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Metacognitive monitoring and control in elementary school children: The interrelations and their role for test performance ☆

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ABSTRACT

Contemporary models of self-regulated learning emphasize the role of distal motivational factors for student's achievement, on the one side, and the proximal role of metacognitive monitoring and control for learning and test outcomes, on the other side. In the present study, two larger samples of elementary school children (9- and 11-year-olds) were included and their mastery-oriented motivation, metacognitive monitoring and control skills were integrated into structural equation models testing and comparing the relative impact of these different constituents for self-regulated learning. For one, results indicate that the factorial structure of monitoring, control and mastery motivation was invariant across the two age groups. Of specific interest was the finding that there were age-dependent structural links between monitoring, control, and test performance (closer links in the older compared to the younger children), with high confidence yielding a direct and positive effect on test performance and a direct and negative effect on adequate control behavior in the achievement test. Mastery-oriented motivation was not found to be substantially associated with monitoring (confidence), control (detection and correction of errors), or test performance underlining the importance of proximal, metacognitive factors for test performance in elementary school children.

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1. Introduction

Imagine a 4th grader trying to answer the questions in a science test: She or he has paid more or less attention when the topic was presented in class and has invested more or less time at home to prepare for the test by reading, memorizing, elaborating, and/or pre-testing her or his knowledge. In trying to achieve an optimal result, the student will — during the exam — put effort in retrieving targeted information, judge the confidence of the upcoming candidate answers, (hopefully!) re-read his or her answers searching for errors, and then possibly correct (or only cross-out) answers that he or she believes to be incorrect. From these descriptions, it is obvious that different metacognitive monitoring (i.e., confidence judgments) and control processes (e.g., detecting and correcting errors) are involved in student's test taking behavior and the resulting test performance. But also motivational factors, especially a student's mastery motivation for school work in general will influence the test taking behavior and the test result.

With the present study, we aim to build a bridge between basic experimental research on metacognitive development between 9 and 12 years and educational research aiming at documenting factors predictive for student's achievement. An experimental approach that allows quantifying students' metacognitive monitoring and control will be combined with an individual differences perspective in order to investigate the role of task-bounded metacognitive processes and motivation for student's test outcomes. Special emphasis will thereby be put on the questions of (a) factorial invariance of the included motivational and metacognitive constructs across age groups and (b) age-related differences in the structural links between mastery-oriented motivation, monitoring, and controlling against the background of recent models of self-regulated learning.

1.1. Theoretical background

Starting with metacognitive processes, these have traditionally been defined as "pure" cognitive processes taking the ongoing cognitive operations as their objects (Flavell & Wellman, 1977). Metacognitive processes differ as a function of the learning phase (acquisition, retention, retrieval), and typically, metacognitive

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monitoring is to be distinguished from control (Nelson & Narens, 1990). In that tradition, metacognitive monitoring mirrors an individual's ability to judge one's cognitive performance "on-line", for example, judging the learning progress made during study (performance predictions), or estimating the correctness of a response just given (i.e., confidence judgments). In other words, monitoring processes inform the learner about her or his learning progress, thereby building the foundation for self-initiated learning behavior or adaptation thereof. From that cognitive perspective, metacognitive control processes are defined as the individual's executive activities enabling the use and adaptation of different cognitive operations with the aim to increase learning behavior or test performance. Thus, metacognitive control is based on the individual's subjective monitoring of current learning, thereby strongly relying on their accuracy, with monitoring accuracy being defined as an individual's ability to reliably distinguish in their metacognitive judgments between, for example, already learned vs. not-yet-learned, or, correct vs. incorrect answers.

In different theoretical frameworks of self-regulated learning, metacognitive processes hold an intermediate position, located between a learner's long-term achievement goals and her or his more general mastery motivation (Wigfield & Eccles, 2002), on the one side, and the task-specific cognitive operations leading to learning progress, on the other side. The degree to which metacognitive processes are emphasized and the precise level on which metacognitive processes are assumed to operate differs across models (Boekaerts, 1999; Efklides, 2011; Pintrich, 2004; Winne, 2001; Zimmerman, 1990): In the traditional conceptualizations of self-regulated learning metacognitive processes are considered as relatively "pure" cognitive constructs that either operate on a general level in the form of declarative metacognitive knowledge and/or during learning in the form of "online" procedural metacognitions (Boekaerts, 1999; Nelson & Narens, 1990; Pressley, Borkwski, & Schneider, 1989).

