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Interactions of Metacognition With Motivation and Affect in Self-Regulated Learning: The MASRL Model

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Metacognition, motivation, and affect are components of self-regulated learning (SRL) that interact. The "metacognitive and affective model of self-regulated learning" (the MASRL model) distinguishes two levels of functioning in SRL, namely, the Person level and the Task × Person level. At the Person level interactions between trait-like characteristics such as cognitive ability, metacognitive knowledge and skills, self-concept, perceptions of control, attitudes, emotions, and motivation in the form of expectancy-value beliefs and achievement goal orientations are hypothesized. These person characteristics guide top-down self-regulation. At the Task × Person level, that is, the level at which SRL events take place, metacognitive experiences, such as feeling of difficulty, and online affective states play a major role in task motivation and bottom-up self-regulation. Reciprocal relations between the two levels of functioning in SRL are also posited. The implications of the MASRL model for research and theory are discussed.

Self-regulated learning is a notion that emphasizes the agentic role of the learner (Boekaerts, 1996, 1999; Boekaerts & Corno, 2005; Pintrich, 2000; Winne, 2004; Zimmerman, 1998, 2008). Self-regulated learning (SRL) refers to the setting of one's goals in relation to learning and ensuring that the goals set are attained. Key components of SRL are cognition, metacognition, motivation, affect, and volition (Boekaerts, 1996). The various theoretical models of SRL place different emphasis on the various components of it, although theorists all agree that SRL is a broader process that refers to the monitoring and control of behavior, cognition, motivation, and the environment. Metacognition, which by definition also involves monitoring and control functions (Flavell, 1979), is mainly limited to the monitoring and control of cognition (Dinsmore, Alexander, & Loughlin, 2008; Schunk, 2008). This conceptual overlap between SRL and metacognition, however, requires a thorough analysis of the processes involved in metacognition to determine whether metacognition interacts with motivation and affect and whether these interactions have implications for SRL.

Metacognition is defined as cognition about cognition (Flavell, 1979) or a model of cognition (Nelson, 1996). It is a representation of cognition that is built on information coming from the monitoring function and that informs the control function, such as strategy use, when cognition fails for any reason. However, exercising control is an effortful process and effort exertion presupposes motivation. Moreover, there are facets of metacognition (i.e., metacognitive experiences [ME]) that can have an affective character (Efklides, 2006). Therefore, there is theoretical basis for connecting metacognition with motivation and affect. The present article aims at highlighting the interactions, that is, mutual effects among metacognition, motivation, and affect in SRL, and proposes that these interactions serve the two modes of self-regulation, namely, top-down and bottom-up self-regulation.

The interactions between metacognition, motivation, and affect can be described either at a macrolevel or at a microlevel as a person works on a task. The level of functioning of SRL processes is important because metacognition, motivation, and affect at a macrolevel are represented by person characteristics (e.g., metacognitive knowledge [MK], achievement goal orientations, self-efficacy beliefs, etc.; see Pintrich, 2000; Schunk & Zimmerman, 1998) that function across tasks or situations. In other words, SRL is conceived of at a generalized level (e.g., self-efficacy *in mathematics*, emotions raised in *a specific course* rather than at the task-specific level). This general level of functioning is henceforth called the Person level of SRL. Models of SRL

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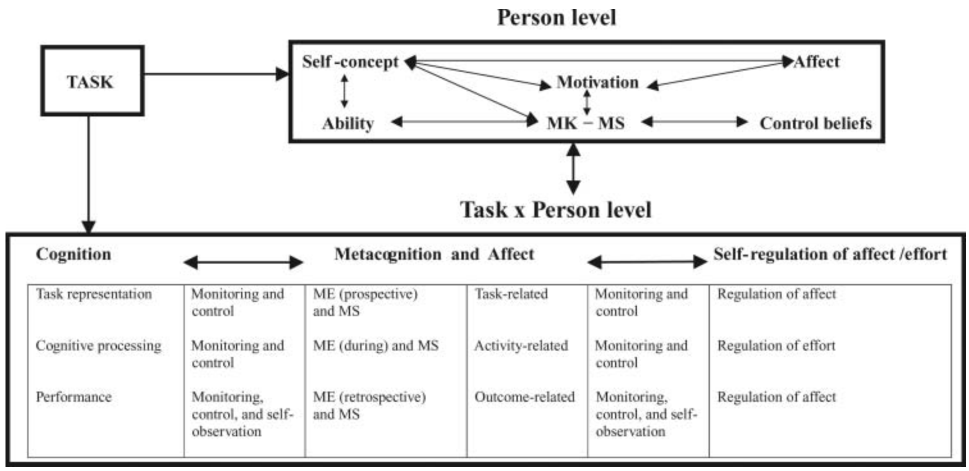

