending on the target of forgetting instruction, the subjects have to forget an entire discrete set of items (global method), a structured subset of items (specific method) or a particular item (distinctive method). Reviewing the literature we concluded that successful intentional forgetting is mainly the effect of retrieval inhibition in the global method, of postretrieval decision in specific forgetting and of increasing encoding of R-cued information in distinctive forgetting paradigm. Considering repression as a successful forgetting of negative items a series of three experiments is conducted in order to offer laboratory evidence for repression and to analyse the differential impact of specific encoding, retrieval inhibition and postretrieval decision in the process of repression. During the learning phase a set of emotionally positive, negative and neutral stimuli will be exposed to the subjects, half of them F-cued and half R-cued, according to the three methods already mentioned. At the test phase subjects are required to complete explicit and implicit memory tests, disregarding previous forgetting instructions. Repression and differential contribution of encoding, retrieval and postretrieval decision to successful forgetting of negative stimuli are highlighted by comparison of the methods and results at memory tests.

Working memory processes in children's mental multiplication

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We present data of two experiments on working memory processes in children's mental arithmetic. In contrast to most previous studies focusing on mental addition, we investigate mental multiplication. According to our central assumption, the relative impact of different working memory subsystems should change when knowledge about multiplication sums becomes more and more automatized. In particular, a strategy change from repeated addition via deriving facts to pure retrieval should be reflected in a decreasing reliance on the central executive and on the phonological loop. To test this assumption we used an interference paradigm. Children of different school grades (i.e. with different degrees of practice in mental multiplication) solved simple and hard multiplication sums in four experimental conditions: with no interference, with concurrent neutral tapping, with articulatory suppression, and with spatial tap tracking. The latter condition was involved in our experiments to gain first insights into the possible role of visuo-spatial processes in mental arithmetic. We present data of all in 150 second, third, and fourth graders, focusing on the effects of articulatory suppression and visuo-spatial tap tracking. Additionally, we will briefly discuss advantages as well as shortcomings of the dual-task paradigm for investigating working memory functions in more complex non-memory tasks.

Apolipoprotein E and memory performance

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Memory performance was assessed in 1000 healthy subjects in a wide variety of tasks, assessing episodic memory, semantic memory, and priming. Blood samples were taken; alleles and genotypes of some genetic markers were determined for all subjects. Of particular interest here was to determine the association between performances in the memory tasks employed and the alleles and genotypes of Apolipoprotein E. One genotype of this marker ($\epsilon 44$) has been proposed as a potential risk factor for cardiovascular disease and for Alzheimer's disease, whereas another genotype ($\epsilon 22$) has been proposed as being a protective factor for these diseases. The purpose of this study was to explore whether these two genotypes might be regarded as risk factors and protective factors, respectively, for poor memory functioning in healthy subjects. Analyses of these data are under way. Preliminary results seem to support the hypothesis of $\epsilon 44$ being a risk factor for poor memory.

Context and enactment - a conceptual or empirical relation?

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Modern cognitive psychology has been accused of containing considerable amounts of "pseudoempirical" research. Pseudoempirical research signifies experimental demonstrations of conceptual relations that not possibly could have turned out otherwise than allegedly shown in an empirical way. Absence or presence of context effect in action memory is used as an illustration. Experiments showing positive or negative context effects are discussed in terms of the pseudoempirical research issue. The position is defended that one ought to distinguish parametric from demonstration experiments, and that demonstrations, including thought experiments, can carry argumentational power in theoretical discussions. It may still be the case that demonstrations without adequate conceptual analysis may represent genuine examples of pseudoempirical research. The question is raised to what extent current cognitive psychology is an empirical enterprise.

Categories of situations from photographs and drawings: About the ecological value of constructed stimulus in memory research

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Research on natural categories (Rosch, 1978) empirically demonstrated the existence of typicality. These results however mainly rely upon the analysis of simple objects for relatively well-defined (or commonly known) categories. The present research extends the exploration to photographs of scenes where organization depends upon a specific and finalized activity, what we call situations, here pictures of driving situations. The analysis of the categorial structure of such unknown cognitive representations requires the development of mathematical representations where meaningfulness has to be tested along with the psychological investigations. We present results that, at the same time, establish the relevance of the concept of typicality for photographs of situations and the heuristic value of additive tree representations of similarity (Experiment 1). However, such an investigation limits ourselves to a description of the extension of categories (in terms of exemplars). We then tried to get at a more precise analysis of typicality (or similarity) through the construction of a parameterized stimulus, such as a drawing, constructed from the verbal reports subjects gave in Exp. 1 as descriptions of the categories they sorted (Exp. 2). The same procedure and data analysis were followed for these materials but this time, the schematic drawings elicited classical hierarchical tree representations without any graduality (typicality) within classes. Three further series of experiments led us to conclude that these differences in the categorial structures elicited could be attributed to four main factors: the schematism (shaded vs line drawings) (Experiments 3a vs. 3b), the symbolism (uniqueness vs. identity of the modalities) (Experiments 3b vs. 4), the intentional structure ("natural" combination" (Exp. 4), "family resemblance" (Exp. 5) or

regular and exhaustive (Exp. 2), and the complexity of the combination (number of parameters and modalities) (Exp. 5 vs. Exp. 2). Besides the relevance of such results concerning categorial structures in memory for "situations", it raises questions about the nature of the constructed stimulus and about the constraints they impose on categorisation processes in experimental settings, of the ecological value of a priori schematic parametered stimuli in experimental settings in order to get at long-term memory structures for complex objects.

3.12. LANGUAGE PRODUCTION

Testing the WEAVER model of speech production: Role of semantic transparency and metrical structure

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Two series of implicit priming experiments tested a computational model of word-form encoding in speech production called WEAVER (Word-form Encoding by Activation and VERification) (Roelofs, 1992, 1994, 1996). On each trial, participants had to produce one word out of a small set as quickly as possible. In homogeneous sets, the responses shared part of their form, whereas in heterogeneous sets they did not. According to WEAVER, morphological complexity can play a role in form planning without having a synchronic semantic motivation. This claim was supported by the outcomes of a first series of experiments. Opaque prefixed verbs whose bases are bound morphemes were compared with fully transparent prefixed verbs. Main effects of prefix homogeneity and of transparency were obtained but no interaction. In addition, opaque prefixed verbs whose bases are bound morphemes were compared with opaque verbs whose bases are free morphemes. Again, main effects of homogeneity and type of verb were obtained but no interaction, which suggests that the earlier effect of transparency was a result of comparing bound and free morphemes rather than semantics. WEAVER plans speech by integrating independently retrieved segments and metrical structures that specify the number of syllables and the stress pattern but not the CV sequence. A second series of experiments provided support for WEAVER's claim that implicit priming of word-initial segments is only possible in case of shared metrical structure. An effect of segmental homogeneity was obtained in sets with constant metrical structure but not in variable sets. Furthermore, as predicted, segmental priming effects were obtained for sets with constant as well as variable CV structure. In WEAVER, metrical and segmental spellout occur in parallel. Shared metrical structure should therefore not have an effect if there is no segmental overlap, which was empirically observed.

What psycholinguistics reveals about phonology: Evidence from the syllabification of bisyllabic nouns

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In a series of experiments the syllabification of bisyllabic Dutch nouns was investigated. Using a syllable-reversal task (see e.g., Treiman [Cognition 15, 1983], Treiman & Danis [JML 27, 1988] we tested the influence of phonological and orthographic representations on the syllabification of words. Bisyllabic nouns were presented aurally and participants were asked to produce them again reversing the order of the two syllables. This forced them to make the location of the syllable boundary explicit. They heard, for instance, "filter" 'Filter' and produced "ter-fil". Critical items had a single intervocalic consonant whose syllable affiliation was ambiguous (e.g., "fakkel" /fakel/ 'Fackel' → "kel-fak" or "kel-fa" or "el-fak"). In some of the items orthographic and phonological syllabification were at variance. The role of several independent variables for syllabification is discussed (e.g., word stress, vowel length and quality, etc.). Our data show that native speakers generally follow the phonological syllabification, although a strong orthographic influence was observed. In a processing model for on-line syllabification we account for the results obtained in the experiments. Consequences for models of the mental lexicon are discussed. With respect to the representation of phonological rules our results suggest that syllabification is not likely to be rule-based. Rather, a constraint-based account seems to be appropriate. There are phonological and orthographic constraints which are ranked in a certain order with respect to each other. The preferred (optimal) syllabification behaviour can be inferred from the ranking. Constraints can be violated, however, and this accounts for the observed exceptions.

The role of syllables and lexicality in word writing: An on-line study with a copy task

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Many studies have hypothesized the role of sublexical units in written word processing. They do not agree, nevertheless, regarding the nature of such units: onsets and rhymes, morphemes, syllables, basic orthographic syllable structure (B.O.S.S.), etc. (Cf. Rapp, 1992). In speech processing, the syllable seems to play a more evidenced role in word production (Levelt and Wheeldon, 1994; Sevald, Dell and Cole, 1995) as well as in word perception (Mehler et al., 1981). Our study aims at checking a possible role of this unit in word writing. More precisely, we attempt to analyze whether the syllable is a probable functional unit while lexical representation is transferred from working memory to graphemic buffer (for this notion, Cf. Ellis, 1982, Van Galen, 1990). 21 adult subjects have copied 8-letter items of a list mixing 16 words and 16 pseudowords made up of the same syllables as the selected words; half of the list shows items composed of 2 syllables; the remaining material is composed of 4-syllable

items. Frequency of syllables and words is controlled. Each time an item was displayed on a computer screen, subjects copied it three times on a paper sheet lying upon a graphic pad; as soon as writing begins, items disappeared. A specific software (G-Studio) recorded the whole time protocol (pause duration and speed of writing, for example). The main results are as following: usual effect of lexicality in language processing is observed (words are written faster than pseudowords, and show shorter pause duration within them) and a higher number of syllables yields a slower writing speed only for pseudowords. On the other hand, for copies 2 and 3, when items are still stored in working memory, planning duration (pre-writing pause) increases with the number of syllables for words as well as for pseudowords. These results are interpreted with the help of both interactive processes, more or less implying syllables as processing units: direct orthographic access and phonological combination of syllabic units; motor planning would depend on the number of syllables. A second study, still in progress, aims at checking whether lexicality effect could be altered by frequency effect.

Mental effort and speech fluency

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In the present paper the assumption will be discussed that speech dysfluencies can be the result of interference between the execution of speech movements and concurrently performed cognitive processes. During speech production, information related to subsequent speech is retrieved from short-term memory and transferred into a phonetic code while earlier parts of speech are being produced. Presumably people differ in the extent to which they are able to perform speech movements unimpeded by simultaneous cognitive processes. Empirical evidence which is relevant for this assumption was obtained in a dual-task experiment. On a particular trial a sequence of three unrelated words had to be reproduced ten times (speech production task). Under dual-task conditions a mental addition had to be performed concurrently with the production task. On each day participants were required to perform the mental addition, the speech production, and the dual-task in three successive blocks of ten trials each. This program was repeated on three days. Ten people who do not stutter and eight people who stutter participated in this experiment. Data on speech fluency and speech timing revealed that individuals differ in the amount with which mental addition interferes with speech production and that different speech manoeuvres were used to cope with the requirements of the dual-task situation. The implications of these results for a theory of speech production and for the modularity assumption of articulation will be discussed.

Reasoning processes underlying communication: Extracting the rules of the game from a connectionist network

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We present a computational model of the mental processes involved in evaluating the communicative effect an actor has on a partner. The model is presented inside the framework of Speech Acts' Theory and, consistently, claims that communication must be considered part of action (Austin, 1962; Searle, 1969). Indeed, when an actor A communicates she aims to reach an effect on a partner P by means of changing his mental states. Thus, much of the mental processes involved in communication consists in the evaluation of the effect reached on the partner. In our model, the evaluation of the communicative effect relies on two main factors that may vary according to their strength: 1) the verbal commitment of the partner to play the behaviour game bid by the actor, 2) personal beliefs of the actor concerning their partner's beliefs. The model was validated as follows. First, we devised a questionnaire in order to collect human subjects' evaluations of communicative effects. In particular, subjects were required to consider some scenarios with an actor and a partner as protagonists, then to evaluate the communicative effect the actor had on the partner. Second, we implemented our model in a connectionist network. The input nodes of the network are defined by a set of input variables whose combination describes the scenarios used in the questionnaire. Then, a subset of subjects' evaluations was used to train the network. Finally, the evaluations furnished by the network for the remaining subset of scenarios were compared with those provided by the subjects. The comparison produced satisfactory results. In particular, the rules which describe the activity of the network are psychologically plausible. Our interpretation of the results is consistent with the claims of Levesque (1988): connectionism represents one strategy in the attempt to develop plausible cognitive mechanisms for inference.

3.13. REASONING AND DECISION MAKING

Reasoning with visuo-spatial representations

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Visuo-spatial concepts may be represented as icons (a literal representation of a particular entity, quality, or dimension) or as metaphors (an analogy emphasizing a particular relation between two entities or dimensions). However, most visuospatial representations contain both iconic and metaphoric aspects. Imagine a graph of the growth of a child, with time along the horizontal axis and height along the vertical axis. The representation of height is iconic because it maintains the verticality of height in the physical world. The representation of growth, however, is metaphoric. The slope of the line depicting the child's increasing height across time is analogous to the child's growth rate: steeper lines represent faster rates of

change. What determines which aspects of representation are iconic and which are metaphoric? Adults were asked to reason about functional dependencies between continuous variables using graphs that obeyed an iconic mapping of a single dimension (the verticality of altitude) or a metaphoric mapping of a higher order relation (the rate of change in two variables represented by the slope of a line). Accuracy was higher when a metaphoric mapping existed between slope and rate of change, even if that mapping violated an iconic mapping, such as the verticality of altitude. Research in a variety of visuospatial representational systems reveals a similar pattern: entities are represented iconically but relations are represented metaphorically. Does the iconic-metaphoric distinction reflect an arbitrary representational convention, a general cognitive constraint on visuospatial representation, or a developmental shift in representational abilities? A developmental study investigated these alternative explanations.

Order of term information within premises and mental model restructuring in deductive reasoning

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There is evidence that reasoners construct a mental representation of the information presented in deduction problems and that a solution to the problem is inferred from this representation (Johnson-Laird & Byrne, 1991). Furthermore, with a sequential presentation of the premises, the information given is integrated on line into a spatial mental model (Vandierendonck & de Vooght, 1995). Integrating new information into a model involves the restructuring of this model, and this requires decisions concerning the positioning of new relations with respect to the structure already present. It is assumed that premises such as {A is to the left of B}, evoke {A} to be positioned with respect to {B} which is given an anchor position. It is hypothesised that changing the anchor term while integrating new premises will affect the restructuring process. This hypothesis was tested by manipulating the order of the terms in the premises of 5-term two-dimensional spatial reasoning problems. The results corroborate the hypothesis: a premise presentation format which induces the use of different anchor terms results in (a) longer premise reading latencies, and (b) in higher error rates than when a only one term was given the anchor position. These findings indicate that not only the number of models compatible with the premises is of vital importance for solving deduction problems, but that in addition the model construction process itself has great impact on reasoning performance. The implications for deductive reasoning will be discussed.

Selecting evidence to evaluate hypotheses: Pragmatically determined focus or maximised expected information gain?

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When subjects select evidence to evaluate hypotheses do they do so using the principle of maximising Expected Information Gain (Oaksford and Chater, 1994), or is their choice based on pragmatically determined focus (Legrenzi, Girotto, and Johnson-Laird, 1993; Sperber, Cara and Girotto, 1995)? Two experiments will be described here which attempt to arbitrate between these positions. In both experiments subjects were given problems comprising two alternatives and two items of data relevant to each alternative. In Experiment 1 subjects were given information (either probabilistic or propositional) about the relation between one datum and one alternative and picked one value from amongst the remaining three possible pairs of such relations. The prediction that subjects given propositional information would show an overwhelming tendency to select information relevant to the alternative about which they already possessed evidence was confirmed. This finding is predicted by both earlier work using probabilistic information only (Mynatt, Doherty, and Dragan, 1993), and the propositional problems used here, which were structured so that the only piece of information which allowed subjects to be certain in their evaluation of the hypotheses was the one overwhelmingly chosen. In Experiment 2 it was found that those subjects who received information about the relation between a diagnostic datum and an alternative were more likely to choose information about the relation between the diagnostic datum and the second alternative than were subjects initially given evidence about an undiagnostic datum. This finding is a reversal of the finding in Experiment 1 and accordingly, due to the problem structure, those subjects who displayed a sensitivity to the diagnosticity of the datum may be said to have failed to maximise information gain. It is argued that these results support a model where evidence selection is seen as being dependent on both the perceived relevance of evidential items and a trade-off between processing effort and cognitive effect (Sperber et al, 1995). Although subjects in Experiment 2 did demonstrate a sensitivity to the diagnosticity of evidential items (as predicted by Oaksford and Chater), this sensitivity determined the relevance of individual evidential items rather than informing a global strategy of maximising Expected Information Gain.

