Title
Hypertext Navigation and Conflicting Goal Intentions: Using Log Files to Study Distraction and Volitional Protection in Learning and Problem Solving

Journal
Proceedings of the Annual Meeting of the Cognitive Science Society, 22(22)

Authors
Scheiter, Katharina
Gerjets, Peter
Heise, Elke

Publication Date
2000

Peer reviewed

Hypertext Navigation and Conflicting Goal Intentions: Using Log Files to Study Distraction and Volitional Protection in Learning and Problem Solving

Katharina Scheiter
Graduate College for Cognitive Science
University of Saarland
D-66041 Saarbruecken/Germany
katharis@cops.uni-sb.de

Peter Gerjets
Collaborative Research Center 378
University of Saarland
D-66041 Saarbruecken/Germany
pgerjet@cops.uni-sb.de

Elke Heise
Department of Psychology
Georg-August-University
D-37073 Goettingen/Germany
eheise@gwdg.de

Abstract

This paper describes a theoretical analysis and experimental investigation of difficulty related distraction by conflicting goal intentions in learning and problem solving with hypertext. Log files are used to capture hypertext navigation in the face of opportunities to implement competing goal intentions. We study how differences in task difficulty influence the volitional protection of the current goal intention. First attempts to integrate volitional processes of action control into cognitive architectures are presented.

Conflicting Goal Intentions in Hypertext Navigation

The investigation of learning and problem solving with hypertext gains increasing importance as the use of computer-based learning environments and information retrieval systems develops. The term "hypertext" refers to "computer-based texts that are read in a non-linear fashion and that are organized in multiple dimensions" (Landow, 1992, p. 166). A main feature of hypertext is that the user is not reacting to static texts, but is rather choosing according to his or her current intention when and in which order the information is to be presented (Barab, Bowdish, Young & Owen, 1996). Thus, the navigational path through a given hypertext environment depends mainly on the current intentions of the user. Accordingly, Barab et al. (1996) have shown that users' intentions in interacting with hypertext can be predicted from navigational paths captured in log files (computerized records of screens visited that are stamped with the amount of time spent on each screen). The opportunity of navigating through hypertext environments allows for great flexibility and adaptivity of learning and problem solving with hypertext, it is however also responsible for some difficulties. Users tend to be *structurally or conceptually disoriented* in complex hyperspaces and they seem to suffer from *cognitive overload,* if the navigational task consumes too much of their resources (Conklin, 1987).

In this paper we will focus on a further problem concerning navigating through hypertext environments, namely the problem of *being distracted by conflicting goal intentions*. We assume that learning and problem solving are to be analyzed as goal-directed behavior and furthermore that most learners possess numerous waiting goal intentions not related to the current problem. These waiting intentions can be activated by situational cues in the hypertext environment and then compete with the current goal intention for execution. If the user is attracted by these cues, the current goal intention may be suspended in favor of activities related to the competing intention, or in favor of deliberating which of the two intentions should be further pursued. These interruptions and distractions due to conflicting goal intentions should lead to more or less severe efficiency impairments in learning and problem solving depending on the relative strength of the competing goal intentions. As a theoretical basis for analyzing these issues theories of action control are especially useful.

Cognitive, Motivational, and Volitional Approaches to Action Control

If actions are considered as sequences of activities directed toward a common goal, the term "action control" can be used to describe automatic and controlled processes determining which activity is selected in the next step. Furthermore, action control includes processes that are predominantly *cognitive* (like the selection of a schema or production rule), predominantly *motivational* (like the deliberation of goal values in the course of intention formation), or predominantly *volitional* (like the maintenance of a goal intention in the face of competing intentions). Accordingly, theories from different fields of psychology are concerned with the analysis of action control.

Purely cognitive approaches Most of these approaches to action control postulate processing goals, but do not assume that differences in goal values are relevant for action control. Examples are theories of working memory and attention that postulate a supervisory attentional system responsible for intentional shifts of task sets and the control of working memory contents (Norman & Shallice, 1986). On a higher level of abstraction, theories of planning, strategy selection and metacognition are purely cognitive approaches. All of these approaches typically confine themselves to assuming mental representations and cognitive variables describing them, like activation, availability, or subjective probability. Furthermore, most cognitive approaches focus on single task situations and do not consider conflicting goal intentions.