FIGURE 1 The MASRL model. *Note.* ME = metacognitive experiences; MK = metacognitive knowledge; MS = metacognitive skills.

mainly focus on this level of self-regulation functioning with the exception of Winne's (2004) COPES model, which stresses the task-specific level.

When one is executing a task, online task processing takes place at a task-specific microlevel. So do the respective monitoring and control processes. It is this level of self-regulation that is the focus of most of the basic research in metacognition, and this may explain the lack of communication between SRL and metacognition research. This microlevel of functioning is depicted in SRL events (Winne, 2004; see also Greene & Azevedo, 2007). Henceforth it is called the Task × Person level to emphasize the fact that when executing a specific task, the effect of general person characteristics progressively decreases and information coming from the monitoring of features of online task processing (e.g., fluency, cognitive interruptions, conflict of response, etc.) receives precedence; it is this monitoring that triggers control decisions. At this level, metacognition and affect take the form of subjective experiences, that is, the person is experientially aware of the ongoing thinking, feelings, emotions, or physiological states denoting effort exertion during task processing. This awareness provides the input for online self-regulation of task processing and/or effort and affect.

Distinguishing two levels of SRL functioning entails that SRL is not only a top-down process (Zimmerman, 1998, 2008) dictated by the goal set in accordance to general person characteristics; there is also data-driven, bottom-up self-regulation at the microlevel, guided by the monitoring of task processing as it takes place. The mechanism that connects top-down and bottom-up self-regulation is the object of the Metacognitive Affective Model of SRL (the MASRL model; see Figure 1). The model offers a theoretical integration of two largely unrelated lines of research, namely, metacognition and motivation/affect. It posits particular emphasis on the person's subjective experiences (metacognitive and affective) and how they change self-regulation from a top-down process to a bottom-up one and vice versa. The issues the MASRL model aims to account for are the following:

1. Do metacognition, motivation, and affect interact with each other at the Person level, that is, as person characteristics operating across situations? Such interactions may explain how the learner decides to deal with a (learning) task (i.e., go/no-go or how much effort to invest) and, consequently, the origins of top-down self-regulation.
2. How is bottom-up self-regulation taking place? How do cognition, metacognition, motivation, and affect interact to determine self-regulation at the Task × Person level, that is, as the person executes a (learning) task? What role do subjective experiences play in this process?
3. How does self-regulation at the Task × Person level feed back and inform general person characteristics and, thus, transform from task/situation bound to domain-general and long-term self-regulation at the Person level?

The advantage of such a model is that it offers a theoretical framework that integrates notions from different research traditions and paradigms, goes beyond extant models, and allows insight into the mechanisms of the SRL process, particularly on how metacognition and motivation/affect can inform each other at the two levels of SRL functioning. After the presentation of the MASRL model, evidence that supports it is presented and the implications for educational research and practice are discussed.

METACOGNITION, MOTIVATION, AND AFFECT IN SRL MODELS

The origins of the MASRL model can be traced back to the classic sociocognitive theory of self-regulation and extant SRL models. Metacognition, motivation, and affect as components of SRL are found in all models of SRL, although interactions among these components are not necessarily treated in an explicit manner or in terms of the two levels of functioning of SRL posited here. In what follows, the threads connecting the various models and the implications for SRL theorizing are shown.

Sociocognitive Theory and Self-Regulation

Historically, models of SRL were developed in the tradition of Bandura's (1986) sociocognitive theory and emphasize self-regulation in relation to one's goals and in interaction with the environment, mainly the social one. Self-efficacy is a critical notion in Bandura's work; it comprises beliefs people have about their capability to bring about a particular outcome. Self-efficacy is operationalized as confidence the person has in bringing about a specific outcome (e.g., gain a certain grade in a school subject; Pajares, Britner, & Valiante, 2000). Self-efficacy is important because it has motivational power (i.e., it creates expectancies about the outcome of one's efforts) and, therefore, determines the amount of effort to be invested and the persistence on behaviors that are instrumental for attaining one's goal(s). Hence, self-efficacy beliefs constitute a powerful motivational factor in SRL (Boekaerts, 1999; Pintrich, 2000; Winne, 2004; Zimmerman, 1998). Also, important notions in Bandura's theorizing are self-monitoring and self-evaluation, which contribute to successful self-regulation (see Zimmerman, 1998, 2008).