Preconscious selection of solution ideas in divergent problem solving

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It was hypothesized that the mechanism of becoming conscious of solution ideas during problem solving involves their preconscious evaluation and selection from amongst a greater number of solutions. The paper reports an experiment aimed at getting empirical access to the memory traces of hypothetical unconsciously rejected ideas. Subjects solved a divergent problem under the instruction of "thinking aloud". Then, in an ostensibly unrelated task, they

quickly answered a yes or no question in response to names of things presented on a computer screen. Some of them were assumed to correspond to unconsciously rejected solution ideas. They were bad solutions to the problem - neither fully acceptable, nor completely irrelevant, which generally did not appear in the subjects' verbal reports. Subjects solved either of two problems. Some of the stimuli in the question answering task were related to one problem and unrelated to the other, some the opposite way round. In their final task subjects free-recalled the stimuli. Based on the Glucksberg and McCloskey (1981) two-stage question answering model, longer response latencies were predicted for related than for unrelated stimuli. It was also expected that the stimuli related to the problem would be remembered better than unrelated. The predictions concerning latencies were confirmed for a small subgroup of subjects who in the postexperimental interview reported an "intuitive" strategy of answering the critical question. Significant differences in memory scores were found, but, contrary to the expectations, related stimuli were remembered worse than unrelated. It is hypothesized that preconscious negative verification of solution ideas involves their blocking or inhibition.

Prosecution in the Dutch criminal justice system: Dynamic decision making

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Dutch public prosecutors hold a key position within the Dutch criminal justice procedure. Not only do they make the ultimate decisions about whether or not to prosecute, they also have the power to instigate and guide police investigations. In this way, information which guides later decisions may have become available as a result of earlier decisions. The task of Public Prosecutors can therefore be conceptualized as a series of interrelated decisions. This feature is not often modeled in psychological theories of judicial decision making (i.e. Pennington and Hastie, 1992, Bennett & Feldman, 1981). The current research project aims at modeling these aspects within a dynamic model of judicial decision making. This paper presents results of an experiment concerning judgments about suspect's guilt in two criminal cases. Subjects (criminal law students) were required to make judgments about likelihood of a suspect's guilt and related judgments while they processed the available evidence. They also had the opportunity of requesting new evidence by simulating police investigative actions (such as search of premises, and the questioning of witnesses). Subjects were also required to make 'real life' judicial decisions concerning arrest, pre-trial custody and whether the available evidence warrants the case to go to trial. Both cases are based on actual court cases and efforts have been taken to ensure the information resembles both in content and manner of presentation the actual files prosecutors deal with. The main difference between the study and actual practice is that the information in the experiment is presented on a computer and not on paper, as is the norm in the Netherlands. The results allow us to formulate a dynamic decision making model which will be presented here. A subsequent study to assess its value using actual public prosecutors is in preparation.

Influences of the past on choices of the future

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An often neglected issue in research on decision making is why outcomes of previous decisions sometimes influence current decisions. A review of research on multistage betting, effects of sunk costs, status-quo or omission bias, and escalation suggests both cognitive and motivational explanations. These explanations may be specific, such as judging that prior and current outcomes are related, or nonspecific, such as direct or indirect mood effects. Most of the explanations are complementary. An integration of several explanations are made in a process model. The first stage in this model, affected by availability and salience, is retrieving prior outcomes from memory and the second stage judging their relatedness to the current decision task. Goals and aspirations then determine how a prior outcome is integrated with (added to) the current outcomes before a choice is made. If the goal is to avoid negative events, a loss-sensitivity principle implying that prior outcomes are only added to expected losses may dictate integration. On the other hand, if the goal is to maximize value, buffering losses is important. Thus, prior gains are added to expected losses and prior losses are added to expected gains. Mood may change due to retrieval of prior outcomes. In line with much previous research, a positive mood makes a decision maker more sensitive to losses. However, he or she may also be more optimistic concerning risky outcomes. Empirical results from several studies will be reviewed showing, firstly, both effects of goals and mood and, secondly, how such effects interact with effects of cognitive limitations.

Analysis of cognitive strategies in transportation, staff, and production planning

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Supporting the planning task with the help of computers requires extensive knowledge of execution of this planning task by planners and schedulers. Hayes-Roth & Hayes-Roth (1979) and Gärling (1994) studied the cognitive aspects of planning, but only did it with errand planning tasks. Although cognitively very interesting it is difficult to draw lessons from this experiments for task support with computers in real planning situation. Planning as cognitive activity is an element of planning or scheduling as an overall task in organizations. Therefore, the cognitive analysis of planning has to be extended to more realistic planning and scheduling problems. Because we develop planning and scheduling support systems (Mietus, 1994; van Wezel, Jorna & Mietus, 1996), we looked at well known cognitive theories about planning, such as script based planning, opportunistic planning and hierarchical planning in order to find out cognitive strategies in solving real life planning problems. We designed three realistic planning problems in which capacities, constraints, and goal functions were formulated in agreement with three different contexts: staff scheduling in a hospital, production planning

in a factory, and lorry planning in a transport company. The three problems were mathematically the same. The problems were presented to 18 planners, 6 in each context. Two versions of the problem were constructed, one in which no solution could be found unless the constraints were violated and therefore changed and one that could be solved without changing the constraints. The experiments were done in the working environments of the planners and they took about 25 minutes for each person doing the two problems. Because we were interested in the (real) problem solving processes of real planners, it was not possible to match the individuals in all respects. The data consisted of think-aloud protocols, solutions to the two problems and a questionnaire with questions about the planning context. We wanted to test the following intuitive ideas. Given the same mathematical problem, formulated however in different context terminologies, the same constraints (in mathematical terms) will be violated in the three contexts. Confirmation of this hypothesis has important consequences in developing planning support systems. Another intuition or hypothesis is that different planning contexts will not influence the cognitive strategies in terms of opportunistic or hierarchical orientation. Because extensive protocol analysis was done, we also got a number of relevant factors that influence the problem solving process. These factors are not extensively discussed in experimental work on planning. We will report about the results of the quasi-experimental study and its consequences for designing cognitively realistic software support.

CHAPTER 4

POSTERS

4.1. ELEMENTARY COGNITIVE FUNCTIONS

Modelling perceptual integration by means of coherent oscillations

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The cerebral cortex presents functionally segregated areas as well as a dense network of reciprocal connections among these specialized areas (Zeki and Shipp, 1988). Accordingly, modular processing in cognitive systems (Marr 1976; Fodor 1983) has to coexist with integrative processes in order to let the experienced world appear as a unified whole. In order to provide evidence for the coexistence of modular and integrative processes in cognitive activity, four topics will be discussed, with particular reference to perception. 1) A central timing mechanism generates the 'syntactic structure' that relates processes in different modules to each other; probably, the neuronal oscillations around 40Hz play a key-role in this cognitive binding (Poeppel, 1985; Singer, 1994). By means of these coherent oscillations, the sensorial input is temporally organized by central timing processes. In this top-down perspective, perception would therefore correspond to the verification or falsification of transient hypotheses that the subject has about the observed world. 2) A brain circuit architecture, supported by neuro-anatomo-physiological data, could explain the generation of these integrative oscillations by means of complex recursive interactions occurring between cortical areas as well as between these cortical areas and specific and aspecific (reticular complex and pulvinar) thalamic nuclei. 3) Stimulus-entrained oscillations (of approximately 30-40 Hz) can be generated by means of multiple-pathway exchange of signals, thus allowing integrated object perception through a transition from phasic to cyclic neural signalling. This neurodynamic process depends on feedback loops among neuronal collectives as well as on cyclic attractors (limit cycles) in the cooperative neuronal firing. 4) In order to evidence the relationships between coherent oscillations, feedback loops and cyclic attractors, we simulated the dynamic behaviour of a neural network composed of a set of submodules. Each submodule, functioning as a semi-autonomous oscillatory unit (von der Malsburg and Buhmann, 1992), receives input from a limited region of the 'visual field'. Different patterns (stimuli) were presented to the network; since the submodules are linked to each other by means of associative connections governed by a hebbian rule, the submodules that are repeatedly co-activated present higher temporal correlations. Our simulation also shows that, although the network is 'sensitive' to stimulus patterns, the coherent oscillatory activity (monitored by means of cross-correlation) pre-eminently depends on intrinsic parameters. Moreover, stable cyclic attractors with respect to the dynamic behaviour of all oscillatory units emerged with adequate parameter values.

Visual-spatial attention shifting and awareness

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Experiments performed with brain-damaged patients have led authors (e.g., Posner, 1991) to hypothesize the existence of three subsystems implemented in different brain areas that may play a role in attention shifting processes. The first subsystem seems to be critical to engage attention, the second to move attention and the third to disengage attention. The aim of our study was to determine whether these mechanisms are able to arise independently of our becoming aware of the circumstances in which we attend to objects. Two groups of 24 subjects have been submitted to a visual target detection task. Subjects had to respond to a target that followed the presentation of a cue. The experiment was designed so that 70 per cent of the trials were valid (the target appeared where the cue was presented); 15 per cent were neutral (a cue was presented at both target locations); and 15 per cent were invalid. One group was informed that there was a 70 per cent chance that the target would appear where the cue was presented, whereas another group was not given this information. Results showed a facilitation effect (valid condition) and an inhibition effect (invalid condition) with respect to the neutral condition, and this, regardless of the awareness of the subjects. Ten of the 24 uninformed subjects appeared to be aware of the role of the cue, but their results did not differ from those of unaware subjects. We can therefore conclude that attention shifting mechanisms are automatic and operate regardless of awareness.

Inhibitory effects of cue onset and offset

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The response speed (RT) to a visual target is modulated by the position of previous events (cues) although the position is not predictive of the target position. The modulation has been considered biphasic with an early facilitatory and a later inhibitory component. In the first case RT is shorter and in the second case is longer if cue and target occur in the same position or field than if they occur in opposite fields. The cue is generally presented for a fixed interval of time before the onset of the target and therefore onset and offset of the cue are always present. Our study investigated the importance of the onset and offset features of the cue with a design in which these features were manipulated orthogonally to evaluate their separate and joint effects. The two possible target positions, one in the right and one in the left field, were indicated by two empty boxes and the cues consisted of the onset and/or offset of an arrow (↖) located just under one of the two boxes. Different intervals of time were used between cues and target. Subjects were instructed to ignore the arrow and to respond to the target (a cross inside one of the two boxes) as soon as possible. The data showed consistent effects of inhibition only with the long intervals, but the pattern was different according to the cue type. The amount of the inhibition was much stronger when the onset of the cue was followed by

its offset. The results show that our visual system considers onset and offset of the cue as two events whose effects can jointly inhibit the response.

Influence of orienting of attention on grasping execution

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We used a Posner paradigm to test whether the grasping of an object is influenced by the orienting of attention towards a picture of the same or of a different object. Subjects have to maintain fixation on a central box. Following the instruction given by a cueing arrow, subjects had to orient their attention on one of the two pictures representing graspable objects (sphere, cylinder), one at the right and one at the left of the fixation point. After a variable interval, the imperative stimulus (IS) was drawn inside one of the two visual objects. In some trials (neutral trials) no cue was given to the subject. The cued trials were classically subdivided into 80% of valid and 20% of invalid trials (IS inside the cued or inside the uncued visual object, respectively). Subjects had to respond to the IS grasping a 3D real object (sphere or cylinder) that could have been congruent or incongruent with respect to the visual object marked by the IS. Reaction times (RTs) were measured from the appearance of IS to the beginning of grasping. An ANOVA was performed on RTs subdivided into 5 bins with the following factors: grasped object (sphere-cylinder), trials (valid-invalid-neutral), congruence between the grasped object and the visual object (congruent-incongruent), bins (1, 2, 3, 4, 5). The ANOVA demonstrated a correct cue-dependent orienting of attention (trials, $p < 0.001$), and the significance of the interaction congruence \times bins ($p < 0.001$): A facilitation due to the congruence between visual and grasped objects was present in the third and in the fourth bin across all attentional conditions. A possible interpretation of these results is that an automatic orienting of attention towards an abstract representation of a graspable object facilitates grasping for a congruent real object.

Skill-based automaticity and its transfer

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In our ESCOP VII presentation we proposed a two-factor framework of automaticity (Tzelgov & Yehene, 1994). According to the framework, both Algorithmic processing (e.g., Anderson, 1992; Newell & Rosenbloom, 1986), and Memory retrieval (e.g., Logan, 1988), can explain and underlie automatic performance. The present experiments exemplify transfer of automatic processing, defined in terms of the power law (Logan, 1988) or by ballisticity (Bargh, 1992), and show how the two mechanisms of automaticity can be distinguished, by using different Transfer tests. Experiments 1 and 2 demonstrate the transfer of automatic processing to new stimuli under conditions of intentional and autonomous automatic process-

ing, indicating the activity of Algorithm - based automaticity. Experiment 3 demonstrates transfer of automatic processing to a new task (but for old stimuli), consistent with the notion of automaticity as Memory retrieval, under conditions of intentional automatic processing.

Identity and position: Dependence originates from independence

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Experiments investigating identity processing and position processing have generally shown a dependence of identity responses upon position responses. To show this dependence more firmly, the responses of subjects in such experiments are often corrected for random guessing. It is assumed that random guessing causes the overall set of responses, collected in a 2×2 matrix, to be less dependent; only responses due to perception produce dependence. We argue that random guessing does not cause the overall 2×2 response matrix to be less dependent; random guessing is the cause of the observed dependence. To demonstrate this, the results of an experiment with oriented line-segments as stimuli are reported. The overall data showed a complete dependence of orientation responses upon position responses in the sense that there was no orientation information without position information. The overall response matrix, however, consists of two independent submatrices, one for the set of trials with (position) information (the perception matrix) and one for the set of trials without (position) information (the guess matrix). So, orientation responses and position responses on trials with (position) information are independent and the dependence observed in the overall response matrix is caused by random guessing on trials without (position) information.

Visual marking needs the response selection bottleneck?

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Recently Watson and Humphreys (1995) have shown the role of a top-down factor in prioritising the selection of new objects, which they have termed visual marking. In a modified colour-shape conjunction task, they presented one set of distractors (all with a common colour and shape) before the remaining items. The second set of items would contain the target if present. Search in this task was as efficient as when only the second set of items was presented. An impressive experimental series, provided by Watson and Humphreys, shows that this effect held when eye movements were prevented, provided the "old" and "new" items were temporally separated by at least 300 msec and that visual marking could be distinguished from time-based inhibition of return as well as that, for static stimuli, based on the inhibition of whole "feature maps". Furthermore, giving subjects a load task that fixes attention at the centre of the display when old distractors are present systematically reduces the effect. Our aim is to characterize the attentional demands of visual marking by taking advantage of the substantial set of evidence which indicates that, when two sensorimotor tasks are

performed concurrently, the response selection on the first task holds up the response selection on the second task, whereas perceptual processing in the second task does not wait for any aspect of the first task (Pashler, 1994). Our experimental question is: Is visual marking accomplished by the same system as that which select motor responses, and thus are they subject to postponement when a motor response must be selected in another task? Two experiments are presented that show an affirmative answer as well as a complex pattern when difficulty of the first task was increased. Results are discussed in the context of Pashler's response selection bottleneck hypothesis.

Modular functioning of preattentive processing

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In this work we studied the modular functioning of the preattentive stage following Feature Integration Theory (FIT). More specifically, we explored the possibility that variables as practice and homogeneity of presentation could affect that functioning. In a first experiment we used three different experimental conditions: 1) Targets and Distractors set defined by features belonging to different dimensions (size, slope and curvature). 2a) Targets and Distractors were defined by different values from the same dimension (size of the line). 2b) Targets and Distractors were defined within the same stimulus dimension and shared the same simple feature (curvature for targets and linearity for distractors). There were 2.160 trials in each condition. Results show that only in the 2b condition were subjects able to perform a parallel search of the targets set. In a second experiment we used the same experimental conditions, but this time there was only a single distractor (homogeneous display). Here we found that both in conditions 1 and 2b subjects were able to access in parallel the information of the different modules. These results would stand in contradiction to FIT arguments. These results show that it is necessary for explanation of visual preattentive processing to take into account both the familiarity of the task and certain presentation variables; namely such homogeneity of distractors.