Approaches with motivational assumptions Expanding on cognitive assumptions these approaches introduce variables that can be interpreted as goal values or as being dependent on goal values. Examples are theories of motivation and decision making that postulate expectancy-value-considerations as a basis for choosing between goals and action alternatives. Goal values and success probabilities are combined by calculating resulting motivational tendencies or subjective utilities that serve as a basis for decisions between goals or actions. An example from cognitive science is the cognitive architecture ACT-R (Anderson & Lebiere, 1998). The mechanisms of production rule selection in ACT-R depend on expected utilities of production rules calculated from goal values and success probabilities. A problem of many approaches to action control based on motivational assumptions is that they take differences in goal values for granted without giving further explanations for these values (Anderson & Lebiere, 1998, p. 63).

Approaches with volitional assumptions These theories describe control processes that help to initiate goal intentions, to maintain them in the face of difficulties and to protect them against distractions and competing goal intentions. Like motivational theories, volitional approaches are based on variables that depend on goal values (e.g volitional strength of intentions) but, volitional approaches also describe how these variables change after a goal intention has been formed. They postulate automatic processes of goal protection like the adaptive increase of volitional strength in the face of increasing task difficulty (Gollwitzer, 1990; Heckhausen, 1991) as well as several kinds of volitional strategies to maintain goal intentions (Kuhl, 1987).

Because our paper is concerned with efficiency impairments caused by situational cues for competing goal intentions, theories of volitional action control seem to be best suited for a first analysis. As a framework for the description of volitional control processes we use a condensed and precise version of the rubicon theory of action phases (Gollwitzer, 1990; Heckhausen, 1991) called PART (Heise, Gerjets & Westermann, 1994), which comprises the **P**ivotal **A**ssumptions of the **R**ubicon **T**heory.

PART allows for the derivation of specific predictions concerning efficiency impairments due to competing goal intentions under different conditions. We designed a hypertext learning environment in order to test these predictions within an experimental setting. PART can also serve as a basis for developing cognitive models of our experimental log file data, because the integration of motivational and volitional aspects of action control into cognitive architectures is easier, if a formalized model of volitional action control is available.

PART: A Theory of Volitional Action Control

PART describes the entire course of actions from a time-sequential perspective. In addition to analyzing volitional processes, such as maintaining and protecting a goal intention, the theory also handles motivational processes, such as choosing a goal or assessing action outcomes. Within this framework, an action is typically composed of a sequence of four phases, beginning with the *predecisional* action phase and followed by the *preexecutive*, *executive*, and *postexecutive* phases (see Figure 1).

In the predecisional phase, one of several possible goals is chosen as the current goal intention to be pursued. This decision is based on the *motivational tendencies* associated with the possible goals. In the preexecutive phase, which commences after commitment to a goal intention has been formed, intention-related activities are planned and the intention is maintained until a favorable opportunity for the initiation of these activities occurs.

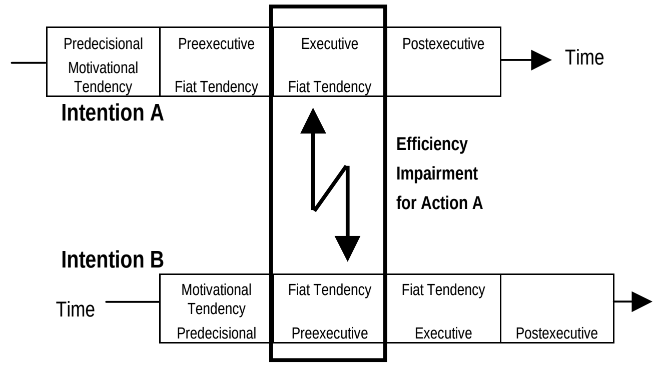

Figure 1: Action phases in PART

The initiation of intention-related activities is controlled by the so called *fiat tendency* and marks the transition to the executive phase. The fiat tendency of an intention depends partly on the suitability of a situation for the implementation of goal-directed behavior. During action execution, the fiat tendency is responsible for the maintenance of the goal intention. If difficulties occur, the fiat tendency of the goal intention increases. This variable is thus of central theoretical importance for explaining volitional action control. It can be interpreted as expressing how strongly an intention demands for implementation in a given situation. The executive phase is followed by the postexecutive phase in which the attained outcome is evaluated.