In more recent models of self-regulated learning, metacognitive monitoring and control processes are assumed to also include an affective, motivational aspect: Task mastery is thought to additionally produce metacognitive experiences (with different degrees of consciousness) and give rise to metacognitive feelings which in turn will affect (a) task-specific metacognitive control processes but also (b) an individual's more general self-perceptions and motivation (Efklides, 2011). Furthermore, it is assumed that the more distal and stable person characteristics (e.g., motivation, self-confidence) interact with motivational and affective states while learning (e.g. enjoyment, boredom), this way impacting on metacognitive experiences, control processes (e.g., investing more effort in retrieving information, termination of memory search, revising answers), but also on learning or test outcomes (Efklides, 2006, 2008; Kleitman & Stankov, 2001; Zimmerman & Moylan, 2009).

Taken together, while traditional conceptualizations of self-regulated learning exclusively defined metacognitive processes as a "cool", task-specific "pure" cognitive information processes (Flavell & Wellman, 1977; Nelson & Narens, 1990; Pressley et al., 1989), more recent models propose a broader conceptualization and integrate a "hot", affective-motivational, task-independent, trait-like aspect to metacognitive monitoring and control (Efklides, 2011; Kleitman & Stankov, 2001). As these complex, multi-layered models of self-regulated learning are relatively recent, empirical tests on the veracity of the entire models are still rare and being called for. Moreover, self-regulated learning is an issue relevant not only for adults, but also for children and adolescents. Thereby, the models seem to make implicit assumptions of age-invariance of the included constituents and their interplay. As the developmental literature provides ample evidence that monitoring and control processes undergo not only quantitative but also qualitative changes in ontogeny (see below), empirical tests of age-invariance are needed; the present study makes a contribution into this direction by including 3rd and 5th grade students and testing for factorial and structural invariance across age groups.

1.2. Empirical findings on the interplay of factors involved in self-regulated learning

Generally spoken, metacognitive processes have repeatedly been shown to impact a learner's performance: Both declarative metacognitive knowledge assessed with questionnaires (for example, included in some of the large international studies such as PISA; OECD, 2005), as well as procedural (online) monitoring and control processes explain substantial amounts of individual differences in test performance (Dunlosky & Metcalfe, 2009; Koriat & Goldsmith, 1996; Schneider & Artelt, 2010; Schneider, Schlagmüller, & Visé, 1998). This general pattern holds true even when psychometric intelligence is being controlled for (van der Stel & Veenman, 2008; Veenman & Spaans, 2005), suggesting a specific and positive impact of metacognitive processes on test performance.

With regard to the specific influence of monitoring in self-regulated learning situations and for students' achievement, the existing empirical evidence is inconsistent, at least at first sight. This is because on the one side, there are numerous studies documenting how "pure cognitive" monitoring influences subsequent control behavior in self-regulated learning: For example, hard-to-learn item pairs (low ease-of-learning judgments prior to learning or low feeling-of-knowing-judgments after an initial learning phase) are typically associated with increased study time allocation (Son & Metcalfe, 2000). Lower judgments of comprehension are positively associated with more effective self-regulation while learning with texts (Thiede, Anderson, & Therriault, 2003). And, of importance for the present approach, confidence judgments are predictive for learners' control behavior, that is, answers receiving lower confidence judgments have a significantly higher probability of being withdrawn (crossed-out answers in the test; "I don't know" answer in a verbal interview; Koriat & Goldsmith, 1998; Roebers & Schneider, 2005). In terms of individual differences in "cool" monitoring, high confidence judgments are thus negatively related to efficient control operations.

When direct effects of monitoring, especially of predictions and confidence, on performance are considered, a positive association has been found: High confidence is typically positively related to performance, for example, in terms of achievement test performance in individual differences approaches (i.e., self-confidence; Kleitman & Gibson, 2011; Kleitman & Mascrop, 2010; Kleitman & Stankov, 2001, 2007), or in terms of learning outcomes assessed in multi-trials experiments (e.g., Shin, Bjorklund, & Beck, 2007). Against the theoretical background of broader conceptualizations of self-regulated learning, these positive relations between optimistic performance predictions or high confidence and performance seem to confirm the benefits of students' motivational states for learning outcomes (Efklides, 2011). From this perspective, confidence seems to additionally mirror "hot", motivation-related individual differences and may this way also yield to positive direct effects on performance.

Together, a picture of interrelations of "hot" and "cool" aspects of self-regulated learning activities emerges in which stable person characteristics such as mastery-oriented motivation (operating on a macro level) are related to task-bounded, micro-level metacognitive experiences and judgments that give rise to learning behavior. However, in these empirical studies, the effects of confidence on task-specific control behavior and on performance were not simultaneously taken into account as either an experimental set-up (i.e., confidence judgments → control: detection and correction of errors) or an individual differences approach was chosen (i.e., confidence as a trait → performance). Thus, the question arises whether high confidence may potentially yield a positive direct effect on performance via motivational processes (high confidence leading to increased effort and persistence) and, at the same time, yield a negative effect on control behavior (high confidence impeding detection and correction of errors). It may also be the case that high confidence stems from a pronounced mastery-oriented motivation (McInerney &

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