4.2. PICTURE NAMING

Production onset latencies vary with sequential activation processes in hierarchic syllable structures

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This study examines picture naming latencies to test four predictions derived from Node Structure Theory (NST: MacKay, 1987): The basis in NST for the first three predictions was as follows: Word production entails a tree-traversal process involving hierarchically organized nodes for the word, its syllable(s), and their subsyllabic units (representing the onset, rime, nucleus and coda of the syllable). Because node activation proceeds sequentially from top-to-bottom and left-to-right in these hierarchies, production onset latencies will vary with how many nodes are contained in the left branch of the hierarchy, i.e., more for bisyllabic than monosyllabic words, and more for words with complex onsets (a consonant cluster preceding the vowel, e.g., bread) than simple onsets (e.g., bead), with additive effects of onset complexity and number of syllables in words such as blanket versus basket. Results of two picture naming experiments supported these three NST predictions and an additional one: Production onset latencies 1) were longer for bisyllabic than monosyllabic words (a replication and extension of Klapp, 1976); 2) were longer for words with complex than simple onsets; 3) combined additively as a function of onset complexity and number of syllables; but 4) were equivalent for words with complex codas (a consonant cluster following the vowel, e.g., pearl) versus simple codas (e.g., pear). This last finding reflects the fact that under NST, production onset latencies are independent of how many nodes appear in the right branch of hierarchical syllable structures.

A MEG study of picture naming

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The aims of this study were (1) to relate a cognitive stage-model of picture naming to patterns of evoked cortical activation, and (2) to obtain descriptive data of whole-cortex involvement in picture naming. In the "single factor" method, an independent variable is chosen that is known to affect a single stage in the cognitive processing model. Any spatio-temporal effect of this variable on the imaging data is a clue to the cerebral localization of that processing stage. The stage in the complex process of picture naming we singled out was phonological access.

Previous research (Jescheniak & Levelt, 1994) had shown that the word frequency effect (low-frequent, LF, words are produced with longer latency than high-frequent, HF, words) arises at this stage of processing. 8 participants repeatedly named a mixed set of 24 pictures with HF or LF monosyllabic names in a Neuromag-122TM whole-head magnetometer. Results: (1) Word frequency had no effects strong enough to be localized by source analysis, but there were small differences between HF and LF naming responses, particularly at right temporal locations. (2) The patterns of cortical activation confirm earlier findings by Salmelin et al. (1994). They involve posterior brain regions related to visual stimulation, followed by temporo-parietal activation, often in the vicinity of the angular gyrus and supratemporal plane. Subsequently, activity spreads to the face motor area and/or to frontal opercular and insular areas. Remarkable was a prominent 400-500 ms activation of the right fronto-temporal area, accompanied by conspicuous modulation of the local spontaneous rhythms.

Error analyses of context effects in picture naming

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In picture-word experiments, the semantic interference effect refers to the finding that a picture (e.g., of a CAT) is named more slowly when it is accompanied by a semantically related word (pig) than when it is accompanied by an unrelated word (pin). The orthographic facilitation effect refers to the finding that a picture is named faster when it is accompanied by an orthographically related word (cap) than when it is accompanied by an unrelated word (pin). These two effects modify each other: The semantic interference effect obtained with the orthographically related words calf and cap is smaller than the semantic interference effect obtained with the words pig and pin, words which are orthographically unrelated to the picture's name. In order to rule out an alternative interpretation of this interaction in terms of speed-accuracy trade off, in the present experiment a speed instruction was given. The speed instruction produced a large increase in the number of errors, which rendered an error analysis meaningful. The error data did not support an interpretation of the interaction in terms of speed-accuracy trade off. In addition, the error data present evidence in favour of the view that speeded naming taps a late, name-retrieval process, and that picture naming is semantically mediated.

4.3. NEUROLOGICAL CORRELATES

Cerebral hemisphere asymmetry and the development of new categorical spatial relation representations

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A right-hemisphere (RH) advantage has been demonstrated in many studies in which right-handed people were asked to process coordinate spatial relations, whereas a left-hemisphere (LH) advantage has been observed for the processing of categorical spatial relations. Kosslyn et al. (1989) observed that the RH advantage disappeared early with practice, which leads us to hypothesize that this disappearance is the consequence of the development of new categorical spatial relation representations. The present study was aimed at testing this hypothesis. We reasoned that if we make categorical spatial relations harder to develop, then the RH advantage should be maintained for a longer period of time. We designed a task where 24 subjects had to make coordinate judgments, which consisted of deciding whether a dot was within 2 cm of a line or further. In one condition, one horizontal line was used, whereas in another condition, two other axes were added in order to make categories more difficult to develop. Two control conditions were used to test the role of manipulating the axis of presentation in a categorical task where subjects had to judge whether the dot was above or below the line. In addition to replicating the task by hemisphere interaction shown by previous authors, our results demonstrated the maintenance of a RH advantage for a greater number of trials in the 3-axes coordinate condition than in the 1-axis condition. This effect was not obtained in the categorical conditions. Our results are consistent with the idea that categorical spatial relation representations can develop in a coordinate judgment task and are not static properties of our cognitive repertoire.

Movement performances in mentally retarded subjects

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Movement performance in handicapped subjects and their errors correlation among proper types of handicapped, regarding its methodology is a new approach in investigation. In this study, results obtained, relating to movements performances of mentally retarded persons will be presented. Subjects in our study, we have investigated movement performance are mentally retarded subjects and those with normal IQ. Subjects of both sexes, age of 16 years, while the intellectual status of the experimental group was 50-70 IQ and controls in normal range measured with WISC and Raven. All subjects were tested by Praxis Protocol. They ought to perform a certain movement as a manipulation with a real or an imagined object (or objects). Qualitative analysis of performed movements with errors in the experimental and

the control group we have described as following types: executive, conceptual, body part as an object, omission of sequence, inversion of sequence, sequence addition, uncritical to distance or object, exchange of sequence, inadequate gripping and substitution. The experimental group achieved a score of 63,3% in comparison to correct movements in control. Same time, subjects of the experimental group showed 150% more errors compared to the control group. It is significant that subjects from the experimental group had 100% more absence of movements than the control group.

Do the hemispheres have different temporal resolving power?

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It has been hypothesized that the left and right hemispheres are biased toward efficient use of higher and lower visual-spatial frequencies, respectively. Christman et al. (1991) found a hemispherical specialization for different visual-spatial frequencies. Whereas the left hemisphere showed an advantage in processing higher visual-spatial frequencies there was a right-hemisphere advantage for lower frequencies. Following on from several demonstrations of the asymmetric processing of very short events (Nicholls, e.g. 1993), we wanted to show that there is a similar hemispherical specialization for temporal frequencies. In contrast to Nicholls, who found a left-hemisphere advantage in a visual-spatial task with very short exposure durations, we chose duration judgement as a temporal task. Our study used visual stimuli which were presented in the visual fields and had to be judged by the subjects as temporally "short" or "long". There were two kinds of short (either one or two screen refresh rates) and two different long stimuli (four or five refresh rates). Categorization was learned by feedback during the training period. The analysis of error rates showed an interaction between the visual field and the exposure duration: The left hemisphere was more accurate in detecting the short stimuli whereas the right produced lower error rates with the longer stimuli. This could be a result of a different temporal resolving power of the two hemispheres. The left appears to be specialized for higher temporal frequencies, the right more for lower temporal frequencies.

Memory span and forgetting in Alzheimer's disease

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Two experiments were carried out to explore the short-term memory span and forgetting in a Brown-Peterson task with two different kinds of material: nonsense syllables and words from different categories (natural versus artificial categories) in Alzheimer's disease (AD) subjects. The Alzheimer's group (N=10) was at the early stages of this disease (M.M.S.E. with a mean of 20.60) and mean age 70.6 years. The control group was formed by subjects (N=20) with a

mean age of 67.4 years. All AD subjects had a retest of the experiments about four months later. The first experiment consisted of the W.M.E. span test (forward and backward serial order). No significant differences were found between the two groups of subjects in both kinds of orders. The second experiment tested the subjects' ability to remember nonsense syllables and natural and artificial categories after an interval of 7, 14 and 21 seconds, during which they were instructed to count numbers forwards from a particular one. Different analysis were carried out. Recall of nonsense syllables versus categories were compared in relation to retention interval and group of subjects (Alzheimer versus Control). The analysis of variance showed that only the three main factors were significant. The second analysis of variance (comparison of natural versus artificial categories in relation also to retention interval and group of subjects) showed only a main significant factor (Control group recalled much more than Alzheimer group). No differences were found between test and retest in the Alzheimer group in both experiments. The results are discussed in relation to the working memory model.

4.4. PRIMING

List context effects on masked phonological priming in the lexical decision task

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A lexical decision experiment tested the effects of briefly presented masked primes that were homophones or pseudohomophones of target words. Different types of nonword foil (pseudohomophone, orthographically regular nonword, orthographically irregular nonword) were used. Pseudohomophone priming effects were insensitive to variations in nonword context whereas homophone priming effects varied from being facilitatory in the presence of orthographically regular nonwords, inhibitory in the presence of pseudohomophones, and null in the presence of irregular nonwords. This clear dissociation in the way nonword context influences masked pseudohomophone and homophone priming effects in the lexical decision task is discussed within the framework of the multiple read-out model of visual word recognition (Grainger & Jacobs, in press).

A competitive role for neighbors demonstrated using a partial priming methodology

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The influence of a target word's orthographic neighborhood upon the processing of that word was investigated using a partial priming methodology. Four letter words were primed by three component letters in a lexical decision task (Pugh, Rexer, Peter, & Katz, 1994). Prime trigrams took four forms: identity; control; ambiguous, consistent with many words other than the target; unambiguous, consistent with zero or one word other than the target. E.g. CODE had ambiguous prime 'ode' and unambiguous prime 'c de'. As Pugh et al. (1994) adopted a 100ms prime duration, Forster and Shen (in press) argued that this duration permitted subjects to use a non-lexical strategy whereby a high frequency target consistent with the prime is predicted, thereby accounting for longer latencies to words preceded by ambiguous than unambiguous primes. In our experiment, targets were selected to be the highest frequency word consistent with their primes. With such stimuli, Forster and Shen's strategy account predicted no effect of prime ambiguity. Alternatively, assuming lower frequency neighbors play a competitive role during lexical access, longer latencies to words preceded by ambiguous than unambiguous primes were predicted. Prime types modulated mean latencies in the following descending order; control, ambiguous, unambiguous, identity. Importantly, ambiguous primes led to longer latencies than unambiguous primes. These effects were robust over two further prime durations of 80 and 60ms, suggesting a competitive role for lower frequency neighbors.

The phenomenon of positive and negative priming and its relationship to psychometric creativity

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The study is aimed at finding whether there is any relationship between the arousal level and completion of priming tasks by creative and less creative subjects. Previous data suggest that there may be two mechanisms that underlie the effect of priming on the acceptance of close and remote associations by more or less creative people: cognitive and motivational (Necka, Gruszka and Orzechowski, in press). Automatic spreading activation is postulated to cause an increased level of memory-sensitization, in which either memory traces critical to the solution are activated (local effect caused by semantic prime), or general activation of the semantic network is increased (global effect produced by nonsense prime). The present study examines whether there is any relationship between these effects-especially the global one, more efficient in case of creative subjects-and susceptibility to negative priming, used as a measure of cognitive rigidity. The motivational mechanism underlying the acceptance of remote associations manifests itself in increased tolerance to temporary lack of results of cognitive activity, hypothesized in the case of more creative people. Considering the links between motivation and the state of arousal, as well as between arousal and the capacity of STM and attention, the

presented study is conceptualized to check whether the arousal level affects the completion of priming tasks by creative and less creative subjects. The data are being analyzed at present.

Testing theories of priming: Backward priming in lexical decision re-examined

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In a lexical decision task unidirectionally associated word pairs (e.g., STORK-BABY) were used to study associative priming. Spreading activation theories of priming predict priming only when the word pair is presented in the forward direction (prime: STORK, target: BABY). The compound cue theory of Ratcliff and McKoon (1988) however predicts a priming effect for both directions. Prior studies have shown both forward and backward priming in lexical decision, which seems to support the compound cue theory. However, most researchers have attributed the backward priming effect to strategies. I will present the results of an experiment that was designed to minimize the influence of strategies.

Priming and visual mental imagery

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The aim of this study was to test the hypothesis that perceptual priming can be elicited by visual mental imagery. This hypothesis was motivated by the fact that visual perception and imagery share common processes and representations (see Kosslyn, 1994). Seventy-two subjects were tested in a perceptual identification task composed of a study phase and a test phase. They were divided into three groups that performed a different study phase. In the first study phase, subjects were presented with concrete words and were asked to form a mental image of the words' referent; in the second study phase, the same words were presented and subjects had to rate the words' pleasantness; in the third study phase, subjects had to name pictures corresponding to the words of the study phases one and two. In the test phase, all subjects had to identify a series of objects, some of which were parts of the objects imaged or perceived in the study phase, while some others were new objects. The stimuli were presented for 33 msec, and were preceded and followed by a mask. Results showed an overall priming effect that interacted with the study phase condition. More priming was observed in subjects who were presented with the objects in the study phase than in subjects who had to form a mental image, and more priming was observed in subjects who had to form a mental image than in subjects who had to rate words' pleasantness. Our results also revealed that perceiving or imaging a whole object can improve identification of parts of the object.

Phonological repetition priming in cross- and unimodal conditions

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Tulving and Schacter (1990) proposed that repetition priming reflects the operation of a pre-semantic, modality-specific, perceptual representation system (PRS). The present study was designed to test this hypothesis by comparing priming within the auditory modality with priming in a visual-auditory cross-modal condition. Forty-eight undergraduates subjects participated in two lexical decision experiments where word primes were phonologically paired with a word target (e.g., vedette/dette), or a nonword target (e.g., banane/nane). The same word primes were also paired with non-phonologically related target words (e.g., vedette/chat) and nonwords (e.g., banane/repe). In addition, the same targets were used in phonologically-related pairs and in phonologically-unrelated pairs and the same stimuli were presented in the unimodal and in the cross-modal experiment. Results showed that priming effects appeared both when targets were words and nonwords, and both in the unimodal and in the cross-modal condition. In addition, more priming was observed for words than for nonwords and more priming was observed when primes and targets were presented in the same modality. These results do not contradict the assumption according to which repetition priming reflects the operation of perceptual modality-specific representation systems, since more priming was observed within than between modalities. However, the fact that cross-modal priming was observed suggests that phonological word forms were activated by visual primes. Moreover, our results reveal that more priming is observed for phonological forms already stored in memory.

Role of syllabic congruency and length of the stem in a word completion priming task

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Word stem completion tasks have been widely used to measure the integrity of implicit memory (i.e., priming) in different types of populations. Although it is critical that a part (e.g., ELE.....) of a previously encountered word (e.g., ELEPHANT) be presented in the test condition to be completed by the first word that comes to mind, the precise characteristics of this part (the stem) have not been studied in detail in the French language. The present experiment was aimed to assess the role of the congruency between the stem to complete and the first syllable of the word used to prime this stem, and the role of the length (2 versus 3 letters) of the stem to complete. Four experiments in which French words were controlled in terms of lexical frequency, word length, number of phonemes, and number of syllables were performed. Forty different subjects participated in each experiment. Two experiments consisted of two-letter stem completion tasks, one with congruency between the stem to complete and the first syllable of the word, the other without congruency. The two other experiments consisted of three-letter stem completion experiments, one with congruency, the other one without con-

gruency. Significant priming effects were observed in all experiments. However, more priming was observed for three-letter stems than for two-letter stems, and more priming was observed in case of congruency between the stem to complete and the first syllable of the word. These results show that priming depends on the amount of information that is shared between the prime and the stem, and suggest that French visual words are processed and stored in long term memory in terms of syllabic units.

Perceptual priming in a gender decision task

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Two gender decision experiments were designed to test the hypothesis that separate subsystems store perceptual and semantic representations. Subjects were presented with a set of stimuli, some of which were repeated in the same font, some others in a different font. Eighteen subjects participated in each experiment that differed according to the number of fonts (2 versus 162) used. Results showed that subjects responded faster for repeated than for non-repeated words and responded faster when words were repeated in the same font. However, these differences were larger in the 162-font experiment. Our results support the conception of an organization of perceptual and semantic representations in memory in separate subsystems. In addition, the use of a gender decision task extends the conditions under which perceptual and semantic priming can be observed.

4.5. WORKING MEMORY AND DUAL TASK

Examining the effectiveness of alternative secondary task methods of implicit skill acquisition: Is primary task difficulty a factor?

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Several studies (e.g. Masters, 1992; Hardy et al, 1996) have shown that motor skills learnt implicitly, as opposed to explicitly, appear to be more resistant to breakdown under stress - a vital component in many situations where a fine degree of motor control is required. However, a difficulty that has been encountered with the use of secondary tasks to cause implicit learning is a consequent decrement in performance of the motor task during the learning phase. It appears that the attentional demand of the most commonly used secondary task (Baddeley's 1966 Random Letter Generation) is too great. In this study we attempted to evaluate the effectiveness of several different secondary tasks and also to determine whether the level of difficulty of the motor-task to be learnt was a factor in whether the secondary task prevented explicit learning.