The theory of action phases is especially suitable for the analysis of action conflicts. In this paper we consider a specific type of conflict that can be described as suspended-intention conflict and is illustrated in Figure 1. It occurs when subjects are instructed to keep working on a task A for a longer period of time, while a competing intention B is waiting to be executed subsequently. In this case, one intention is supposed to remain in the executive phase, while the other is to remain in the preexecutive phase (*preexecutive-executive* conflict). Contrary to the superficially similar task-shift paradigm, where subjects are required to rapidly alternate between the execution of two intentions, no alternation is supposed to take place.

If the fiat tendency of the waiting intention B is strong, then the efficiency of action A should be impaired, because activities related to the competing intention occur or because a process of decision making is initiated in order to determine which intention should be pursued further. The distracting effect of the waiting intention B should be larger the stronger the fiat tendency of B is in comparison to the fiat tendency of the current intention A. The theory of action phases allows for the derivation of several empirically testable hypotheses, from which we chose two predictions that can be easily applied to hypertext navigation:

Hypothesis of distraction by competing goal intentions: The efficiency of a currently executed action A will be impaired if a favorable opportunity for the implementation of a competing intention B occurs. This prediction results from the assumption that an opportunity to realize goal intention B leads to an increased fiat tendency of B.

Hypothesis of difficulty-related volitional protection: Efficiency impairments due to waiting intentions should be stronger for a low level of task difficulty than for a high level of task difficulty. This prediction results from the assumption that an increasing level of task difficulty for intention A results in an increased fiat tendency of A.

In several simple reaction time experiments using word classification tasks we were able to confirm both of these predictions (Heise, Gerjets & Westermann, 1997). In the domain of hypertext navigation we can test our predictions within a naturalistic setting, where problems of distraction due to competing intentions are of practical relevance. Furthermore, the use of log files to capture hypertext navigation enables us to investigate whether the distractional effects of a competing goal intention can be traced back to cognitive activities related to the implementation of this competing intention. Finally, we assume that research on hypertext navigation can benefit from insights in the way information processing strategies may change in the face of conflicting goal intentions.

Experiment

Method

Subjects: 134 students (84 female, 50 male) at the University of Goettingen, Germany participated in the experiment. The average age was 24,8 years.

Procedure The subjects' main task (the current goal intention) consisted of a hypertext-based learning and problem-solving task. Subjects had to solve three probability word problems. For each problem the correct solution principle and two correct variable values had to be marked in a multiple-choice form available in the hypertext environment. All three problems were presented at the beginning of the experiment. Subjects were instructed to solve the problems as fast and as correctly as possible using information provided in the hypertext environment. To acquire the relevant knowledge subjects could browse the hypertext environment freely. Six problem categories from the domain of probability theory were explained using worked out examples for illustration. All examples were embedded in interesting cover stories about attractiveness and mate choice (e.g., the probability of guessing the first three winners in a beauty competition between 10 people). The examples and the explanations of the problem categories were available during the whole experiment.

Design As independent variables two different levels of difficulty of the word problems to be solved (easy versus difficult problems) and two levels of distraction due to conflicting goal intentions (strong versus weak distraction) were introduced. Both variables of the resulting 2x2-design were varied interindividually. Two further levels of distraction were introduced as control conditions.

In accordance with preliminary studies we manipulated the level of difficulty by using smaller numbers in the easy problems and by stating them in a more familiar way than the difficult problems. The method used to increase difficulty was similar to the one used by Ross and Kilbane (1997). The cover story and the underlying solution principle of a problem were not affected by this manipulation.

In the *condition with strong distraction* we introduced a competing intention and a favorable opportunity for its implementation. Subjects were informed that they would have to work on a second task within the same hypertext environment after having finished the problem-solving task. The second task consisted of answering three questions about attractiveness and mate choice that were presented briefly at the beginning of the experiment. Subjects were instructed to work on the problem-solving task first and to postpone thinking about the question-answering task until they finished the three word problems. They were assured to have enough time afterwards to browse the hypertext environment for information relevant to the second task. Subjects were told that all information available could be helpful in solving the word problems. As favorable opportunities to execute activities related to the waiting intention we included additional information about attractiveness and mate choice in the hypertext environment. This information was not helpful for solving the probability word problems, but it was related to the topic of the waiting intention. To make this information available during the first task, the examples used to explain the solution principles contained "hot words" linked to that information.