Bandura (1986) connected the development of self-efficacy beliefs, among others, to the monitoring of one's subjective experiences (i.e., mastery experiences), and awareness of physiological states (e.g., arousal during effort exertion) and affect (see also Usher, 2009; Usher & Pajares, 2008). Self-monitoring is clearly a metacognitive process (although not stated as such) and mastery experiences (e.g., confidence during task processing) take the form of ME (Efklides, 2001, 2002a, 2002b, 2006, 2008; Flavell, 1979), which play a complex role in the online regulation of cognition and affect. Specifically, ME are experiences manifested during task processing and take the form of online task-specific knowledge (i.e., task information heeded), active MK, metacognitive judgments/estimates, and metacognitive feelings (Efklides, 2001; Flavell, 1979). One such ME, namely, feeling of difficulty (Efklides, 2001, 2006), is crucial for awareness of problems, regulation of effort, recognition of need for help, or use of strategies. Moreover, feeling of difficulty implicates affect (Efklides, 2006) and, therefore, bridges metacognition with affect and motivation.

On the other hand, vicarious experiences and social feedback or persuasion, which also contribute to self-regulation (Bandura, 1986), give rise to reflection and analytic processes that have as their object one's own and others' cognitive processing, their experiences during learning and the outcomes of their activities. This kind of knowledge constitutes what is called MK (Efklides, 2001, 2008; Flavell, 1979). Metacognitive strategies—also called metacognitive skills (MS; Veenman & Elshout, 1999)—along with MK are crucial for the control of cognition. Specifically, MK comprises declarative knowledge, beliefs, theories retrieved from memory regarding cognitive functions (e.g., memory, attention, etc.), tasks, persons (including one's self), strategies, and goals (Efklides, 2001; Flavell, 1979). Thus, from the point of view of metacognition, self-efficacy is intricately connected to both ME and MK. On the other hand, MS comprise procedural knowledge, strategies such as orienting, planning, self-monitoring, and evaluation (Veenman & Elshout, 1999) that are used for the regulation of cognition. Therefore, the sociocognitive theory seems to acknowledge the importance of metacognition, in the form of ME and MK, for self-regulation, although MS are also involved in self-regulation.

Models of SRL

Following the sociocognitive theory, Zimmerman (1986, 1998, 2008) was the first to envisage the whole process of SRL. He proposed the cyclic model of SRL with three phases in each cycle. Motivation (i.e., self-efficacy, goal orientations, outcome expectations, and task interest/value) along with task analysis determine goal setting and planning at the Forethought phase; the execution of the task follows at the Performance/Volitional Control phase, and self-evaluative and interpretational processes at the Self-Reflection phase, which concludes the SRL cycle. The self-reflections and attributions pave the way for a new SRL cycle. Zimmerman's (1998, 2008) model describes SRL specific to a task but the description of the processes involved is at a macrolevel. The idea is that the learner will use or adapt such processes depending on the needs of the task. The model includes metacognition mainly in the form of MS such as task analysis and planning, self-observation, use of self-control strategies, and self-evaluation. This emphasis on MS is compatible with the conception of SRL as a top-down process leaving less room for spontaneous ME such as metacognitive feelings and affect that serve a bottom-up self-regulation mode.

Pintrich (2000) extended the cyclic model to include four phases, namely, (a) Forethought, (b) Monitoring, (c) Control, and (d) Reaction/Reflection. Pintrich's model is describing SRL from the point of view of the interaction of the person with the task at hand (i.e., Task × Person level) and distinguishes monitoring from control; it also distinguishes different areas of regulation, namely, regulation of cognition, motivation/affect, behavior, and context. Pintrich took a further step and made conjectures on facets of metacognition that are involved in the various phases of SRL in the various areas of regulation. For example, in the case of regulation of cognition, MK is involved in the Forethought phase; it can be activated automatically or deliberately through the use of MS. Feeling of knowing and judgment of learning (i.e., ME; Efklides, 2001, 2008) are manifested in the Monitoring phase; they are indicative of metacognitive awareness and provide input for the regulation of cognition in the Control phase. Cognitive and metacognitive control strategies (i.e., MS) are present in the Control phase, whereas cognitive judgments, in the form of self-evaluation of performance on the task are present at the Reaction/Reflection phase.