The "irrelevant babble" effect: Disruption of serial recall by background voices

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Serial recall of visually presented items is disrupted by irrelevant background speech. This phenomenon is known as "irrelevant speech effect". Salamé & Baddeley (1982, 1989) explain this effect within the framework of the working memory model (Baddeley, 1986). Speech sounds gain obligatory access to the phonological store and interfere with the to-be-remembered items. Non-speechlike sounds are excluded from this store and hence are not disruptive. This explanation does not differentiate between various speech sounds. According to the "changing state"-hypothesis (Jones, 1993), the disruptive effect depends on various sound characteristics of the irrelevant material, regardless of being speech or non-speech. In a series of experiments the disruptive effects of different speech sounds were examined. By systematically increasing the number of different voices in the background, the disruptive effect was gradually reduced, but even a "babble" of approximately one hundred voices still significantly disrupted performance. In contrast, by superimposing two different sequences of the same voice, disruption was cancelled out. Improvement of spatial localization and discrimination of the voices through the utilization of artificial head recordings did not change the effect. The results are discussed with respect to the different models described above.

Irrelevant music effect: The effect of temporal structure

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Salamé and Baddeley (1989) found that music played in the background impairs the immediate serial recall of visually presented items. They showed that instrumental music has weaker effects than vocal music and narrative speech. The authors interpreted these findings in the frame of the phonological similarity hypothesis. Klatte and Hellbrück (1993), however, found differential effects of instrumental music. They showed that the effects depend on the temporal structure of the music. Music with extensive staccato passages causes higher error rates than pieces of music containing legato passages. This effect was confirmed by the experiments presented in this poster. In these experiments the same piece of music was sung as well as hummed by a professional singer. It was also played by a Cello player in a staccato as well as in a legato version. Thus, on the one hand the melody was presented vocally and instrumentally and on the other hand had different temporal structures. These presentations revealed that there was no significant difference between the vocal and instrumental version, whereas a significant difference was found between the two temporal structures. These findings are in sharp contrast to the phonological similarity hypothesis of Salamé and Baddeley. They will be interpreted with respect to the changing state hypothesis proposed by Dylan Jones.

Effects of irrelevant speech on serial recall of verbal and spatial information: Do they support functional equivalence or functional dissociation?

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Immediate serial recall of visually presented consonants or digits is severely disrupted by task-irrelevant background speech, even if the speech is foreign and if the subjects are instructed to ignore it. This "irrelevant speech effect" (ISE) has been interpreted by Salamé & Baddeley (1982) in the framework of the working memory model (Baddeley 1986). They proposed that irrelevant speech gains obligatory access to the phonological store component of the phonological loop, where it interferes with the memory traces of the recall stimuli. In contrast, according to the "changing-state"-hypothesis proposed by Jones and his coworkers, the effect occurs because time-varying sounds are automatically represented as a stream of succeeding perceptual objects in short-term memory. This stream carries strong cues about the serial order in which the separate objects occurred. These order cues are assumed to interfere with the associations between adjacent list items, leading to impaired serial recall. According to the Jones (1994) model, the ISE is not speech-specific, but the result of a modality-independent interference between different sets of order information. In line with this view, Jones et al. (1995) showed equivalent effects of IS on serial recall of verbal and spatial items. In a series of experiments, we compared the effects of IS on serial recall of digits vs. spatial positions. While digit recall was severely impaired by IS, no disruption was found on serial recall of spatial positions. These findings do not fit the predictions derived from the Jones (1994) model of serial order retention, but are in line with a modular view of working memory and the assumption that IS disrupts a phonological short-term memory system, leaving visuo-spatial memory unaffected.

Obstructing effect of performing two concurrent spatial tasks while we drive: A tracking task of a simulated driving and listening to a radio broadcast football game

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There is widespread evidence that processes underlying how the use of imagery interferes with tasks that are known to rely on imagery. In particular, the departure point of our work was to tackle a similar problem in traffic safety, based on a dual-task method developed for the study of working memory and attention. The aim of our research was to analyse the role of visual imagery in memory while we drive a car. We were interested, specially, in ascertaining the effect of performing two concurrent spatial tasks that we usually achieve. The first one was a simulation task of driving down the freeway, keeping the car control in the lane. In fact, the main task was a traditional laboratory tracking task in which the subjects were required to keep the prompt in contact with the spot of light that follows an asymmetric track. Difficulty was varied by changing speed of rotation, and performance measured percentage of time on target. At the same time, subjects had to follow an obstructing task. This secondary one, involved listening or not to a tape-radio broadcast of football game. Our results showed that listening to the football information on the tape-radio seriously disrupted the tracking-driving task. Therefore, this study has shown that other concurrent spatial tasks have an effect on the suppression of visual imagery. According to our data accurate driving is interrupted by listening to the radio football match or any kind of spatial information. Furthermore, a general recommendation to facilitate safe driving would be to turn off the radio or switch to music.

Cognitive components of mental movement imagery

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Mental movement imagery is the ability to imagine oneself performing an act without motor output. The aim of the present study was to examine which are the different components of mental movement imagery. We assumed that at least two critical cognitive components are involved in mental movement imagery, that is, a visual and a kinaesthetic component. In order to determine the involvement of these components in various movement imagery tasks, we used an dual task interference paradigm aimed at creating a conflict between perceptual and imagery mechanisms. Such a conflict appears if one or several subsystems are shared in both tasks. Thirty-six right-handed subjects participated in five experimental conditions. In the first and fifth condition, subjects were instructed to imagine an action. The same task was presented in the second, third and fourth condition along with an auditory, a visual, and a kinaesthetic task, respectively. We recorded the timing of mentally executed movements in the imagery tasks and response accuracy in the perceptual tasks. The number of errors was higher in the visual and kinaesthetic tasks than in the auditory task in the dual task conditions, al-

though the visual and the kinaesthetic tasks had not engendered more errors than the auditory task when considered in isolation in a control experiment. However, mental movement times did not differ between the three interference conditions. In addition, subjects took more time to imagine an action that involved the left hemibody than an action that involved the right hemibody, which is as expected in right-handed people and tends to prove that subjects did perform the imagery tasks.

Sequence learning mechanism in double serial reaction time tasks

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Serial reaction time tasks (SRT) are used to study the learning of perceptual-motor skills and the elaboration of temporal associations between events. In the present study, we used the logic of dual tasks that allowed or did not allow the learning of temporal associations to test whether this association process is central or distributed. We reasoned that when two SRT tasks are performed simultaneously, learning will be disrupted if both tasks allow the learning of temporal associations, compared to a condition where only one task allows such a learning, if the mechanism that underlies temporal associations is central. Four single (with hands or feet) SRT tasks and 4 dual (with alternate hand and foot responses) SRT tasks have been designed, presenting every combination of random and sequenced series of events. Each of the 8 tasks was performed by 12 subjects. Results showed that subjects learned sequences with hands and feet both in the single and in the dual tasks, even when two sequences could be learned simultaneously, which provides support for a distributed mechanism for the learning of temporal associations.

Some more evidence for a central bottleneck in dual-task performance

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Bottleneck interference in dual-task performance was localised in several experiments. Subjects had to carry out two choice reaction tasks together with a variable interval between them (SOA). It was asked whether there is a central bottleneck in the stage of response selection or a peripheral bottleneck in the stage of motor responses. The Critical-Path technique (Schweickert, 1983) was used to decide between these possibilities. This technique predicts different effects of difficulty of response selection stage in task 2 and SOA on reaction time for centrally or peripherally localised bottlenecks. In the experiments difficulty of response selection in task 2 was varied by increasing the number of response alternatives (1, 2, 3). Results: The comparison of 2 and 3 alternatives yielded an additive effect of SOA and difficulty of response selection on reaction time in task 2. This is evidence for a central bottleneck. Reaction times (task 2) for the condition with 1 and 2 alternatives converged with increasing SOA. These results are contrary to previous results in literature (e.g. Karlin & Kestenbaum,

1968), which are assumed to be evidence for a peripheral bottleneck. The second experiment was conducted to show that the evidence of Karlin & Kestenbaum (1968) should not be interpreted by a peripheral bottleneck, but can be better interpreted by different mechanisms of response preparation. Taken together the results are evidence for a central bottleneck and contradict assumptions which substitute central interference mechanisms by different local peripheral interference mechanisms.

The effects of randomisation behaviour on memory span: Random switching between two and three keys

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The requirement to be random has abundantly been shown to affect the performance of working memory (e.g. Baddeley, 1990). Among the most commonly used randomisation tasks are random number generation and random letter generation. Both tasks involve the central executive component of working memory and the phonological loop. Most of the other central executive interference tasks also load on either of the slave systems. Vandierendonck, De Vooght, & Van der Goten (submitted) have developed a task that is allegedly pure in the sense that it does not load on the phonological loop or the visuo-spatial sketchpad. In this poster, an alternative to this task is presented. Participants are required to switch in a random fashion between two or three keys on the keyboard. Three experiments are reported in which the interference from this task on memory span is shown. One could easily argue that the alternation between keys involves some spatial representation. So, in a fourth experiment the influence from this key switching task on the visuospatial sketchpad is investigated.

The rehabilitation of executive deficits in closed head injury patients

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The aim of the study was to verify the effect of practice on a dual-task paradigm in closed head injury patients (CHI). We employed a dual-task paradigm that was first devised by Umiltà et al. (1992). In it, the dual-task cost was attributed to an interference at a central executive stage, where the two responses must be coordinated. In two previous studies (Stabulum et al., 1994, in press), we found that the dual-task cost was greater in severe and mild CHI patients with respect to matched controls. Other studies showed that, in the absence of specific rehabilitation, executive deficits did not recover spontaneously, and were still present two years after injury. This suggests the need of developing some remedial procedure able to

overcome this difficulty. A group of 10 CHI patients were submitted to a treatment that consisted of 5 experimental sessions, in each of which the patients performed in the dual-task paradigm. The dual-task cost was assessed before the treatment (test), immediately after the treatment (retest), and three months after the treatment (follow-up). Mean correct RTs for the single and dual tasks were entered into ANOVAs. A significant reduction of the dual-task cost from test to retest was found. There was no significant difference between retest and follow up. This practice effect will be discussed with reference to the absence of spontaneous recovery of this specific executive function and to the possibility that effect of the treatment generalizes to other executive functions and/or to daily living activities.

Does the dual-task situation disturb information processing?

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This experiment studies the effect of divided attention at encoding in a free recall task. A concurrent task produces a clear impairment of learning (dual-task effect: Baddeley, Lewis, Eldridge & Thomson, 1984). We assume that this impairment is due to an encoding deficit because of the limited amount of attention available to perform the learning task. So, information is only integrated (i.e. a lexical processing) but not semantically elaborated. We used a dual-task paradigm. Half of the subjects performed the learning task concurrently with a secondary reaction time task (dual-task situation) and the other half performed only the learning task (single-task situation). Each group was divided in three subgroups: Subjects had either to elaborate (semantic condition) or to integrate the to-be-learned information (phonetic condition); in a third condition, the subjects had no specific processing to do (free condition). Results are as follows: 1) We observe a dual-task effect in the free condition. 2) This effect disappears in the semantic and phonetic conditions. 3) The secondary task cost (increase of reaction time between the single and the dual task situations) is higher in the semantic and phonetic conditions than in the free one. High level of processing seems to prevent the dual-task effect.

Context and inhibition in working memory: The effects of aging

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One of the hypotheses to explain the age-related deficit in many memory tasks is a deficiency of contextual memory. It has been suggested that elderly people have difficulties in connecting the information they are learning and the context in which the information is learned (Craig & Simon, 1980). One relevant paradigm to study this hypothesis is the source amnesia paradigm. Many researches suggest an age-related deficit for source memory. But, some others studies found no specific deficit for contextual memory: old people may recall less contextual information because they remember less target information (Denney, Miller, Dew & Levav, 1991). Another hypothesis is an inefficiency of the inhibition mechanism with aging, older people being less able to suppress distractors which interfere with targets at retrieval (Hasher & Zacks, 1988). In a recognition test, to decide if a distractor was seen in the study list, people make a decision based on familiarity. When a distractor appears for a second time in the test-list it gives rise to the same feeling of familiarity as a target: subjects can no more make their decision on familiarity. They have to remember when they saw this word, i.e., they have to make a source judgment. With an efficient mechanism of inhibition, people can inhibit the distractor after it has been judged the first time. Then, at a second presentation, they have an index to know that it was a distractor. When it is not the case, they would be more susceptible to judge it as a target. We compared the performance of young and old adults in a recognition test in which some of the distractors were repeated twice. We observed that older adults make more false source attributions than younger, despite their good recognition scores. Though older people have a good recognition memory, they have a poor contextual memory. A less efficient inhibitory mechanism can also contribute to explain this effect. False recognitions reveal a deficiency in familiarity judgment. Then, the elderly appear to have a general deficit in retrieval that can be explained by an impairment of deliberate recollection.

Central executive, phonological loop and text composition: An experimental attempt to explore writing processes with secondary tasks

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This research examines the distribution of the composition processes within the on-going activity of writers as regards the assumptions we can make about the way they imply the different working memory components (Baddeley, 1986). Text composition is considered as a very complex activity within which two kinds of processes may be distinguished. The first involve conceptual choices related to communication goals, text content generation, selection and organisation; these planning processes are highly strategic. The second, dealing with sentence generation and revision, are more concerned with using and managing linguistic units.

Whereas the latter certainly make a large use of the phonological loop, the former is assumed to be the most demanding for the central executive. This study is a first attempt to use concurrent tasks in order to specify the contribution of those two types of processes within the temporal parameters of text production. Three groups of adult writers compose an expository text about a simplified map while performing one of three concurrent tasks: 1/ control secondary task (tapping with foot), 2/ phonological loop disruption (uttering "bla") or 3/ central executive disruption (random digits generation). During text production, pen movements performed upon the paper were recorded with a digitizing tablet. The recording program allows us to monitor the interactions of three sources of information: the map, the writing assignment and the text produced. On the basis of the map structure, products are analysed and segmented into semantic blocs. Data are currently being gathered. The effects of secondary tasks will be examined as regards idea generation and organisation, linguistic accuracy of the formulation, and pause duration (related to their location in the text and to the nature of the activity the writer engages in).

Exploring the development of the rehearsal strategy

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Two experiments are reported which vary the ways in which memory span is assessed. In the first experiment, words (presented auditorily) or pictures (presented on a computer screen) are presented in short sequences (3 to 6 items). The subject is then probed with a single item and required to indicate, on a touch screen, where the item appeared in the sequence. In the second experiment the same sequences are presented, but the entire sequence has to be repeated by the subject, again using the touch screen. Errors and response times are recorded. Subjects were 4-, 7- or 10-year-old children, or adults. The purpose of the experiments was to infer, from serial position curves and presence or absence of the word length effect, to what extent verbal recoding and/or rehearsal occurs across these tasks, and to chart its developmental sequence. Results indicate that word length effects can appear even in very young children, though serial position effects characteristic of adults (i.e. showing primacy and recency) appear only in older children.

Does working memory play any role in adults' mental multiplication?

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What kind of cognitive processes can be used in solving a multiplication sum such as 9 times 6? First it is possible to retrieve the answer 54 directly. Alternatively, one could rely on mental calculation, like repeated addition (6+6+6+6+...), counting by n (6,12,18,...) or deriving

facts ($10 \times 6 = 60 - 6 =$). We investigated the influence of the working memory subsystems phonological loop and visual-spatial-sketchpad (Baddeley & Hitch, 1974) by using a dual-task paradigm. Subjects were asked to solve a multiplication sum while carrying out different concurrent tasks. These secondary tasks were: irrelevant speech for disturbing the function of the phonological loop, visuo-spatial tap tracking for disturbance of the visuo-spatial sketchpad and neutral tapping as a measure for effects of an unspecific concurrent task. Solution times and error rates were observed. In the first experiment 48 adults solved 128 easy ($2 \times 4 =$) and hard ($7 \times 9 =$) sums from the times table. Four experimental conditions (control, neutral tapping, irrelevant speech and tap tracking) were contrasted in a within-subject design. Effects for easy and hard sums were reliable, but we did not find any effects of the concurrent tasks. The 80 sums of the second experiment were more difficult ($8 \times 17 =$). Design and conditions were comparable to the first experiment. The sample consisted of 24 adults. Unexpected effects of the interference conditions could be observed. Hence, there are several open questions about the role of working memory in adults mental multiplication which finally will be discussed.

4.6. MEMORY

Representation of the temporal order of social episodes in memory

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Our knowledge of social episodes is represented as scripts of routine situations, events and actions. The script is a plan-like structure where the horizontal organization involves the temporal order or causal relations between component units. The investigations that I shall present concern this particular aspect of script organization. To determine the temporal order of script units I applied the method of comparing every unit with every other in terms of succession. A matrix analysis of subjects' answers showed that the representation of the order of units has complex and non-homogeneous structure. In every script there are at least two segments (chunks) in which unitary order is strictly defined. Between segments there is the certain number of single units belonging to given places, and there are as well constellations of units without a set place. Discovery of this fact has changed basically my interpretation of the degree of script misordering and its consequences at the level of memory. Misordering is not a simple displacement of certain number of units with a given number of positions in canonical order of script, but deformation of the gestalt structure. This structure supports this deformation within certain limits, by beyond these limits it breaks down or is transformed. Changes in order therefore have more of qualitative than quantitative nature. The empirical part of my paper will be devoted to comparing the effect of different patterns of misordered stories on: subjective evaluation of their coherence and sense, and capability of their recognition after learning.