In the *condition with weak distraction* no competing intention was induced. Subjects were only required to solve the three word problems. In order to keep the number of hyperlinks in the learning environment constant, the same amount of irrelevant information was linked to the worked out examples as in the condition with strong distraction. In order to prevent subjects from forming an intrinsically motivated competitive intention to browse the irrelevant information, we replaced the interesting information about attractiveness and mate choice with rather uninteresting information concerning irrelevant terms in the cover story.

To control motivational effects of this replacement a *condition with intermediate distraction* was used. In this condition hyperlinks to irrelevant information about attractiveness and mate choice were inserted but no competing intention concerning that information was induced. If subjects form competing intentions based on personal interest, stronger effects of distraction than in the condition with uninteresting irrelevant information are to be expected.

A *baseline condition* with no hyperlinks to irrelevant information was implemented as a second control condition. This condition was used to estimate additional cognitive costs of navigating hypertext environments containing irrelevant information.

Dependent variables To test our hypotheses concerning efficiency impairments we obtained two different kinds of dependent variables. As an outcome measure the percentage of errors for the three word problems was registered. As process measures several time and frequency parameters were calculated from the log file data recorded during subjects' interaction with the hypertext system. Especially, the total amount of time spent on relevant information as well as time spent on irrelevant information was calculated. The latter measure was obtained to test whether efficiency impairments can be traced back to cognitive activities related to the competing intention.

Results and Discussion

Comparing the conditions with strong and weak distraction yields a significant main effect of distraction on error rates (cf. Figure 2)[1]. In accordance with our distraction hypothesis, subjects with competing intentions and favorable opportunity to initiate corresponding activities show worse performance in the problem-solving. No differences between the condition with weak distraction and the two control conditions were found.

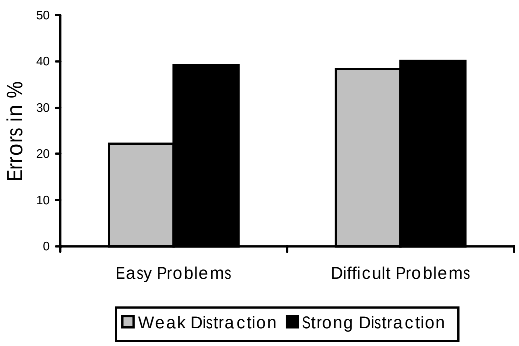

Figure 2: Error rates as a function of task difficulty and distraction (N = 68)

The manipulation of difficulty was successful. The respective main effect is significant. As predicted, the influence of the competing intention on performance depends on the difficulty of the problem-solving task. In the condition with low task difficulty, efficiency impairments due to competing intentions are larger than in the condition with high task difficulty. The respective interaction is significant.

To test whether these efficiency impairments can be traced back to cognitive activities related to the competing intention, we compared the four conditions regarding time spent on irrelevant information (see Figure 3). In the groups with competing intention and opportunity for implementation, the time spent on irrelevant information was significantly longer than in the groups with no competing intention. This was especially the case for the easy word problems. The respective interaction was marginally significant.

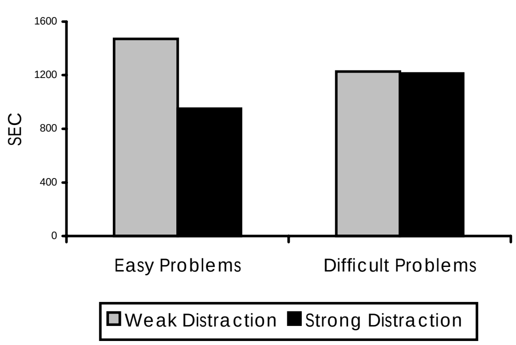

Figure 3: Time spent on irrelevant information as a function of task difficulty and distraction (N = 68)

[1] Our specific predictions have been tested using one-tailed *t*-tests. Concerning the general advantage of planned contrasts as opposed to unspecific ANOVA *F*-tests see Hays (1988) or Rosenthal and Rosnow (1988).

These data support the assumption that the observed efficiency impairments under the condition of low task difficulty result from cognitive activities which are relevant for the implementation of the competing intention.