In Pintrich's (2000) model metacognitive judgments, such as ease of learning or perceptions of task difficulty, are considered components of the regulation of motivation; thus, they are distinguished from the monitoring of cognition. Yet, this is counterintuitive, because ease-of-learning judgments are based on monitoring of features of material-to-be-learned and predict the rate of learning (Leonesio & Nelson, 1990). Moreover, judgments of learning, which are conceived of as part of the regulation of cognition, may lead not only to the use of cognitive strategies but also to the regulation of effort (Ariel, Dunlosky, & Bailey, 2009).

Another distinguishing feature of Pintrich's (2000) model is the separation of the regulation of behavior from the regulation of both cognition and motivation/affect. Intentions, along with time and effort planning, are present at the Forethought phase of the regulation of behavior. In the monitoring phase monitoring of effort, time use, and need for help are included, as well as self-observation of behavior. However, awareness and monitoring of effort cannot be dissociated from awareness of ME (e.g., feeling of difficulty, ease of learning, judgment of learning, etc.) involved in the regulation of cognition and motivation. Also, control of effort and time cannot be completely independent from the regulation of cognition and motivation/affect. The same critique applies to the notion of regulation of context, which also includes perceptions of the task and its context; these perceptions are interwoven with MK of tasks, which is involved in the regulation of cognition.

Pintrich's (2000) model, although it does acknowledge the importance of metacognition for SRL in various areas, does not place emphasis on affect and on the interactions of metacognition, motivation, and affect. Pintrich was fully aware of the need for research on the linkages between motivation (e.g., achievement goals) and activation of MK or metacognitive awareness (self-monitoring of cognition). However, this line of thinking was not developed. Still, he opened a window for understanding bottom-up self-regulation in SRL. Alternation of top-down with bottom-up self-regulation is mainly emphasized in research on metacognition (Koriat, Ma'ayan, & Nussinson, 2006), but in that line of research there is no reference to motivation or other variables operating at the Person level.

Winne (2004), on the other hand, in the COPES model of SRL envisages a cognitive architecture that involves variables at the Person level (called Cognitive conditions by Winne) and processes at the Task × Person level (called SRL events by Winne). In Winne's model, monitoring and control are included within each of the model's four phases. Monitoring is informed by the cognitive conditions through the standards the latter dictate and informs them back through cognitive evaluations that are based on the monitoring function. From the point of view of metacognition, these cognitive evaluations are metacognitive in nature, that is, ME such as ease of learning, judgment of learning, feeling of confidence, and so on. On the other hand, MK of task and MS are part of the cognitive conditions that inform the standards and control processes, respectively. However, the model places less emphasis on motivational and affective factors, although they are included in the components of the cognitive conditions and can be present in SRL events.

Greene and Azevedo (2009), following Winne's model, made a detailed analysis of think-aloud protocols with respect to the activities manifested in SRL events. They showed that the various microlevel activities depicted in think-aloud protocols can be categorized as five macrolevel SRL processes, namely, planning, monitoring, strategy use, handling of task difficulty and demands, and interest activities. The first four of the macrolevel activities are indicative of cognition and metacognition, whereas the last one is indicative of motivation and affect. These activities are orchestrated by the needs of task processing. This kind of research is important for understanding self-regulation at the Task × Person level, but the effects of conditions on online processing, although present in the theoretical model, are not easily identified if one focuses only on processes at the microlevel.