Creation of false memories: The effect of clinical interpretations

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Previous studies, using a misinformation procedure, have shown that both children and adults tend to accept false information concerning an event, when the information is embedded in the post-event questions. Other studies have shown that people recognize or recall items that were never presented before; and still other results suggested that false memories can be even implanted in children or adolescents. All these data give a picture of memory as a malleable tool, that could be easily manipulated and distorted by external interventions. In this research we wanted to examine the possibility to create, in adult subjects, false beliefs about autobiographical events. We used a particular procedure in which we measured initial beliefs concerning autobiographical events and we manipulated the beliefs through an interview. Preliminary results confirm the idea of memory a highly malleable element, and give some important information on the extent to which beliefs of a valued person can modify subjects beliefs about their own past events.

Connectionist modelling of implicit and explicit memory tasks

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Recent additions to the ELAN (ELaboration and Activation Network) family of connectionist models are presented. Members of this family are initial implementations of a theoretical view concerning the implicit/explicit memory distinction. According to this view, dissociations between implicit and explicit memory performance are considered a function of different learning mechanisms (i.e., activation and elaboration learning) and the compatibility between study and test processes within a single, modularly organized and interactive memory system. As such, the architectures of these models are modular, consisting of separate but interacting representational CALM (Categorizing And Learning Module) modules for item, category, and context information, and additional modules for input and output purposes. The ELAN-2 and ELAN-3 models presented here are extensions of the initial ELAN-1 model. In the ELAN-2 model, the CALMs for representing item and context information are supplemented with a CALM representing category information. In the ELAN-3 model, the single perceptual input stream to the item CALM in ELAN-1 is subdivided into two separate streams, representing the visual and auditory input modalities. Whereas simulations with ELAN-1 were concerned with the dissociative effects of word frequency and anterograde amnesia on an implicit word-stem completion and an explicit free recall task, the new ELAN-2 and ELAN-3 members are concerned with the simulation of dissociative effects of organization and input-modality, respectively. In the ELAN-2 simulations, categorized word lists were presented in a blocked or random order fashion in a study phase. Subsequently, memory performance was tested using an explicit free recall task and both a data-driven (word identification) and conceptually-driven (category exemplar generation) implicit task. In the ELAN-

3 simulations, words were either presented in the visual or auditory modality during study and memory performance was tested using an explicit free recall task and an implicit (visual) word identification task. Initial simulation results are presented.

4.7. LANGUAGE PROCESSING

The interactive-activation model of bilingual memory: Support from noncognate interlexical homographs and nonwords

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Noncognate French-English homographs (identical orthographic items with distinct meanings in French and in English, such as "pain", "four", "main", etc.) and "noncognate" French-English nonwords (nowords derived from noncognate homographs that produce regular nonwords in both languages — for example, "appaint", "ligs", "monce", derived from the bilingual noncognate homographs, "appoint", "legs", and "mince") are used to study bilingual memory organization. Particular attention is paid to reaction times to "unbalanced" homographs and nonwords, i.e., homographs with a high frequency in one language and a low frequency in the other and nonwords with a large orthographic neighbourhood in one language and a small neighbourhood in the other. First, bilingual lexical access is shown to be compatible with a model of parallel self-terminating search through independent lexicons in which the search speed through a lexicon is a function of the overall activation of that lexicon. This model seems to effectively resolve a number of conflicts between word-naming data, which seem to support a dual-lexicon hypothesis, and interlexical priming data, which seem to favour an overlapping, distributed organization of bilingual memory. We then show that this particular independent-lexicon model is functionally equivalent for word recognition to a distributed interactive-activation model. Most significantly, we then consider reaction times to a particular set of "noncognate" interlexical nonwords to differentiate the two models. A distributed, interactive-activation model can account for this nonword reaction-time data; an independent-lexicon model cannot. We conclude with evidence from a variety of other priming studies that provide further support for the distributed interactive-activation model of bilingual memory.

Reading efficiency for stationary vs. gliding texts: Developmental aspect

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There is evidence (Krischer et al., 1995; Pavlidis, 1989) that some problems of beginner readers can be overcome by providing them texts in one-line sequential or gliding mode. It was supposed that one-line reading does not need more involuntary gaze control and, thus, is free from one potential source of words decoding interference. On the other hand, one can expect that relative efficiency in reading of normal stationary and one-line sequential texts is changing with developmental reading skill mastery. In the present study we measured oral and silent reading rate in children of 7 to 16 years old (2 - 11 grade) while they were presented stationary and gliding texts. The latter mode of presentation was based on original computer software (Belopolsky, Dubrovsky, 1994) and allowed us to obtain the threshold data. The search for a target word was used as a control task. It was found that reading rate increased with age, and silent reading was more fluent than oral reading. Gliding text had an advantage over a stationary one during oral reading but their relative loads were inverted for silent reading. The beginners only read stationary text more slowly than gliding but skilled readers showed the opposite trend. Irrespective of an age of the reader his or her search rate exceeded their reading rate in the same conditions by 20-30 wpm. The high level of the range correlations over all reading conditions give us some information about individual stability of obtained individual data patterns. The results, combined with error typology as well as comprehension control data, were analyzed in the context of developmental reading strategies.

The use of verb control information in sentence processing in Spanish

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We will present the results of the experiments we are currently running, that deal with how and when verb control information is accessed and used by the parser in the process of establishing the relationship between PRO and the element that exercises control over it. The studies we will report examine the influence of verb control information in the processing of PRO, using the cross modal priming paradigm. We use two types of experimental sentences: 1) Subject Control Sentences, and 2) Object Control Sentences. See the following examples: 1. a. SUBJECT CONTROL: El chico (Subject) le aseguró (Verb) a la profesora (Object) (PRO) haber (Infinitive) llamado (Past Participle) al entrenador (Object). (direct translation: The boy assured the teacher to have called the trainer). 1. b. OBJECT CONTROL: El chico le agradeció a la profesora (PRO) haber llamado al entrenador. (direct translation: The boy thanked the teacher for having called the trainer). The sentences only differ in the matrix verb. The interpretation of the infinitival complement depends on the information associated with the matrix verb. Whereas, in 1. a. the understood subject of the infinitival complement is the subject of the main clause, in 1. b. the understood subject of the infinitival complement is the object of the main clause. If we assume, following Tanenhaus and colleagues, that verb

control information is rapidly accessed and used by the parser, then we will find a difference between the degree of activation of the two possible elements, as soon as the system has found the infinitive. If verb control information only comes to play later, then, following Frazier, we will find an initial advantage of the object over the subject, because the system will be constructing the structure proposed by the Most Recent Filler Strategy.

The probability, but not the time course, of predictive inferences is affected by emotional factors

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According to current models of inference processing in comprehension (e.g. McKoon & Ratcliff, 1992; Graesser, Singer & Trabasso, 1994), predictive inferences are unlikely to occur automatically on-line during reading; rather, they would be drawn strategically and with delay. We examined the hypothesis that emotional factors (subjects' anxiety level and the description of threat events in the materials) would (a) increase the probability of predictive inferences, and (b) speed up their time course. Subjects high and low in test anxiety were presented with sentences describing neutral or threat events. A target inference sentence was either primed or not primed by a previous sentence. Subjects read the sentence at their own pace with a moving-window procedure. There was facilitation when reading target sentences confirming threats for high-anxiety subjects, thus reflecting activation for the inference concept. The interaction between anxiety and threat material reveals that the probability of predictive inferences increases as a function of emotional factors. In contrast, the fact that this effect was observed in the post-target region, but not in the target word itself, reveals that the inference process does not occur automatically, but with delay; therefore, the time course is not affected by the emotional factors.

Gender processing in French nouns: Evidence from lexical decision and eye movement experiments

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Grammatical gender represents an important phenomenon in French: nouns, adjectives, and articles are either masculine or feminine. Adjective and article gender is generally marked by the presence or absence of a terminal -E (e.g.: joli-joliE). However, concerning nouns, the picture is less clear because 89% of them possess an arbitrary gender which is not so closely related to the presence or absence of a final-E. Nevertheless, Tucker, Lambert, and Rigault (1977) have shown that the orthographic correspondent of the final phoneme can sometimes be informative as to noun gender (e.g.: words ending in -AT are predominantly masculine),

and other times uninformative (e.g.: the letter sequence -TE appears more or less equally in masculine and feminine nouns). In three experiments, using classical reaction times and eye movement recording, we examine the role of grammatical gender in word recognition by manipulating the information conveyed by endings of masculine and feminine nouns presented in isolation. Two types of orthographic cues were selected: the final letter (presence or absence of -E) and the orthographic correspondent of the last phoneme (informative or not). Taken together, these two orthographic cues can give either congruent or incongruent gender information. For example, although -E is predictive of feminine, -GE is predictive of masculine. The results showed that the processing of feminine nouns seemed to be affected only by the final letter. On the contrary, the processing of masculine nouns seemed to be influenced by the two orthographic cues. More precisely, we observed an effect of informativeness of the orthographic correspondent of the last phoneme only for masculine nouns ending in -E. The locus of intervention of these orthographic cues of gender during recognition processes is discussed.

Effect of a sonority hierarchy on the visual identification of syllables in French first graders

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Learning to read involves an automatic mechanism that maps letters to sounds in order to recover phonological codes in memory. However, following a principle of contrast, phonetic features are likely to influence the visual identification of syllables: a large difference of sonority between syllabic constituents should facilitate phonemic assembly. On the other hand, the principle of contrast may not apply if pronunciation of frequent orthographic strings is directly accessible by a lexical route. We conducted a study in which French first graders (N=25) were required to identify Consonant-Vowel syllables displayed for 42 ms and followed by a mask. An interaction between sonority contrast and orthographic frequency was observed: only low-frequency syllables were sensible to the facilitatory effect of sonority contrast. On the other hand, sonority contrast and orthographic frequency had no effect in a reading task performed without temporal constraints. These findings suggest that it is possible to assess the connection weights between graphemes and phonemes by means of a visual masking paradigm. Moreover, the absence of a sonority hierarchy on high-frequency syllables could be taken as an indication of the kind of orthographic units used by beginner readers.

The role of second degree neighbours in visual word recognition

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It is now generally accepted that orthographic neighbours of a target word, mainly higher frequency neighbours, play a role in its visual recognition. We assumed that the neighbourhood relationship between the different higher frequency orthographic neighbours of a word, called second degree neighbourhood relationship, may also play a role in the visual recognition of the target word. Three lexical decision tasks were conducted in order to investigate this issue. The second degree neighbourhood relationship was manipulated by considering the absence or presence of a neighbourhood relationship between the only two higher frequency orthographic neighbours of a word. For example, the neighbours of *firme* (*ferme* and *forme*) are considered as second degree neighbours whereas the neighbours of *foire* (*faire* and *boire*) are not. The same words were used in the 3 experiments. The difficulty of the word - pseudoword discrimination was manipulated across the 3 experiments by varying the pseudoword neighbourhood characteristics (respectively null neighbourhood, mixed neighbourhood and large neighbourhood). In experiment 1 the word - pseudoword discrimination was easy. Results showed that stimuli reaction times were slower when the two neighbours were themselves neighbouring than when they were not. Experiment 2 and 3 used, respectively, a difficult and a very difficult pseudoword context. Results showed that reaction times and error rates for words increased but pseudoword context did not modify the pattern of the second degree neighbourhood effect observed in experiment 1. All together, these findings suggest that second degree neighbourhood relationship can affect word recognition. Results are discussed in the framework of the interactive activation model (McClelland & Rumelhart, 1981).

Information and processing from deductive mental models among dyslectic readers

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The previous eye movement recordings of reading earlier in the late seventies and early eighties found that dyslectic readers had more fixations and more regressions during reading. Research-findings in the seventies and eighties concluded that fixation span, recognition and scanning behaviour played an important role due to reading problems concerning dyslectic persons. With more sensitive recording systems there may be a new side of this classical impossibility of a dyslectic person reading. There was made a new setting where the reader was going to judge different deductive propositions made out of a new artificial language called 'PegLeg'. One group of normal readers were compared with another group of dyslectic readers. They were diagnosed by an ordinary discrepancy definition. The findings concluded that the dyslectic readers did not cope well when reading complex deductive problems because all read information were processed as equal. On the other hand there was no difference during

'easy-reading' tasks between the 2 groups. Regarding to Frege's notions about function and argument, we concluded that the dyslectic reader was not capable of distinguishing between the sentence's logical function and the argument. There are many errors included in such a quasi-design; we cannot induce dyslexia and we have not taken account of the eye-mind delay in relations to reading vs. understanding. This may however be a new contribution to distinguish dyslectic and normal readers with new scientific eye movements equipment, in an old field of research.

Effects of orthographic similarity in a translation verification task

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In a series of studies we have investigated the effects of semantic similarity and the effects of orthographic similarity in a translation verification task. In this paper we will focus on orthographic similarity, operationally defined as the number of letters two words have in common. We hypothesised that during the translation process words in L2 that are orthographically similar to the correct translation are activated to some degree. If so, we should expect some interference effects to occur. In the Experiment, pairs of words were selected, one in Italian and the other in English. For each item, in addition to the correct translation there were three conditions varying for the degree of orthographic similarity between the distractor and the correct translation. For example, for the word *fiore* the four pairs were *fiore-flower*, *fiore-flow*, *fiore-fire*, and *fiore-cloud*. The percentage of shared letters in the high, medium, and low similarity conditions was .55, .33, and .22 respectively. The word pairs were shown on a computer screen and subjects were asked to judge as fast as possible if the words in each pair were or were not correct translations of each other. Both reactions times and errors were recorded. The pattern of reaction times and errors was affected by the degree of orthographic relationship: With respect to the correct translation, the high, medium, and low similarity distractors were 185, 81, and 37 msec slower. The results are discussed with reference to current proposals about the distinction between cognate and non-cognate words.

Static and dynamic approaches to letter perception

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Recently, Snodgrass and Mintzer (1993) proposed the fragmentation technique as a new tool for studying visual word recognition. In the present study, we use this novel technique to investigate issues concerning similarity and confusability in letter recognition. In experiment 1, a letter is presented in a highly fragmented form and participants gradually demask it until they are able to identify it. Identification thresholds are the critical dependent variable. In experiment 2, a letter is presented at a fixed level of fragmentation and participants "guess" its

identity. Identification errors are the critical dependent variable. Two classes of models are adapted to account for the data. The static mathematical models (distance density and feature matching models) provide a quantitative and analytic description of letter similarity and confusability. The dynamical, computational models (interactive activation and resonance models) complement the static, mathematical models by specifying possibly underlying mechanism.

Sentence context and attentional window in visual word recognition

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In reading, prior context that validly predicts a word increases the speed and accuracy of identifying that word. The present study investigates whether the effect of a semantically constraining sentence occurs at an early stage of the processing of a target word, and operates on the adjustment of the size of the "attentional window". In our experiment, sentences were presented a word at a time, the first words persisting on the screen until the sentence was complete. Forty-eight subjects read silently the sentence and made a lexical decision on the last stimulus. Half of the target words were strongly predictable; some of them were short words (mean: 3.3 letters), others were long words (mean: 7.5 letters). Half of the target words were incongruent, some of them containing the same number of letters as the predictable word, others containing either more or less letters. Data showed that the lexical decision latency on a long incongruent word was longer when it was substituted for a short word than when it was substituted for a long one. This suggests an influence of the semantic context on an early pre-lexical aspect of the word recognition process. In contrast, the latency for incongruent short words was not affected by the length of the predictable word. It was hypothesized that short words did not involve a modification of the size of the attentional window. Forty different subjects participated in each experiment. Two experiments consisted of two-letter stem completion tasks, one with congruency between the stem to complete and the first syllable of the word, the other without congruency. The two other experiments consisted of three-letter stem completion experiments, one with congruency, the other one without congruency. Significant priming effects were observed in all experiments. However, more priming was observed for three-letter stems than for two-letter stems, and more priming was observed in the case of congruency between the stem to complete and the first syllable of the word. These results show that priming depends on the amount of information that is shared between the prime and the stem, and suggest that French visual words are processed and stored in long-term memory in terms of syllabic units.

On integrating letter strings during reading

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Processing of letters during visual word recognition is usually considered as parallel in normal subjects and serial in pure alexics: The hallmark of pure alexia, an acquired reading impairment due to temporo-occipital brain lesions, is "letter-by-letter" reading. In a double approach (normal subjects vs. a pure alexic patient), we attempted to isolate some of the factors that underlie parallel processing of letter strings in normals. To this end, reading performance of normal participants was contrasted with performance of a pure alexic patient. Our results show that for both normal participants and the patient, processing of letters in words can be parallel or serial, depending on the visuospatial format of words.