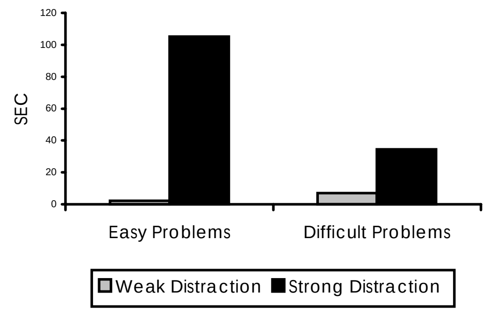

Figure 4: Time spent on relevant information as a function of task difficulty and distraction (N = 68)

In a second step we analyzed time spent on relevant information (Figure 4). As can be seen, higher difficulty of the word problems caused no increase in time on relevant information. Unexpectedly, the groups with a competing intention and opportunity for implementation spent significantly less time on relevant information than groups without such intention. This main effect is caused by differences in the low difficulty task condition. The respective interaction effect is significant.

Taken together, our data support the following conclusions: For high levels of task difficulty no distraction effects can be observed, whereas for low levels of task difficulty the presence of a competing intention leads to an increase in error rates and in time spent on irrelevant information as well as to a decrease in time spent on relevant information. This pattern of results can be interpreted as indicating strategy shifts if a strong competing intention with favorable opportunity is present (speed-accuracy trade-off).

Further analysis of the log file data yields several other strategy shifts under different levels of distraction and difficulty. For example, they concern the time spent on studying the solutions of worked out examples or the order in which the three word problems were solved.

Summary

The aim of our study was to investigate how conflicting goal intentions can influence learning and problem solving in hypertext environments. As a theoretical background we used a theory of volitional action control (PART) that describes efficiency impairments caused by competing goal intentions under different levels of task difficulty. We used PART to derive two hypotheses about hypertext navigation in the face of conflicting goal intentions. These hypotheses could be confirmed in an experimental study. Furthermore, the experimental log file data show that there are numerous differences between the experimental conditions that cannot be completely explained by our volitional framework (e.g., different kinds of strategy shifts). To further analyze this data, it would be helpful to use a theoretical model that combines volitional assumptions about conflicting goal intentions and more detailed cognitive assumptions about learning and problem solving behavior. We therefore began to integrate the volitional mechanisms of PART into the cognitive architecture ACT-R (Gerjets, 1997).

Modeling Volitional Action Control

As illustrated in Figure 5, PART includes detailed assumptions about the interrelations of variables underlying volitional processes.

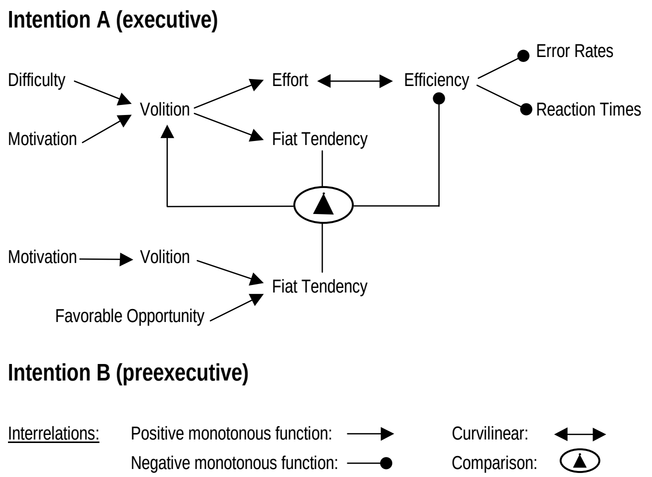

Figure 5: Interrelations between variables related to fiat tendencies in PART

Each possible goal is associated with a certain *motivational tendency* that determines which of the competing goals in the predecisional action phase will be pursued as goal intention. Each goal intention is assigned a specific degree of *volitional strength* that determines how much effort will be exerted for the implementation of that goal intention. Furthermore, each goal intention is assigned a *fiat tendency* that expresses its demand for implementation. In the preexecutive-executive conflict, the fiat tendencies of the competing goal intentions determine which of the two intentions becomes dominant. The fiat tendency of the current intention A depends essentially on the volitional strength of this intention. The volitional strength, however, not only determines the respective fiat tendency but also the level of effort and the efficiency of the implementing activities. The volitional strength of the current intention is affected by its motivational strength and the level of task difficulty. An increase in task difficulty results in an increased volitional strength of the current goal intention. This dynamic regulation of volition and effort in the face of increasing task difficulty is one of the main volitional mechanisms of the action phase theory and corresponds to the so-called *law of difficulty* (cf. Heckhausen, 1991).