According to the three-layered model (Boekaerts, 1996, 1997, 1999; Boekaerts & Niemivirta, 2000), SRL involves (a) regulation of the self (i.e., choice of goals and resources), (b) regulation of the learning process (i.e., use of MK and MS to direct one's learning), and (c) regulation of processing modes (i.e., choice of cognitive strategies). Regulation of the self represents the broader (general) layer. Regulation of the learning process represents the intermediate layer, whereas the regulation of processing modes (mastery/cognitive vs. coping/affective) represents the more focused layer, which is specific to the task. Thus, the three-layer model is positing the self as the guiding force of SRL that gives coherence and integration to the SRL process. Moreover, motivation and affect are considered crucial for the determination of the processing mode, cognitive or affective. Adopting (or switching from) one processing mode over another depends on appraisals of the task. The appraisals may take the form of ME such as feeling of confidence (see Boekaerts & Rozendaal, 2010). Therefore, Boekaerts's model allows for interactions among metacognition, motivation, and affect; however, Boekaerts views affect more in terms of a threat to the self and coping to maintain one's well-being rather than as an indispensable component of any cognitive processing.

To sum up, the extant SRL models vary in regards to the emphasis they place on the self as the basic organizing principle of SRL or on the task with the self at the background. However, the emphasis on the self or the task has implications for the conceptualization of the SRL process, that is, being only (or primarily) a top-down process guided by the self (or person characteristics), or primarily a bottom-up process guided by the task and the person's metacognition and affect arising in response to cognitive processing.

THE MASRL MODEL

The *Metacognitive and Affective Model of SRL* (MASRL model) proposed here (see Figure 1) focuses on the self-regulation of cognition and motivation/affect and less so on the self-regulation of behavior or the environment/context. Yet, for the self-regulation of cognition and motivation/affect one may also use strategies that control the behavior or the environment/context—that is, regulation of behavior and environment/context is a means rather than a goal in and of itself.

Specifically, the Person level involves cognitive, metacognitive, motivational, affective, and volitional person characteristics that summarize the person's relatively stable characteristics (traits) as they have been formed in different (or representative, from the person's point of view) learning occasions. These are the person's relatively stable resources that lead to decisions regarding engagement with a particular task and top-down self-regulation. However, any decisions can be modified, changed, or cancelled depending on the monitoring of task processing and the subjective experiences associated with it in bottom-up self-regulation. For example, one may start with the belief that a problem can be easily solved but, while working on it, because of the experienced feeling of difficulty, give up the effort to solve it. These subjective experiences take the form of ME and/or affective reactions (e.g., positive or negative affect) as the person works on the task. Task processing and the subjective experiences that go with it constitute the Task × Person level. The Person and the Task × Person levels interact and inform each other so that what is specific and transient at the Task × Person level may feed back and inform the more stable person characteristics and vice versa.

As shown in Figure 1, the Task, as embedded in a specific situation and context, is an entity independent from the two levels of SRL but impacts them both. Thus, self-regulation is always done in response to the task, but the way it is done is differentiated in the two levels.

The Task

The MASRL model is based on the idea that learning tasks can be objectively defined based on task features such as novelty, complexity, conceptual requirements, mode of presentation, and so on (Efklides, Papadaki, Papantoniou, & Kiosseoglou, 1997, 1998), and on instructional goals. Moreover, tasks are embedded within contexts (e.g., learning environments) of various affordances or constraints (Winne, 2004). However, the person's representation of the task is not necessarily the same as the objective task characteristics or the instructional goals. When coming across a task, individuals bring along with them more or less stable person characteristics, such as cognitive ability and metacognitive task knowledge, which are independent from the particular task to be carried out and which mediate the representation of the task.

The Person Level

The Person level represents a generalized level of SRL functioning. It is operative when one views a task resorting mainly on memory knowledge, skills, motivational and metacognitive beliefs, and affect (e.g., attitudes or dispositions). The task is perceived in general terms (i.e., as representative of a class of tasks rather than as a specific task with its peculiarities that require the person's attention). An individual can be said to be operating at the Person level in situations such as the following:

1. When one thinks of a task and how to deal with it (e.g., go on and get involved or avoid it, how much effort to invest, how to deal with failure, etc.). Thus, the person builds a framework of action based on a gross task analysis, goal setting, and planning without going into details and without starting task processing. For example, "This is a mathematical problem with fractions" (i.e., MK of the task); "I know how to deal with fractions" (MK of the person/self); "I like this kind of problems" (i.e., affective reaction); "I will solve it" (i.e., goal setting). Alternatively, "This is mathematics; I am not good in mathematics; I cannot do it. Why should I try?"
2. When one gives instructions, help (e.g., cues), or explanations in general terms using MK of task and MK of strategies. Also, when one encourages someone or predicts how the other will feel during task processing. For example, "I know you can do it" (motivation; MK of person).
3. When one recalls or reflects on the experiences, feelings, thoughts she or he (or another person) had when working on a task, the interest or dislike developed in the respective domain (i.e., MK of person/self, or MK of task, or MK of strategies).