Cross-modal transfer in word recognition

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Two cross-modal experiments have been carried out in order to test the hypothesis that phonological representations activated by visual masked primes are available to facilitate a subsequent auditory processing. In a lexical decision task, auditory targets are responded faster when preceded by briefly presented forward-masked identical visual primes than when preceded by non-related visual primes. The exposure of the prime was rapid enough (37 ms) to prevent the identification of primes. Two different ISI were used to explore the time course of this activation. At 0 ms of ISI, a cross modal repetition effect was observed for high frequency words and medium frequency words whereas at 150 ms of ISI, the results failed to yield a repetition effect although a tendency was still observed for high frequency words. This finding suggests that phonological representations activated by a briefly presented forward-masked prime can be available to facilitate the following processing of an auditorily presented target word, and underlines the necessity to take into account activation flow between orthographic and phonological representations in models of word recognition.

The role of morphology in the French mental lexicon

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In our study we investigated the lexical entry for morphologically complex words in French. Our experiment, using a cross-modal repetition priming task (auditory prime - visual target), asked whether the lexical entry for derivationally suffixed and prefixed words is morphologically structured and how it is related to the phonological transparency of the surface relationship between stem and affix. We observed different patterns of results for prefixed and suffixed words. We found that prefixed words primed their stems independently of phonological transparency (e.g. 'relancer' primed 'lancer' and 'imberbe' primed 'barbe'); whereas suffixed words primed their stem only if the stem was transparently contained within the derived word (e.g. 'frontal' primed 'front' but 'digital' did not prime 'doigt'). The important idea for the interpretation is the sequential delivery of stimulus information in the auditory domain, with the consequences it has for the processing of prefixed as opposed to suffixed words (with their different ordering of stem and affix). We assume that suffixed words activate a particular Cohort that corresponds to all regular suffixed members of the morphological family; on the other hand we assume that prefixed words are not pre-lexically decomposed but post-lexically decomposed because of the salient transparency of prefixation in French language. So we make the assumption that the difference between prefixed and suffixed words is due to French language structure and that lexical entry of prefixed word are word-based, while lexical entry of regular suffixed words are morpheme based.

Suprastructural and macrostructural planning and control in oral and written communication

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This work arises from previous research in which we checked that differences between oral (listening/speaking) and written (reading/writing) communication only influence semantic transformations leading from microstructure to textual macrostructure. On the contrary, we did not find influence on structural recall. We have argued that the familiarity of textual structure (children read and hear more narratives than all other types of extended discourse during their preschool and elementary school years) could be acting as an implicit aid, leading to no significant differences between both presentation (listening/reading) and production (speaking/writing) modalities. To investigate this, we conducted this second study where we present an explicit macrostructural aid. It consisted of a macrostructure appearing as the first sentence of each paragraph. In this way, our objectives were achieved if the aids about the story structure and about the macrostructure cancel the differential effects of presentation and production modalities. We used a sample of 40 children from a 5th grade group (about 10-years-old), randomly divided into four groups: G1 (listening and speaking condition); G2

(listening and writing condition); G3 (reading and speaking condition); G4 (reading and writing condition). The combination of these four groups produced a between-subjects 2x2 design. The levels of dependent variables were determined by measures based on Kintsch & van Dijk's model (literal recall, omissions, additions, confusions, and generalizations, construction, integration and deletion macrorules), and Thorndyke's model (frame, theme, plot and resolution recall). Two multifactorial analyses of variance (ANOVA) of total accuracy score, one in micropropositional and other in story grammar measures, were performed. The first, did not reveal main effects of the two factors. The second, only revealed main effects of two factors in resolution recall. Thus, we confirmed our hypotheses: all aids tested proved to be efficient for listeners, readers, writers and speakers, cancelling the modality differences. Because of this, we could reject the idea that there are no differences in reading comprehension strategies and structural recall in relation to presentation and production modalities in school age children; at least, when they receive information about macro- and textual-structure.

A study about the relationships between the identification and construction of principal ideas

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The aim of this work is to study the identification of principal ideas through underlying structures (identification task) and summary texts (construction task). We used a sample of 40 average-primary school children (mean age: 10,5 years-old) randomly selected. The levels of dependent variables were determined by measures based on the number of underlying principal ideas and on the number of principal ideas appearing in the summary (literal recall or through the use of generalization, construction, deletion or integration macrorules, according to Kintsch and van Dijk's model). Results showed significant differences in the principal ideas identification in relation to the type of measure. Because of this, we could argue that the input and output strategies are different: that is, subjects are able to identify through the underlying structure the principal ideas, but the same children have problems writing these ideas when they have to write them. The problem could be found in the rules or strategies that lead from reading comprehension to the written production.

4.8. „HIGHER“ COGNITIVE FUNCTIONS

Elimination and inclusion procedures in judgment

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Under uncertainty, one could answer a question either by selecting the best choices from an initial set of alternatives or by eliminating the least unlikely choices from this set. Invariance implies that both procedures should result in the same final subset. In two studies, individuals answered questions using either the include or eliminate procedure. One study involved making interval estimates on a continuous scale. A second study involved choosing from a discrete list of items. We found that the included subset and eliminated subset were not complementary. This "sub-additivity" was particularly strong when the choices were from a discrete list. Also, accuracy (hit rate) was greater under the elimination procedure. This result suggests elimination as a practical method for increasing the accuracy of judgment under uncertainty. A possible explanation for the findings is that in inclusion, people select only items they believe are likely to be the correct answer. In elimination, people eliminate only items they believe are not likely to be the correct answer. The underlying cognitive process presumably involves evaluation of the reasons and confidence for inclusion/elimination of each choice separately. Therefore choices about which a subject has no strong confidence remain included (by default) under the elimination procedure; however, they remain "un-included" (by default) under the inclusion procedure. Thus the very same evaluation process generates different selections depending on whether one subtracts from the full set or adds to a subset.

Pragmatic factors in conditional reasoning

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We have investigated the importance of the pragmatic factors in conditional reasoning. The performance of 54 subjects, with the four basic inferences of modus ponens (MP), denial of the antecedent (DA), affirmation of the consequent (AC) and modus tollens (MT), on the usual three-response format, was examined. The empirical relation in the world between the antecedent and consequent of the premises on the conditional arguments (probabilistic, deterministic and without relation) and the availability of the scenario were manipulated. The results showed that: a) The availability of the scenario is not sufficient by itself to explain differences in performance, but affect the subjects' degree of confidence in their conclusions, b) There is an interaction between availability and the logical structure of the rules on the correct performance. The results support the semantic theories of conditional reasoning and are not consistent with theories based on formal rules of inference.

Individual cognitive strategies and differences in personality traits

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The purpose of this paper is to illustrate the role of personality traits on individual problem solving strategies. It is well known that traits such as anxiety, extraversion, motivation, and so on, affect cognitive performance in various tasks (learning, memory, verbal comprehension...). Recently, some authors have assumed that personality traits have also an effect on individual strategic behaviour in problem solving tasks (Kossowska, 1994; Rolland & Lautrey, 1995). In a study centred on the individual strategies used in a complex spatial task, a relationship has been observed between the scores obtained in personality questionnaires and the time allocated to the successive stages of the task. For example, in this task, the subjects could see the stimuli as many times as they wanted before giving their responses; the subjects who most often used this opportunity obtained the highest anxiety scores and the lowest self-esteem scores, although they had high working memory capacity, as well as high visual memory capacity. From these results, it is concluded that a) different subjects spontaneously adopt different processing strategies; b) and personality traits affect the strategy choice, even in tasks requiring minimal cognitive involvement. Another study has been planned in order to investigate the relationship between personality traits and time allocation strategies in a task (a verbal reasoning task), which subjects generally assume to measure verbal intelligence.

Cognitive failures due to ignorance

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Cognitive failures of everyday life due to ignorance have not been investigated in a systematic way. This research aims to examine the mistakes due to lack of knowledge committed by university students in their everyday life. In this research 218 students from the faculty of philosophy were examined in three groups. Of these subjects 33 were male (mean age 20.3 years) and 185 were female (mean age 19.1 years). Each subject was asked to describe a mistake recently committed in everyday life, and to respond to the following questions: 1) When was the ignorance failure committed? 2) What was the right thing to do which you failed to do? 3) What was ignored which led to the failure? 4) Under what conditions was the mistake committed? 5) When did you discover the mistake? 6) What were the consequences of your mistake? The failures that were selected were classified on the basis of frequency into categories for each sex. The responses were also analysed in relation to the time of occurrence, conditions and consequences. The results are discussed on the basis of a general theoretical framework concerning ignorance and the cognitive failures due to ignorance.

Cognitive uncertainty: Evidence for simultaneous activation of different processing modes

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Although many psychologists favour unitary models of cognitive development, our research emphasizes a pluralistic approach. This recent approach assumes that, in many situations, individual performance is determined by different processing modes that are activated simultaneously, with different weights for different individuals and for different situations (Lautrey, 1990). Furthermore, the resulting interaction may be one source of cognitive development. A literature review justifies the use of the conservation notion to investigate these issues. To account for the development of conservation, the nature of an unique process was much debated in the 1960's. A synthesis of this controversy leads to two hypothesized information processing modes: (a) an analytic treatment of the object dimensions that are subject to change (Piaget & Szeminska, 1941), and (b) a generalization process based on the object qualitative identity (Bruner, 1966). The pluralistic processing hypothesis was investigated with a probabilities procedure (Acredolo & O'Connor, 1991). Subjects are two groups of non-conserving children (mean age: 5;5), who differed on their dominant processing mode («a» or «b»). In modified conservation tasks, toy characters endorsed one of the three alternative answers (more, same, less) as his best guess. Subjects were asked to use a 5-point scale to rate the likelihood that each character has guessed correctly. The results confirmed our hypotheses of pluralistic processing and showed differential task performance depending on the subjects' dominant mode of processing. Cognitive uncertainty (doubt and dissonance) is more often observed in the group of subjects in which processing mode «b» receives greater activation.

Mental accounting and motives for saving and consumption

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How people cognitively describe decision outcomes is the focus of much research. Mental accounting refers to a process of categorizing outcomes (Henderson & Peterson, 1992; Tversky & Kahneman, 1981). In this vein, the economic self-control theory of Shefrin and Thaler (1992) assumes that people classify assets in three mental accounts: current income, current assets, and future income. The present research attempted to validate these three mental accounts which may provide an understanding of decisions as a function of changes in asset positions. An experiment was performed in which undergraduates made fictitious choices between paying for a good in cash or according to a more expensive instalment plan. In different conditions subjects were told that their income was less, the same, or higher than usual. At the same time they were supposed to have an amount saved which made their total assets equal in all conditions. As was predicted from the mental accounting theory, the propensity to pay in cash was lower when subjects had to use savings (current assets) compared to using money from the current-income account. It was, furthermore, predicted that introducing dif-

ferent motives for saving and for consumption would lead to an increased willingness to use savings if these motives corresponded. This prediction was only partly supported. If savings was a buffer for unforeseen emergencies, the propensity to use savings was higher for replacing something broken than for buying something desired for a long time. However, if the motive for saving was to attain a desired goal, the willingness to use savings did not differ for the two consumption motives. As a possible explanation of the results, it is suggested that subjects impose a limit on what have to be left of these savings, and that this limit differs for the two saving motives. The results thus confirmed that different mental accounts exist and directly influences decision making.

Effects of prior outcomes in risky decisions related to changes in perceived probabilities

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When prior outcomes in a sequence of decisions are experienced, they may be either integrated or segregated in the evaluation of the current decision. A number of factors accounting for whether one or the other occurs have been proposed. One possibility is that subjects integrate/segregate in order to maximize value (Linville & Fischer, 1991; Thaler & Johnson, 1990). In earlier studies we found evidence for a different integration principle (loss-sensitivity), stating that a prior outcome is added only to expected losses. Another possibility is that prior outcomes may also influence the perceived probability of a subsequent outcome. Thus, after a gain people may be more optimistic about winning and less pessimistic about losing. This phenomenon has been referred to as the gambler's fallacy or the "hot-hand" effect (Gilovich & Vallone, Tversky, 1985). By varying the uncertainty of the probabilities of the current outcomes in an experiment, subjects changed the weight they place on the future gains and losses. As predicted, the results showed more integration of the prior outcome when the probability was defined as a range and subjects were also more likely to gamble after a prior gain and less likely after a prior loss. Such effects would add to those of integration of the prior outcome.

Sequential versus parallel models of analogical reasoning and individual differences in human cognition

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Sternberg's (1977) model of analogical reasoning assumes the sequential nature of the cognitive process underlying analogy solution. Also, it does not take into account the individual parameters of memory and attention, which seem to influence both the process of analogical reasoning and the relation of this process to psychometric intelligence. Trying to avoid these faults, a new model of analogical reasoning is outlined, which introduces two formal parameters of the cognitive system's functioning: (1) parallel versus sequential information processing and (2) linear versus non-linear allocation of attentional resources. Three computerized tasks were used in the verification study. First, a non-verbal analogical reasoning task was constructed according to the dual-task paradigm. A series of nonverbal analogies (primary tasks) was accompanied by a simple psychomotor task, whose performance served as an index of the amount of attentional resources which remained after feeding the primary tasks. Task difficulty, sequential or parallel mode of display of the task's elements, as well as the exposition time, were systematically manipulated. Second, a selective attention task was used in order to estimate the magnitude of one's attentional resource pool. Third, Saul Sternberg's task was applied as a test of one's short term memory capacity. Raven's Progressive Matrices were also used as a psychometric measure of intelligence. The data are being analyzed at present.

Attentional resources, cognitive control, and creativity

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There is a substantial body of evidence showing that general intelligence is related to the increased capacity of attentional resources. As to creativity, though, the evidence is less clear, and the predictions are sometimes contradictory, depending on the accepted model of creativity or, maybe, the phase of the creative process. The author's own research shows that creativity, assessed by means of psychometric tools, may be negatively correlated with dual-task performance. At the same time, there are some preliminary data suggesting that creativity may be positively correlated with level of cognitive control, measured by typical interference tasks (Stroop, Navon). Since these preliminary data are accidental, the present study aims at systematic investigation of the problem of the attentional correlates of creativity. A battery of creative thinking tests is accompanied by three experimental tasks to measure various aspects of attention: the DIVA task, previously exploited in the study of intelligence, and the modified versions of the Stroop and Navon tasks. The data are now being gathered, and the results will be discussed in terms of the competing theoretical models of creativity. The general idea is to discover the cognitive bases of this trait, as has already happened in the case of intelligence.

CHAPTER 5

The Würzburg School

Texts from the exhibition presented during the Conference in appreciation of the 100th anniversary of the foundation of the Würzburg School

*Arranged by Joachim Hoffmann, Armin Stock and Roland Deutsch**

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Some of the quotations are taken from J.M. Mandler & G. Mandler, *Thinking: From Association to Gestalt*. New York: John Wiley & Sons, 1964, and G. Humphrey, *Thinking*. London: Methuen, 1951, pages 30 - 315.

5.1. THE FOUNDATION OF THE WÜRZBURG SCHOOL IN 1896

In 1894, Oswald Külpe was appointed professor of philosophy and aesthetics at the University of Würzburg. Two years later, in 1896, together with Karl Marbe, he founded an institute of psychology modelled on the Wilhelm Wundt Institute in Leipzig, where he had worked with Wundt from 1887 to 1894. One of the main subjects of research at the Würzburg institute was the examination of thought processes and their control by volition. Subjects (usually colleagues at the institute) were given simple tasks to make them think: for example, they had to add two numbers or say whether they had understood a sentence such as

„One should not look for the rogues among the criminals but among those who do not commit crimes“. („Unter den Verbrechern soll man nicht die Schufte suchen, sondern unter denen, die nichts verbrechen“).

In addition, the subjects were asked to describe the processes preceding their answers as precisely as possible. An analysis of these experimentally induced self-observations led the experimenters to conclude that the thought processes observed could not be explained as the result of associative connections between images alone. Rather, they believed that there were *imageless factors* which imparted a direction to the thought processes and determined their course. These considerations were in sharp opposition to the prevailing associationism at that time and were attacked vehemently by its followers, Wilhelm Wundt in particular. It is probably as a result of this at times passionate dispute that the concepts developed at the Würzburg institute evolved into a school of psychology and the methods used to analyse the factors which determine the structure of thought processes were increasingly refined.

Oswald Külpe and Karl Marbe as well as Karl Bühler and Narziß Kaspar Ach were the main figures behind the movement known as the Würzburg School. Otto Selz, who had worked under Oswald Külpe when he taught in Bonn, joined them later. The work of these researchers played an important role in establishing the analysis of „complex“ mental processes with direct experimentation as an integral part of psychological research. Thus they have helped to lay the foundation for today's cognitive psychology.

Other co-workers at the Würzburg institute:

Henry Jackson Watt (1879 - 1925)

August Messer (1867 - 1937)

Johannes Orth (1872 - 1949)

August Mayer (1874 - 1951) as well as

Ernst Dürr, Adolf Grünbaum, Johannes Lindworsky, Friedrich Schulze and Charles Taylor



Oswald Külpe (1862 - 1915). In Würzburg (1894 - 1909)

5.2. OSWALD KÜLPE

Born: 3 September, 1862, in Candau.