The fiat tendency of the waiting intention B not only depends on its volitional strength but also on the perceived favorability of the opportunity to initiate corresponding activities. If the fiat tendency of the waiting intention becomes sufficiently large (relative to the fiat tendency of intention A), then the efficiency of the current action can be impaired as will be reflected in error rates or reaction times. It can also be assumed that the presence of a waiting intention with a strong fiat tendency will be perceived as an increased level of task difficulty that reactively results in an increased level of volitional strength. This may at least partly compensate for efficiency impairments. Volitional action control is most adaptive when it results in a balance between shielding a current intention against competing intentions and flexibly responding to situational changes.

Based on our theoretical framework and our experimental findings, there are at least three requirements for the cognitive modeling of volitional action control. First, a cognitive model of our task will have to take into account that learners may simultaneously possess multiple conflicting goal intentions of differing strength. The model has to explain *efficiency impairments* caused by situational cues related to waiting intentions. Second, the model has to reflect the *law of difficulty*. Third, the model has to account for data indicating *strategy shifts* under different levels of distraction and difficulty that cannot be explained at PART's level of abstraction (time spent on different kinds of information, order of solving different problems and trade-offs between speed and accuracy).

As a theoretical basis for cognitive modeling we will refer to Anderson's ACT-R architecture (Anderson & Lebiere, 1998). ACT-R has been developed as a unified theory of cognition applying to domains as diverse as problem solving, learning, or memory. In ACT-R human actions are analyzed in terms of production rules and spreading activation in a network of declarative memory chunks. Production rules are matched to currently activated memory chunks and can be executed if their conditions are sufficiently satisfied. Actions are described as sequences of production rule firings. Action-guiding intentions can be represented by a specific type of declarative memory chunks (*goal chunks*). These chunks are organized by means of a last-in-first-out goal stack and act as temporary sources of activation that guide current information processing by spreading activation to other memory chunks and by thus constraining the set of executable production rules. Most productions are goal specific and can only be executed if the goal referred to in their conditions is the current goal on top of the goal stack.

A major drawback of the ACT-R architecture for our current purposes is that ACT-R is mainly designed as a single-task architecture for modeling tasks in isolation. Processing is completely controlled by the current goal on top of the goal stack. Production rules referring to other than the current goal cannot be selected for execution. Alternative cognitive architectures like EPIC (Meyer & Kieras, 1997) are explicitly designed for modeling dual task performance and multiple goal handling but are however restricted to very simple cognitive tasks lacking complex goal structures. Furthermore, they are not capable of integrating different cognitive components like learning, memory, and problem solving. For that reason, it seems easier to adapt ACT-R to handling multiple goals than to adapt architectures like EPIC for modeling complex cognition.

Our approach for modeling volitional action control in ACT-R comprises two main steps: In a first step we will try to map the concepts and assumptions of PART onto concepts and assumptions of ACT-R. These mappings can be evaluated theoretically (Gerjets, 1997) as well as empirically (Gerjets, Heise & Westermann, 1997). Because dynamic variables like motivational tendency, volitional strength and fiat tendency are of major importance in

PART, the modeling in ACT-R will focus on variables with analogous functional roles, e.g., goal values or source activation. If no satisfying mapping can be found for necessary assumptions of PART, we attempt to develop new concepts and mechanisms based on the ACT-R framework that are compatible with the main assumptions of the theory.

The aforementioned requirements for modeling volitional action control lead to three main subtasks in developing an ACT-R model for our domain.

Efficiency impairments Efficiency impairments due to competing intentions cannot be explained in ACT-R without additional theoretical assumptions, since the theory assumes that only the top goal on the goal stack controls performance. To model our data it will be necessary to introduce a new chunk type representing *preexecutive intentions* waiting for implementation. To allow the system to interrupt its performance for information processing related to a waiting intention, we will have to introduce goal unspecific production rules which, in the case of goal conflicts, initiate a decision about which task to pursue further. These *interrupt productions* should be executed whenever declarative memory chunks associated to waiting intentions become activated. Chunks representing waiting intentions can be equipped with additional functional characteristics like an increased base level activation to account for their superior availability in memory (Goschke & Kuhl, 1993).