These examples suggest that the Person level may serve self-regulation or other-regulation and is operative before or after working on a task at the Task × Person level. The examples also suggest that the person has explicit knowledge (i.e., MK) and access to task- and self- or other-related memory knowledge, to motivational beliefs and considerations, as well as to affect. However, implicit theories (e.g., of ability; Dweck, 1998) and/or automatic processes (cognitive or affective) can also exert their effects on the decisions made at the Person level without the person being aware of them.

The Person level in the MASRL model comprises cognitive, motivational, metacognitive, affective, and volitional components; these components can interact. The specific components posited are the following: (a) *Cognition* in the form of the person's *capabilities* (ability, knowledge, skills) or *competences*; (b) *Motivation*, in the form of achievement goal orientations and of expectancy-value beliefs; (c) *Self-concept* as a representation of one's competence in various domains; (d) *Affect* in the form of attitudes (i.e., cognitive, affective, and behavioral dispositions), and emotions (e.g., anxiety, interest, fear, pride, shame as enduring dispositions) in relation to learning; (e) *Volition* in the form of *perceptions of control*;[1] (f) *Metacognition* in the form of MK that captures the person's learning history as knowledge of the self and of others, as well as of tasks, goals, and strategies. Furthermore, MK comprises the person's beliefs about cognition or about memory and other cognitive processes, implicit theories of intelligence, epistemic knowledge and epistemological beliefs; and (g) *Metacognition* in the form of MS and learning strategies, which constitute the person's usual strategies (e.g., planning, self-monitoring, use of cognitive strategies, and self-evaluation) for the control of cognition and learning.

Component Interactions at the Person Level

Cognition and metacognition are by definition interrelated, as MK is a representation of cognition and MS are a means for the control of cognition. However, motivation can also be related to MK. Specifically, in the expectancy-value theory of motivation (Eccles & Wigfield, 2002; Wigfield & Eccles, 2000) expectancy of success is based in part on self-perceptions of ability, on perceptions of tasks and their demands, and perceptions of others' beliefs about the person's ability. Perceptions of ability are, in essence, MK about the self and the domains in which the person is strong or weak (Flavell, 1979). Perceptions of tasks, on the other hand, are the person's beliefs about task difficulty and effort demands (Watt, 2004), that is, they constitute MK of tasks. Thus, MK of persons and tasks is implicated in motivation in the sense of creating expectations of success.

Value beliefs are based on previous achievement-related experiences and their interpretation (i.e., causal attributions), on one's self-schemata and on affective memories that mediate the effects of prior achievement-related experiences on subjective task value (Wigfield & Eccles, 2000). From the point of view of metacognition, the person's representation of achievement-related experiences and affect felt in achievement situations are essentially the memory of ME and emotions the person experienced during task processing (e.g., feeling of difficulty, feeling of confidence, feeling of satisfaction, anxiety, or pride for the response produced), or when the person or significant others evaluated his or her performance. These achievement-related experiences and affect provide the database for the formation of MK of the self and tasks as well as for interpretational processes (e.g., causal attributions) that shape the subjective task value (Wigfield & Eccles, 2000). Therefore, the person's MK of the self and tasks along with memory of ME and affect experienced in association to task processing and performance are crucial for the formation of expectancy-value beliefs.

On the other hand, achievement goal orientations are theoretically linked to beliefs about ability, such as implicit theories of intelligence (i.e., whether intelligence is malleable and controllable or a non-changing, stable entity; see Dweck, 1998). Implicit theories of intelligence regard the nature of cognition and ability and, hence, constitute MK (Nelson, Kruglanski, & Jost, 1998). This implies that achievement goal orientations can be related to MK, although it is not clear whether this is done only through implicit theories of intelligence.