- 1881 Went to the University of Leipzig to study history and philosophy. Became more interested in philosophy and experimental psychology after attending Wilhelm Wundt's lectures.
- 1882-1883 Studied in Berlin (in particular history under Mommsen und Kirchhoff).
- 1883-1885 Studied in Göttingen under G.E. Müller, who inspired his work on „sensual feeling“.
- 1886 Returned to Leipzig and worked on his dissertation for Wilhelm Wundt.
- 1887 PhD „On the theory of sensual feeling“.
- 1887-1894 Assistant at the Institute of Psychology in Leipzig.
- 1888 Postdoctoral thesis on „The theory of will in modern psychology“.
- 1894-1909 Professor of Philosophy and Aesthetics at the University of Würzburg.
- 1896 Founded the Institute of Psychology in Würzburg together with Karl Marbe.
- 1909-1913 Professor in Bonn.
- 1913-1915 Professor in Munich.

Died: 30 December, 1915, in Munich.

Külpe's most important contribution: The extension of the subject of experimental psychology

For Wilhelm Wundt only the simpler psychical processes of sensation and presentations (*Vorstellungen*) could be analysed by experimental study. In his opinion, access to the higher psychical processes could only be obtained by using the comparative methods of ethnic psychology. In 1909, in „Grundriß der Psychologie“ (Outlines of Psychology) he wrote (p. 29):

„Thus, psychology, like natural sciences, has two exact methods: the first, the experimental method, serves to analyse the simpler psychical processes; the second, the observation of general mental products, serves the investigation of the higher psychical processes and developments.“

His pupil Külpe, however, came to the conclusion that an application of experimental methods was also possible for the investigation of higher psychical processes - in particular thinking. He encouraged procedures for the controlled induction of such processes and their systematic self-observation and thus opened up psychological research to areas such as judgement, knowing, understanding and interpreting. Looking back, in his work „Über die moderne Psychologie des Denkens“ (On the modern psychology of thinking) (1912, p. 1077), he wrote:

„What finally led us to a different theory in psychology was the systematic application of self-observation. It used to be common not to have the subjects report after the experiment on everything they had experienced during the experiment. Thus only a rough

picture was obtained. In addition, the use of the common conceptions of sensations, feelings and presentations prevented the subjects from noticing and naming what was neither sensation, feeling nor presentation. As soon as we began to make people experienced in self-observation to give a complete and impartial report immediately after the experiment on what they had experienced during the experiment, the necessity for inventing new conceptions and definitions became obvious. One discovered in oneself procedures, states, directions and acts which did not fit in with the system of older psychology. The subjects began to speak in the language of life and assign less importance to the presentations for their inner world. They knew and thought, they judged and understood, they grasped the meaning and saw connections without receiving any real help from occasionally occurring imagery.“

Why there nearly was no Würzburg School!

In 1894, the chair for philosophy and aesthetics in Würzburg became vacant and the commission first decided on Theodor Lipps as Johannes Volkelt's successor. As Lipps had already been offered a post in Munich, there seemed little point in offering him the chair in Würzburg. The next candidate was Prof. Falkenberg from Erlangen. It was only when he declined the Würzburg chair that Oswald Külpe was offered it. Later, in 1913, Külpe became Lipps' successor in Munich.

The most important pupils

In addition to the members of the Würzburg School, several world-renowned psychologists did dissertations for Oswald Külpe or worked with him for a time. Among them were Max Wertheimer, Kurt Koffka, Richard Pauli, Albert Michotte and Charles Spearman.



Karl Marbe (1869 - 1953). In Würzburg (1896 - 1905; 1909-1935)

5.3. KARL MARBE

Born: 31 August, 1869, in Paris.

- 1887 Went to Freiburg to study German, philosophy and psychology (Attended lectures by Münsterberg).
- 1890 Studied in Bonn.
- 1890-1891 Studied in Berlin (Attended lectures by Ebbinghaus).
- 1891 Studied in Paris, worked with Binet.
- 1891-1893 Resumed studies in Bonn, completed dissertation on „Untersuchungen zur psychologischen Optik und Akustik“ (Investigations of psychological optics and acoustics).
- 1893 Spent one year in Leipzig with Wilhelm Wundt, worked with Oswald Külpe.
- 1894 Worked in the private laboratory of Götz Martius in Bonn.
- 1896-1905 Lecturer in Würzburg for Külpe, with whom he founded the Würzburg institute. Postdoctoral thesis on „Zur Theorie des Talbot'schen Gesetzes“ (On the theory of Talbot's law).
- 1905-1909 Professor at the Frankfurt Academy for Social and Commercial Sciences.
- 1909-1935 Professor in Würzburg, succeeded Oswald Külpe as head of the Würzburg institute, in addition from 1926 to 1931 Director of the Institute of Psychology of the School of Commerce in Nuremberg.
- 1935 Retired.

Died: 2 January, 1953, in Würzburg.

Karl Marbe, the „inventor“ of controlled self-observation

August Mayer and Johannes Orth, who were both pupils of Karl Marbe, published the first report on the results of controlled self-observation in the „Zeitschrift für Psychologie und Physiologie der Sinnesorgane“ (Journal for the psychology and physiology of sensory organs) in 1901. The title was „Zur qualitativen Untersuchung der Assoziation“ (On the qualitative investigation of association). A stimulus word was presented to the subject, who had to react to it by saying a word out loud. Immediately after having said the reaction-word, he was asked to

„report all conscious events which had gone on from the moment the stimulus word was given to the end of the reaction.“

As the self-observations of this first investigation were not very fruitful, Marbe used tasks which were able to evoke more extensive conscious events: for example, the subjects had to determine which of two weights was heavier; to imitate the tone of a tuning fork; to answer simple questions (e.g. „How long is a foot?“ or „How many words did Anaximander write?“); or to judge the accuracy of sayings such as „One swallow does not make a summer“. The results of these investigations were published in the monograph „Experimentell-psychologische Untersuchungen über das Urteil“ (Experimental psychological investigations

of judgement) in Leipzig in 1901. In one part, Marbe expresses one of the most important theoretical conclusions (p. 43):

„The present data are quite sufficient to draw the conclusion that no psychological conditions of judgements exist regardless of the nature of the experiences which become judgements in a given case.“

and in another part he writes (p. 94):

„Thus in future one will no longer have the right to discuss problems of psychological judgement unless one is able to justify them by experiment.“

Oswald Külpe as Karl Marbe's subject

The persons examined by Marbe were, without exception, colleagues from the institute, and also included Oswald Külpe. Below are some of the original protocols.

Task	Külpe's report
Subject hears the words „Where are we going afterwards?“	Acoustic-motor pronunciation of the words „To the cafe“. But the words „Wherever you want“ competed. State of consciousness which can be called doubt.
The question „Which do you think is the most commonly used particle in the German language?“ is asked.	Reflective, acoustic - motor pronunciation of „and“. Subject has an optical picture of the written word at the same time.
Two cylindrical objects differing in weight but not in appearance have to be lifted one after the other. The one which appears to be heavier has to be turned over. The objects weighed 25 and 110 grams.	Before turning over the weight, the acoustic pattern of the word „umkehren“ (turn over) entered the subject's consciousness. (The subject did not feel any sensations apart from pressure and kinæsthetic sensations).

Marbe as an applied psychologist and methodologist

Karl Marbe was extremely interested in the problems of applied research and the development of new methods, as shown by the following selection of relevant publications:

- (1896) Neue Methode zur Herstellung homogener grauer Flächen von verschiedener Helligkeit (A new method for the production of homogeneously grey areas of differing brightness)
- (1908) Die Verwendung rußender Flammen in der Psychologie und deren Grenzwissenschaften (The use of sooty flames in psychology and its border sciences)

- (1932) Über mathematische Wahrscheinlichkeit und Erfahrung (On mathematical probability and experience)
- (1913) Grundzüge der forensischen Psychologie (Outlines of forensic psychology)
- (1926) Praktische Psychologie der Unfälle und Betriebsschäden (Practical psychology of accidents and industrial damage)
- (1927) Psychologie der Werbung (Psychology of advertising)
- (1928) Psychotechnische und faktische Eignung (Psychotechnical and real aptitude)
- (1931) Die Abhängigkeit der Schulleistungen von Lebensalter und Milieu (The dependence of performance at school on age and class).

The most important pupils

Wilhelm Peters, Maria Schorn, Maria Zillig, Theodor König



Karl Bühler (1879 - 1963). In Würzburg (1907 - 1909)

5.4. KARL BÜHLER

Born: 27 May, 1879, in Meckesheim.

- 1899 Went to Freiburg to study medicine.
- 1903 PhD in medicine in Freiburg for Johannes v. Kries on the physiological theory of seeing colour.
- 1904 PhD in philosophy in Strasbourg for Clemens Baeumker on the psychology of Henry Home (Lord Kames).
- 1904-1907 Studied in Berlin under Stumpf and in Bonn under Erdmann.
- 1907-1909 Assistant to Külpe in Würzburg. Postdoctoral thesis on „Tatsachen und Probleme einer Psychologie des Denkens“ (Facts and problems of a psychology of thinking).
- 1909 Went to Bonn with Külpe.
- 1913-1914 Went to Munich with Külpe (Associate professor).
- 1918 Professor at the Technical University of Dresden.
- 1922-1938 Professor at the University of Vienna.
- 1926/27/29 Visiting professor in the USA (Stanford, Johns Hopkins, Harvard, Chicago).
- 1938 Briefly imprisoned by the Nazis. Emigrated first to Oslo, later to the USA.
- 1939 Scholastica College in Duluth, Minnesota, USA.
- 1940-1945 St. Thomas College, St. Paul, Minnesota, USA.
- 1945-1955 University of California, Los Angeles.
- 1960 Honorary president of the 16th International Psychology Congress in Bonn.

Died: 24 October, 1963, in Los Angeles.

Karl Bühler's contribution to the acknowledgement of the Würzburg School

It is generally acknowledged that it was with the publication of Bühler's postdoctoral thesis in the journal „Archiv für die gesamte Psychologie“ 1907/1908 and Wilhelm Wundt's critical reflection on it that the Würzburg research came to be accepted as a consistent approach. Some important passages are quoted here:

The aim

„We ask the general question: What do we experience when we think?“ (p. 303)

The method

„The most natural way to make someone think is to ask him a question. If this question is put in such a way that it can be answered with Yes or No, ... the subject will be able to tell us afterwards how he arrived at this Yes or No. ... My subjects were professors or had PhDs in philosophy. I will give you some examples of the questions I asked them: Was the theorem of Pythagoras known in the Middle Ages? Can the atomic theory of

physics ever be shown to be untenable by any discoveries? Does monism really mean the negation of personality?" (p.304)

Some results

- „If we consider everything the subjects reported, the sensory presentations stand out from the others as a group of bits of experience which can easily be characterised. ...Then come feelings and the peculiar stretches of consciousness described as doubt, astonishment, recollection, expectation, ... for which one can retain as a provisional designation the term *Bewußtseinslage* (states of consciousness) coined by Marbe. But this is not all. The most important bits of experience are something that, in all the categories through which these formations can be defined, are not touched at all. Something which before all shows no sensory quality, no sensory intensity ...These entities (*Stücke*) are what the subjects, using Ach's term, have designated as awarenesses, or sometimes as knowing, or simply as 'the consciousness that', but most frequently and correctly as thoughts. Thought, that is also the term proposed by Binet." (p. 316)
- „The thoughts alone can be regarded as the real constituent parts of our thought experiences." (p. 317)
- „According to Wundt, it is almost a psychological demand that each act of thought has to be represented in our consciousness in the form of certain single presentations. But our protocols demonstrate this theorem as completely wrong. There are thoughts without any trace of imagery." (p. 318)

A careful analysis of the protocols of his subjects led Bühler to distinguish different types of thought, some of the most important of which are mentioned below:

- The *Regelbewußtsein* (consciousness of a rule): „It is the coming to consciousness of a method of solution, ...knowing how to solve a problem in general. (p. 335) It is not simply thinking about a rule, rather it is thinking of a rule or in the form of a rule." (p. 339)
- The *Beziehungsbewußtsein* (consciousness of relation): „If all that the subject remembers of the thought 'How can the worm in the dust attempt to work out where the eagle will fly to' is: the thought contained an opposition, then we can assume that the consciousness of an opposition was contained in the first experience as a 'moment'." (p.343)
- The *Intentionen* (intentions): „The thoughts which Husserl would describe as purely signitive acts are among the most striking thought experiences. In the 'intentions' the act of meaning, rather than what is meant, is in the foreground; it is as if the What were already fixed and the thought only consisted in the relation to this already fixed fact." (p.347)
- The *Aha-Erlebnis* (the aha experience): „The subject encounters a rather difficult new thought, hesitates a moment, and suddenly comprehends as if by enlightenment. This leads us to the more general question as to what actually happens up to the moment when the characteristic 'Aha' occurs ...our protocols leave no doubt as to the fact ...that

the characteristic experience of comprehension takes place between two wholes." (p.14)

- The *Erinnerungserlebnis* (the experience of remembering): „There are (ideal) conscious relations to earlier experiences without a reliving of them." (p.62)

Karl Bühler, the language and developmental psychologist

In addition to the research on the psychology of thought of the Würzburg School, Karl Bühler made important contributions to the psychology of speech and, together with his wife Charlotte Bühler, to developmental psychology. His examination of the concept of sign in the book „*Sprachtheorie*" (Speech theory) (1934) and the organon model of speech he developed in it formed an important basis for psychological language research. His book „*Die geistige Entwicklung des Kindes*" (The mental development of the child) (1918) prepared the way for a cognitive developmental psychology.

The most important pupils

Egon Brunswik, Peter Hoffstätter, Lajos Kardos, David Klein, Paul Lazarsfeld, Konrad Lorenz, Neal Miller, Edward Tolman, Albert Wellek.



Narziß Kaspar Ach (1871 - 1946). In Würzburg (1899 - 1902)

5.5. NARZIß KASPAR ACH

Born: 29 October, 1871, in Ermershausen.

- 1890-1895 Studied medicine in Würzburg.
- 1895 PhD in medicine in Würzburg.
- 1896-1897 Travelled as a ship's doctor to East Asia and North America.
- 1898-1899 Studied psychology in Strasbourg.
- 1899-1901 Returned to Würzburg to continue psychology, PhD for Oswald Külpe, worked on the psychology of will.
- 1902 Assistant in Göttingen, postdoctoral thesis for G.E. Müller.
- 1904 Lecturer in Marburg.
- 1906 Professor in Berlin.
- 1907 Professor in Königsberg.
- 1922-1937 Professor in Göttingen (succeeded G.E. Müller).

Died: 25 July, 1946, in Munich.

Ach's experimental analyses of will

Probably the most important contribution of Narziß Ach to the Würzburg School is in his monograph „Über die Willenstätigkeit und das Denken“ (On the activity of will and on thinking) (1905). Here he reports on reaction experiments and hypnotic experiments which he began in Würzburg in the summer term of 1900 and later continued in Göttingen. The investigations aimed to „carry out a treatment of the problem of the will upon an experimental basis.“ (p. V). He further developed the method of reaction time measurement introduced by Donders and Exner in two ways:

„on the one hand, through the use of the method of systematic experimental self-observation and, on the other hand, through the introduction of experimental designs.“
(p. V)

The method

Each individual experiment is subdivided into three sections (p 9):

The fore-period: which includes the time between the signal (Ready/Now) and the appearance of the stimulus.

The main period: which includes the actual experience to be investigated experimentally (Not the reaction itself but the experience that leads to the reaction is of interest).

The after-period: which follows the period which includes the reaction.

The instruction

„The instruction of the subject regarding the self-observation was to report in detail in the after-period the experiences during the fore-period and main period.“ (p. 9)

An example: reactions with two responses (p. 126 ff)

Stimuli:

„The letters O and E were used as stimuli. They were printed on white cards and appeared in random order in a card changer.“

Instruction:

„Cards with E and O will appear. On the signal word 'Now', press down both index fingers. If E appears, lift the right index finger. If O appears, lift the left index finger.“

Course of the experiment:

The duration of the fore-period was approximately three seconds. Afterwards the stimulus was applied and reaction time was measured using the Hipp chronoscope. The self-observations reported during the after-period were written down.

Results of the self-observation (Excerpts from two subjects A and B):

„During the fore-period, A at no time thought of a particular letter or of the movement to be made; rather, there was an imageless expectation of something coming ...that is, if a particular change was about to occur at the point he was fixating a uniquely defined change in behaviour would have to take place. Occasionally B had one of the two letters as an acoustic-kinæsthetic presentation. In this case, it influenced the course of the process when the stimulus appeared ...“ (p. 127).