Difficulty-related effort allocation Two interpretations of effort can be modeled in ACT-R. First, high effort can be interpreted as working more accurately. This can be modeled by high goal values, which lead to the selection of production rules with higher probability of success. These rules, however, also yield higher costs for execution. Second, high effort can be interpreted as working faster. This can be modeled by high source activation of goal chunks, which leads to a high amount of activation that spreads to associated chunks in declarative memory. Matching a production rule to chunks in declarative memory will be the faster the higher these chunks are activated. To model the law of difficulty, the concept of task difficulty has to be mapped onto analogous concepts in ACT-R. In our experimental context task difficulty can be best interpreted as missing declarative or procedural knowledge that results in problem-solving impasses. These impasses can be connected to goal values and source activation without violating the ACT-R theory.

Strategy shifts As our log file data indicate, level of distraction and difficulty influence the trade-off between speed and accuracy, the order in which test problems are solved, and the time spent on studying the solutions of worked out examples. As aforementioned, speed-accuracy trade-offs can be modeled by goal values and source activation. Time spent on studying worked out examples can be interpreted as reflecting a time demanding strategy with high success probability. Deviations from a given order of test problems can be explained by interrupt productions that react to activated chunks representing waiting intentions. To test whether these ideas suffice to model the influences of difficulty and distraction on strategy selection it will be necessary to develop a detailed ACT-R model of our experimental task.

Acknowledgements

We would like to thank Peter Breuer for his support.

References

Anderson, J. R. & Lebiere, C. (*1998). The atomic components of thought.* Hillsdale, NJ: Erlbaum.

Barab, S. A., Bowdish, B. E., Young, M. F. & Owen, S. V. (1996). Understanding kiosk navigation: Using log files to capture hypermedia searches. *Instructional Science, 24*, 377-395.

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

Gerjets, P. (1997). Volitionale Handlungssteuerung und kognitive Mechanismen: Reduktionsmöglichkeiten auf der Basis intertheoretischer Bänder. *Psychologische Beiträge, 39*, 441-470

Gerjets, P., Heise, E. & Westermann, R. (1997). Motivational strength of goals and cognitive strength of goal representations. In M.G. Shafto & P. Langley (Eds.), Proceedings of the 19th Annual Conference of the Cognitive Science Society (S. 928). Mahwah, NJ: Erlbaum.

Gollwitzer, P. M. (1990). Action phases and mind sets. In E. T. Higgins & R. M. Sorrentino (Eds.), *Handbook of motivation and cognition: Vol II* (pp. 53-92). New York: Guilford Press.

Goschke, T. & Kuhl, J. (1993). Representation of intentions: Persisting activation in memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 19*, 1211-1226.

Hays, W. L. (1988). *Statistics (4th ed.)*. Fort Worth, TX: Holt, Rinehart and Winston.

Heckhausen, H. (1991). *Motivation and action*. New York: Springer.

Heise, E., Gerjets, P. & Westermann, R. (1994). Idealized action phases: A concise Rubicon-theory. In M. Kuokkanen (Ed.), *Structuralism, idealization and approximation* (pp. 141-158). Amsterdam: Rodopi.

Heise, E., Gerjets, P. & Westermann, R. (1997). The influence of competing intentions on action performance: Efficiency impairment and volitional protection in tasks of varying difficulty. *Acta Psychologica, 97*, 167-182.

Kuhl, J. (1987). Action control: The maintenance of motivational states. In F. Halisch & J. Kuhl (Eds.), *Motivation, intention, and volition* (pp. 279-291). Berlin: Springer.

Landow, G.P. (1992). *Hypertext. The convergence of contemporary literary theory and technology*. Baltimore: John Hopkins University Press.

Meyer, D. E. & Kieras, D. E. (1997). A computational theory of executive cognitive processes and multiple-task performance: Part 1. Basic mechanisms. *Psychological Review, 104*, 3-65.

Norman, D. & Shallice, T. (1986). Attention to action. In R. J. Davidson (Ed.), *Consciousness and self-regulation* (pp. 1-18). New York: Plenum Press.

Rosenthal, R. & Rosnow, R. L. (1988). *Contrast analysis: Focused comparisons in the analysis of variance*. Cambridge: Cambridge University Press.

Ross, B. H. & Kilbane, C. (1997). Effects of principle explanation and superficial similarity on analogical mapping in problem solving. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 23*, 427-440.