Another kind of MK that is often assumed to have motivational power in the context of SRL is epistemological beliefs (see Butler & Winne, 1995; Hofer & Pintrich, 1997). Epistemological beliefs regard the nature of knowledge and knowing (Schommer-Aikins & Easter, 2008); for example, that knowledge is simple and certain or that knowledge is readily acquired (speed of knowledge acquisition). Although there is ongoing debate about the dimensions underlying epistemological beliefs (Bråten & Strømsø, 2005), there is evidence that they are related to implicit theories of intelligence, to self-efficacy beliefs, and to achievement goal orientations (Bråten & Strømsø, 2005). Hence, epistemological beliefs can exert their motivational effects through their association with motivational beliefs and goal orientations but also through their effect on MS and selection of cognitive strategies and the decision regarding how much time and effort to be invested in task processing.

Self-concept is also considered to have motivational power. Although, to my knowledge, there is no study that directly compares self-concept of competence with MK of the self, it is plausible to assume that MK of the self captures not only the person's competence in a domain, as self-concept does (Harter, 1985), but also the situations the person encountered and experiences he or she had, that is, what kind of difficulties the person faced, how they were resolved, what are the preferred strategies, tasks, and so on. Therefore, MK has to do with self-perception as cognitive processor. Self-concept of competence, on the other hand, involves not only self-perception of ability, which is cognitive in nature and presumably closer to MK, but also self-efficacy beliefs (Bong & Skaalvik, 2003) that have a motivational character as well as self-esteem, which is the affective response to one's self (Harter, 1985). Therefore, self-concept has a motivational, an affective, and a (meta)cognitive character. Moreover, self-concept may involve social comparison and

[1] Perceptions of control are beliefs the person has about him- or herself as an agent (Skinner, 1995). Perceptions of control comprise means-end beliefs, control beliefs, and agency beliefs.

one's beliefs about one's positioning in relation to others as well as perceptions of how the others perceive his or her ability (Dermitzaki & Efklides, 2000). Representation of others' competence and of others' perceptions of one's self are also metacognitive in nature since they refer to one's and others' cognition and constitute MK of persons.

Perceptions of control can also interact with MK and MS. From a metacognitive point of view, means-ends beliefs presuppose MK of goals, tasks, and strategies as well as MS as control strategies; perceptions of control and agency beliefs presuppose MK of the self as agent. Specifically, agency beliefs can be based on memory of ME the person had with task/situations where he or she was in control (Metcalfe & Greene, 2007) as compared to tasks/situations in which he or she was not.

Finally, affect (e.g., academic emotions) is independent from MK, but it is related to motivation (Pekrun, Elliot, & Maier, 2006). According to Pekrun's control-value theory (Pekrun et al., 2006), academic emotions should be also related to perceived control and value beliefs. Therefore, one may hypothesize indirect relations of academic emotions with MK through perceptions of control and motivation. Moreover, academic emotions can have a direct effect on MS such as self-monitoring (Perry, Hladkyj, Pekrun, & Pelletier, 2001), because MS are related to the control of cognition. Attitudes, on the other hand, represent how one feels about a task/task-domain, how much one likes it (or not). Attitudes also have a cognitive component (i.e., beliefs) and behavioral dispositions (e.g., approach-avoidance behaviors) toward the task/task-domain (McLeod, 1989). Hence, they should be related to MK of the self, task/task-domain, and strategies. Therefore, affect may have direct or indirect relations with MK, although it could have a direct effect on MS.

To sum up, at the Person level interactions between person characteristics can be identified and it is these interactions that impact the person's SRL.

The Functioning of the Person Level

All person characteristics constitute the endowment one brings along when confronted with a learning task/situation. At the *Person level*, a general decision for the processing of the task at hand is formed, particularly on the effort to be invested (Brehm & Self, 1989; Kahneman, 1973). Specifically, at the Person level the scene is set in a way that guides cognitive processing and the amount of effort the person is willing to invest in the particular task. Such a general decision is formed based on the interactions of the person's competences, self-concept in the task domain, motivation, and affect, vis-à-vis the perception of the task and its demands. Hence, at the Person level, when a student is entering a learning situation, for instance, a test involving mathematics, he or she activates his or her domain-specific knowledge and skills, as well as MK, to decode the concepts or skills needed—at a general rather than microlevel (e.g., the test is on fractions and problems are easy); at the same time, the student "predicts" that she or he will most probably succeed, because he or she is good in mathematics and in the classroom they had a lot of practice on fractions. The student also "feels" good because she or he likes mathematics and believes that mathematics is worth working on and worth the effort. The negative scenario would be that the student predicts failure, feels fear or anxiety, and gives up or decides to put as little effort forth as possible to avoid costs in self-perception, or others' perception of his or her competence. A third scenario is that the student, due to lack of or limited prior knowledge and skills on fractions, underestimates the task demands (e.g., the student thinks that the fraction problems are easy) and overestimates his or her ability to deal with the task (i.e., the student is ignorant and unaware of it; Kruger & Dunning, 1999). Consequently, the student feels good, predicts a successful outcome, and sets out to solve the fraction problems anticipating little effort expenditure and successful outcome. (The opposite could also be true if the student overestimates task demands.)