„In the main period it was only during the first trials that A had an intermediate link consisting of the word image „left“ or „right“ following the perception of the letter. The movement of the finger in question followed immediately. On the first day, after 16 trials, a shortening occurred to the effect that the letter appearing immediately evoked the movement of the finger (in question). On the second day, the presentation „right“ or „left“ appeared again during the first seven trials. From the eighth trial on, the letter immediately evoked the movement associated with it. ...For the subject B the elimination of the intermediate link did not take place as quickly. It was only after the tenth trial on the second day that the movement immediately followed the stimulus for the first time“ (p. 129).

Determining tendencies and abstractions

For Ach the most important conclusion from his experimental observations was that the course of the thinking process was not determined by associative and persevering reproductive tendencies alone, as was generally assumed at that time. He writes:

„The investigations show ...that the associative and persevering reproductive tendencies have to be complemented by other factors which have an important influence on the state of consciousness: the determining tendencies. By determining tendencies we understand influences proceeding from the presentational content of the aim presentation (eigenartige Vorstellungsinhalte der Zielvorstellung) which carry with them a determination in the sense of, or according to the meaning of, the aim presentation.“ (p. 187)

Among the effects of the determining tendencies Ach distinguishes among others the following:

Referential presentation (Bezugsvorstellung): *„The same stimulus reproduces different presentations, ...in a given case the presentation which is in accordance with the intention predominates.“ (p. 193)*

Associative abstraction: *„...when a meaning is given, only those presentations which regularly existed as experiences are consciously effective, while adventitious associations are abstained from.“ (p. 219) ...“Associative abstraction is fundamental for conceptual thinking.“ (p. 239)*

Determined abstraction: *„...among a certain number of simultaneously (or successively) given impressions only some of them are present in consciousness due to determining.“ (p. 239 f).*

In conclusion, Ach writes:

„The effectiveness of the determining tendencies has been shown in various ways in our investigations. Needless to say psychology has not ignored these facts. Recently there have been repeated discussions which point to the phenomena in question on the basis of special observations, for example, v. Kries, O. Groß, and A. Binet.“ (p. 248).

Ach, the technician

In addition to his scientific research, Ach was greatly interested in technical problems. He constructed most of the apparatus which he and his co-workers used. The apparatus which measured successive reaction times below 0.5s is especially worth mentioning. A major advantage of this chronotyper was that the reaction times were continuously printed on a strip of paper and thus did not have to be read. But he also developed technical solutions to problems outside psychology and had patents for more than 50 inventions; for example, for the perfecting of the gyrocompass and for the „auto-controller“, an early form of the tachograph.



Otto Selz (1881 - 1943). With Oswald Külpe in Bonn (1909 - 1912)

5.6. OTTO SELZ

Born: 14 February, 1881, in Munich.

- 1900-1908 Studied philosophy under Lipps in Munich and Stumpf in Berlin.
- 1909 PhD in philosophy in Munich on „Die psychologische Erkenntnistheorie und das Transzendentalproblem“ (The psychological epistemology and the transcendental problem).
- 1910-1915 Investigations of thinking with Külpe in Bonn, postdoctoral thesis „Über die Gesetze des geordneten Denkverlaufs“ (On the laws of the ordered thought process).
- 1915-1918 Military service.
- 1919 Returned to the University of Bonn.
- 1921 Associate professor at the University of Bonn.
- 1923-1933 Professor of philosophy, psychology and educational theory at the Commercial College in Mannheim.
- 1929-1930 Principal of the Commercial College.
- 1933 Dismissed for being of Jewish descent.
- 1933-1938 Worked for himself in Mannheim.
- 1938 Arrested and sent to the concentration camp in Dachau.
- 1939-1943 Emigrated to Amsterdam, lectured for the Coursuswerk.
- 1943 Arrested and sent to the concentration camp in Auschwitz.

Died 27 August, 1943, while being transported to Auschwitz.

Otto Selz, the „perfector“ of the Würzburg School

In the book „Thinking: From Association to Gestalt“, Mandler and Mandler (1964, p. 223) wrote:

„Probably the major turning point in the history of thinking came with the work of Selz... Not only does he deal ... with the problem of directed thinking, but he is the first psychologist who is both willing and able to deal with the problem of productive thinking under the same rubric as reproductive thought.“

An example of the experiments conducted by Selz

Words were presented to the subjects, who were instructed to name another word which was related to the first word in a certain way: for example, for the word „scaffold“ a part was to be named (e.g. ladder); for the word „farmer“ a superordinate (e.g. occupation); or for the word „crystal“ a concrete whole (e.g. vase). In addition to the words produced and the reaction time the introspections during the search for the appropriate word were also recorded.

An exemplary result:

Subjects often failed to produce a correct reaction word. For example, a subject produced the word „tradesman“ for the word „farmer“, which is a coordinate to „farmer“, instead of the required superordinate. The analyses of the introspections revealed that such failures do not result from competing diffuse reproductive associations with „farmer“; instead they result from applying a false „anticipatory schema“ to the stimulus word.

The theory of specific responses

When discussing such observations, Selz proposed a theory of specific responses (all quotations from Selz, 1927, „Die Umgestaltung der Grundanschauungen vom intellektuellen Geschehen“, taken from the translation by Mandler & Mandler; 1964):

„The task „superordinate“ and the stimulus word „farmer“ cannot be treated as factors acting in isolation, but rather they act like the coherent question „What is the generic concept for farmer?“ This question already anticipates schematically the knowledge unit (Komplex) „Farmer is an occupation“ which the subject has previously acquired. The question contains one member (A) of the known facts of the case and the relation (γ) to the other sought-for member, ... it can, therefore, act as an eliciting condition for the intellectual operation of knowledge-production (Wissens-aktualisierung), whereby the uncompleted knowledge unit (Aγ), which the question represents, is completed by restoring the reproductive unit (AγB). Instead of a diffuse play of competing reproductive tendencies, this theory offers a comprehensive process ... of structure completion, since the fragmentary structure of the question is made complete by the operation of knowledge production.“

Further central concepts in Selz's theoretical approach

Schematic anticipation

„The overweening importance of schematic anticipation becomes comprehensible as soon as we realise that the most primitive drive in mental life -desire- contains within itself an anticipation of the final state, and this anticipation becomes schematic even when the partial conditions for reaching the goal are still unknown.“

Means production

„The primary operations of productive thinking are the operations of means-production....We are concerned here with the application of previously developed methods of solution to the mastery of a task in an analogous case...“

Means abstraction

„...operations of means abstraction ...are designed for the discovery of new methods of solution and are arrived at by analysing the structure of the immediately given or reproductively restored problem (Aufgabesituation).“

Determining and anticipating factors

„The determining or will-determining factor is part of each task ... and it makes the conditions of eliciting of the intellectual operations a dynamic process. The anticipating factor consists ...in the schematic anticipation of the complete structure of the solution.“

Otto Selz, a pioneer of artificial intelligence

In their seminal paper „Elements of a theory of human problem solving“, published in 1958 in „Psychological Review“, Allen Newell, J.C. Shaw and Herbert Simon wrote (p153):

„Our position is that the appropriate way to describe a piece of problem-solving behavior is in terms of a program: a specification of what the organism will do under varying environmental circumstances in terms of certain elementary information processes it is capable of performing.“

And in a footnote they add:

„We can, in fact, find a number of attempts ... to explain behavior in terms of programs. One of the most interesting, because it comes close to the modern conception of a computer program is Adrian de Groot's analysis of problem solving by chess players. The theory of de Groot is based on the thought psychology of Selz, a somewhat neglected successor to the Würzburg School.“

And in their book on „Human Problem Solving“ (1972) Newell and Simon confirmed: „Our own work and de Groot's owe large debts to Selz.“ (p. 875)

Otto Selz, one of the millions of victims of National Socialism

Under decree No. A 7642 of the Ministry of Culture and Education, Selz was suspended on 4 April 1933 and later, when the Hochschule was integrated into the University of Heidelberg, he was not given another post. The principal of the Commercial College, Sommerfeld, wrote to him on 26 October 1933:

„I am not aware of nor have I been informed by the appropriate Ministry what could argue against your person or your scientific reputation ... the reason can only be your descent, as non-Aryans cannot be offered posts at German universities.“

In the Reichskristallnacht, Selz was sent to Dachau but was released in the middle of December 1938 - probably because he had agreed to emigrate. In the middle of May 1939, he went into exile in Amsterdam, where he lived in a small room in No. 6 Cllostraat. Selz's Dutch

colleagues supported him by giving him a scholarship and the possibility to lecture and take part in their research. In 1942, he lost his German citizenship. In July 1943, he was arrested by the *grüne Polizei* (the police force of the German occupying power) and taken to the concentration camp in Westerbork. On Tuesday 24 August 1943, train No. DA 703 departed for Auschwitz with hundreds of Jews. Among them was Otto Selz. He died of suffocation or exhaustion during transportation.

5.7. THE WUNDT - BÜHLER CONTROVERSY

The rejection of the Würzburg School by Wilhelm Wundt

The awakening psychology at the end of the last century was characterised by the association theory and the enthusiasm for the applicability of scientific experiments to psychic phenomena. The associationists based their theory on the work of David Hartley, John Locke, David Hume and others, as well as the Aristotelian dogma that thought is impossible without images. It was assumed that the laws of mental life can be completely reduced to associative relations between elementary units (images, presentations). The application of the experimental method to psychic phenomena was encouraged by the success of psychophysics (e.g. Weber, Fechner, Helmholtz) as well as the successful application of the reaction time method (e.g. Donders, Exner, Wundt).

It was, however, confined to the analysis of the simple psychical processes, according to Wundt's dictum. The representatives of the Würzburg School doubted these two „essentials“ of psychology at that time. To explain the directed aspect of thinking, they introduced completely new concepts such as the state of consciousness (Marbe), the thoughts (Bühler), the determining tendencies (Ach) or the schematic anticipation (Selz), which, according to their observations, could not be explained by elementary images, and they used the experiment for the analysis of more complex mental processes as well. Needless to say these views were fiercely attacked by the established representatives of associationism. To show the passionate nature of this dispute, excerpts from a discussion between Wundt and Bühler are given below:

The attack by Wilhelm Wundt

In his polemic entitled „Über Ausfrageexperimente und über die Methoden zur Psychologie des Denkens“ (On the Ausfrage experiments and on the methods of the psychology of thinking) in 1907, Wilhelm Wundt subjects the Würzburg School to a thorough criticism. The most important point is the rejection of the method used by the Würzburgers, to which he ironically refers as the „Ausfrageexperimente“. Wundt formulates four rules which must be observed by any experimental investigation and argues that none of these rules are obeyed in the Würzburg work.

The 4 rules for an experiment according to Wilhelm Wundt (1907, p. 308):

1. The observer must as far as possible be in a position to determine of himself the occurrence of the event to be observed.
2. The observer must be in a state of the utmost concentration of attention to observe the phenomena and to follow them in their course.
3. In order to safeguard the results, every observation must be capable of being repeated a number of times under similar circumstances.

4. The conditions under which the phenomenon occurs must be ascertained by variation of the accompanying circumstances, and, when they are ascertained, they must be regularly changed in the appropriately varied experiments. That is to say, in the different experiments they must be on the one hand completely isolated, on the other graded in their intensity or quality.

None of the rules are obeyed in the „Ausfrage experiments“ of the Würzburgers, according to Wundt (p. 329 ff):

1. In the „Ausfrage experiments“ the real observer is not the experimenter but the subject. „The question that is put to the subject is for him an unexpected event which constitutes the most unfavourable condition for precise observation.“
2. „Is the observer able to follow the course of events during the „Ausfrage experiments“ with concentration...? This question comes down to the other: Can there be psychic processes, e.g. acts of logical thinking, which require our utmost attention and which can be observed at the same time with an equal degree of attention? Every psychologist who has seriously worked on the problem of attention would agree that there are none.“
3. „The character of the 'Ausfrage experiments' precludes a repetition of the observation under the same circumstances. Each question must be a completely new one. The same one put a second time would almost unavoidably change the character of the experiments into a memory experiment or at least lead to a mixture and thus to an unforeseeable complication.“
4. „The order of questions ...in the judgment experiments by Marbe or in the thought experiments by Bühler, which I used as typical examples in the section above, shows no systematic variation whatsoever of the experimental conditions. For when in different experimental groups the type of question or the form of the answer was chosen differently, this was as little a variation of conditions in accordance with experimental methodology as if one were to have the answers recorded once in German and once in Latin. The fourth and, next to the first, most important rule, the famous rule of degrees according to Bacon, also fails in these experiments and even proves to be incompatible with them.“

Conclusion

„The „Ausfrage experiments“ are not experiments at all in the sense of a scientific methodology but they are sham experiments, which have the appearance of being systematic only because they take place, as a rule, in a psychological laboratory. In reality, they have no scientific value because they fall short when judged by all the criteria which distinguish the self-observations of experimental psychology from those of ordinary life.“

Karl Bühler's reply

In a paper entitled „Antwort auf die von W. Wundt erhobenen Einwände gegen die Methode der Selbstbeobachtung an experimentell erzeugten Erlebnissen“ (Reply to W. Wundt's objections to the method of self-observations applied to experimentally evoked experiences), Bühler (1908) goes into Wundt's criticism in detail. The article begins with the sentence:

„Even before we were able to make the necessary additions, as promised, to the first part of our investigation, the method applied and the results were subjected to a criticism from someone whom I would have believed to be more understanding.“

Excerpts from the ensuing arguments are given below:

1. The accusation that the events to be observed were unexpected: „This is wrong, because on the word 'bitte' (ready), the subjects were asked to get ready... Of course, the subjects did not and were not supposed to know the special content of the questions which followed, but they knew the general form of the questions, which was sufficient to avoid a recurring surprise, just as in reading experiments it is sufficient to know that a printed word will appear on the fixation area.“ (p. 97)
2. The accusation that the subjects had to work something out in their heads and observe themselves at the same time: „Has Wundt never considered whether it might not be possible to report one's experiences without doubling one's self? ...Does he not know that it is possible to experience something and then report this experience by looking back on it? We have proof from the time when Wundt was a subject himself that he once knew it. ...It is, incidentally, vain self-delusion to think that it is possible to do without self-observation in psychology; if we do not use the subjects' statements, we base the interpretation of the experiments on our own uncontrollable opinions. ...Psychology ...has to develop an evaluation of the validity of different data sources - a general evaluation which includes a theory of self-observation as well as a specific one which is able to give us a measure of reliability for an individual protocol for a particular subject.“ (p. 100/101)
3. „A further claim of Wundt's is still a psychological mystery to me ... that is, the whole nature of the thought experiments precludes a repetition of the observations. ...The 'identity', which is required for the repetition of an observation, of course only needs to be equality concerning the concept the observation is directed towards. When the associationist obtains the sound association 'Himmel-Schimmel' (e.g. hip-ship), this sound association cannot be used again either; nor is it necessary to use it since the association 'Leder-Feder' (leather-feather) and many others are considered by him as sound associations equal to the first one and sufficient for the repetition of observations of the associations of sounds. ...What we want to find out is precisely the psychological equality despite dissimilarity in a physical or other respect.“ (p. 107/108)
4. In reply to the accusation that controlled experimental variations of conditions are impossible, Bühler describes some of the variations he made and writes: „I see nothing which prevents us from varying the experimental conditions according to all rules of exact experimenting in the direction indicated. ...I think that it must be clear to anyone who wants to see it that this objection of Wundt's reveals an armchair approach to experimenting.“ (p. 106/107)

4. The conditions under which

...ertain: the simpler processes for the experi-
for the ethnic psychological inspection.... After
...ests how we should proceed in the psychology of
...ne occasional self-observation with ethnic psychological in-
...be happy that self-observation has come back into favour. And if we
...ve to choose between the occasional self-observation of the individual and the
self-observation of our experiments, then there is no doubt as to the decision for anyone
who remains free of Wundt's misunderstandings and first examines before he judges.
They are opposites just as chance and method are." (p. 110/111)

Wilhelm Wundt and his pupil Oswald Külpe

On 26 October 1907, Wilhelm Wundt replied to a letter from his former pupil Oswald Külpe in which the latter had defended the „Ausfrage experiments“. Among other things he wrote:

„Up to now I had thought that Marbe was the intellectual creator of this, in my opinion, totally reprehensible method, all the more because he first attempted to justify it in his investigations of judgement, and because Ach, as well as Bühler of late, credited the introduction of this method to Marbe. But the method made sense to me as Marbe's method. For I consider Marbe to be a man who is well able to construct an ingenious instrument but who has absolutely no talent whatsoever for psychology. For this reason, I have long been accustomed to consider his work on this subject as essentially non-existent. ...As far as your position in this matter is concerned, I assumed that you, because of the conciliatory attitude I know you have, would prefer to leave people working in this direction to their own devices and wait and see what happened rather than be enthusiastic about it yourself. Now, of course, I can see how wrong I was, and I have to say that I regret this most of all...(and he adds by hand) ... and you may rest assured that I regret it all the more because I value your work, in particular your systematic philosophical and historical work, very highly.“

Despite this dispute, the two researchers remained on friendly terms all their lives.

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