

# Analyzing Effects of Goal Competition and Task Difficulty in Multiple-Task Performance: Volitional Action Control within ACT-R

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## Volitional Action Control

### Competition between Current and Pending Goals (Heise, Gerjets, & Westermann, 1997)

- Important problem of volitional action control in everyday multiple-task behavior (e.g., distraction, resistance against temptations)
- May arise if suitable opportunities for the implementation of a pending goal occur
- May result in performance impairments depending on the task difficulty of the current goal (so-called law of difficulty)

### Findings on Goal Competition in Hypermedia Learning (Gerjets, Scheiter, & Heise, 2002)

**Experimental task:** Complex hypertext-based learning and problem-solving environment with worked examples (probability word problems together with step-by-step solutions) that illustrated different problem categories. The examples were couched into cover stories related to mate choice and contained task-irrelevant hyperlinks:

- *Problem-solving task:* Solving isomorphic test problems
- *Question task:* Answering questions related to the cover stories of the worked examples after having finished the problem-solving task

#### Design and dependent measures:

- Independent variables: *Difficulty of word problems* (easy vs. difficult) x *goal competition* (with vs. without question task)
- Dependent measures: Problem-solving errors, time spent on task-relevant / task-irrelevant information pages (log file analysis)

#### Results:

1. Distraction effects: Increased problem-solving errors together with a speed-up in studying task-relevant information pages in the conditions with goal competition

#### Cognitive-load explanation:

Goal competition → activation of task-irrelevant information → extraneous workload → simpler processing strategy

2. Distraction effects due to goal competition only for easy but not for difficult test problems: Performance impairments and a resource-adaptive strategy shift towards simpler processing strategies

#### Cognitive-load explanation:

- Easy problem → low workload → sophisticated strategy (without goal competition) vs. simple strategy (with goal competition)
- Difficult problem → high workload → simple processing strategy

## Modeling Approach

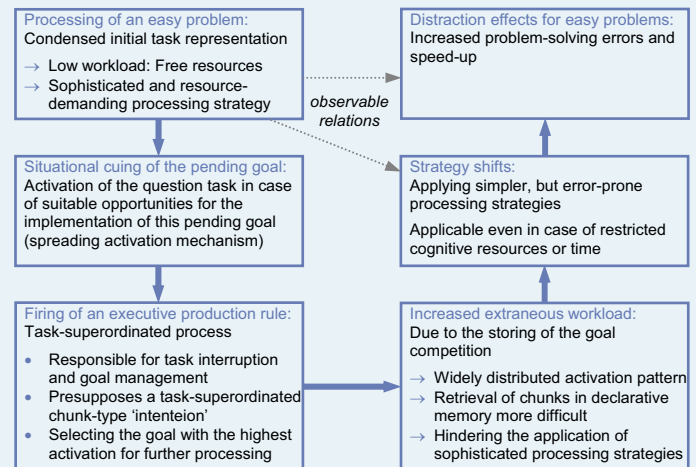
(Gerjets, Scheiter, & Schorr, in press)

### Basic ideas from models of elementary executive control

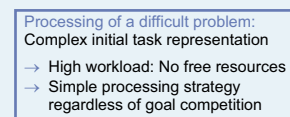
- Cognitive models of action control in low-level multiple-task situations as in the task shift or the PRP paradigm rely on activation mechanisms (Altmann & Gray, 2000), executive control productions (Meyer & Kieras, 1997), or both (Sohn & Anderson, 2001)
- Attempt to apply the constructs and mechanisms used in the context of “microscopic” choice reaction time tasks to “macroscopic” issues of volitional action control in everyday multiple-task behavior

## An ACT-R model of Volitional Action Control

### 1. Distraction effects for easy problems with goal competition

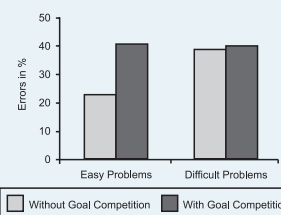


### 2. No distraction effects for difficult problems:



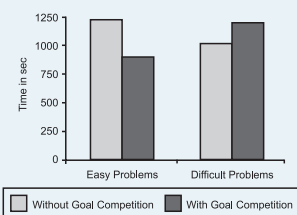
## Model simulations

### Problem-solving errors [%]



Distraction effects due to goal competition moderated by task difficulty, i.e., effects for easy problems only

### Time demands [sec]



Strategy shift for easy problems with goal competition: speed-up and more processing cycles → cursory processing (executive production rule, simple strategy)

## Conclusion

- Good fit between the model data and the empirical results
- Successful simulation of effects of goal competition and task difficulty on processing strategies and performance for a complex learning and problem-solving task
- Using activation mechanisms and executive control productions similar to those applied in “microscopic” multiple-task situations

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