As shown in this example, the student's prediction of the learning outcome is based on his or her self-concept in the knowledge/task domain and on the overall perception of task demands as represented by prior knowledge and MK of tasks and persons (in this case, one's self); all these provide input for the expectancy component of the expectancy-value beliefs and for the activation of achievement goal orientations. Feeling good emerges from a positive attitude toward the specific knowledge/task domain, or from interest as a relatively stable disposition toward the knowledge/task domain, or from the positive self-concept of competence in the knowledge/task domain. The person's affective substratum toward the task is, thus, formed at the Person level and contributes to the intrinsic value attached to the task. (This value is also determined by beliefs about attainment, utility, or cost; see Eccles & Wiegfield, 2002). Hence, the willingness to get involved in task processing is formed (goal setting). At the same time, perceptions of control along with perceptions of task demands give direction to memory activation of MS and MK of goals, standards, and epistemological beliefs. Perceptions of control and MK, in their turn, along with achievement goal orientations contribute to the activation of control strategies to be used and the decision for effort expenditure.

Therefore, it is the interaction among the components of SRL at the Person level as orchestrated by the self that shapes the person's decisions regarding how to deal with a task/situation. Individual differences in these kinds of decisions can be understood not only in terms of differences in single person characteristics but also in terms of differences in constellations of person characteristics (e.g., profiles of goal orientations and other person characteristics) formed because of the interactions that exist among the person characteristics.

The Task × Person Level

When the person is engaged in task processing, the level at which SRL is functioning is the Task × Person level. This is the hands-on, online, or microlevel of task processing, where SRL events take place (Efklides, 2001; Greene & Azevedo, 2009; Winne, 2004). It is the level where the task is processed rather than deciding on whether (and how) to process the task—the latter corresponding to decisions at the Person level. The Task × Person level can follow the deliberate goal setting and general planning decided at the Person level. In such a case, analytic task representation and cognitive processing takes place in a goal-driven, top-down self-regulation mode. However, the Task × Person level can also start on its own following the task presentation. In this case, there is an initial screening of the task based on automatic or nonconscious processes guided by familiarity (Scott & Dienes, 2010).

This conception of the SRL functioning at the Task × Person level presupposes a cognitive architecture in which there are conscious analytic processes and explicit knowledge as well as nonconscious automatic processes and implicit knowledge that have a direct effect on behavior (Kahneman, 2003; Stanovich & West, 2000). Explicit knowledge presupposes conscious awareness of one's knowledge of the world as well as of one's self in relation to the world, whereas implicit knowledge is making use of nonconscious heuristic processes. Nonconscious heuristic processes underlie both cognitive processing and the formation of metacognitive feelings (Koriat & Levy-Sadot, 2000). On the contrary, metacognitive judgments and other forms of ME, such as online task-specific knowledge, are based on conscious analytic processes or explicit knowledge (Efklides, 2001). The fact is that metacognitive feelings, although produced by nonconscious processes, themselves are objects of conscious awareness. Thus, they contribute to self-awareness, including awareness of one's motivation and affect (i.e., drive; Stuss & Benson, 1986), and initiate data-driven or bottom-up self-regulation.

At the Task × Person level, four basic functions are operative, namely, cognition, metacognition, affect, and regulation of affect and effort. One way to describe these four functions is to look at each one of them separately, thus reading Figure 1 in a vertical mode. Another way is to read it in a horizontal mode, with emphasis on the integration of the various functions and the unified character of conscious experience. The second mode is followed in the following description. In doing so the notion of "phases" is used, although it is understood that task processing is a continuous process. The "phases" serve the idea that there is a logical temporal order (beginning, during, after task processing) and that task processing can be interrupted and resumed because of obstacles in cognitive processing or feedback from monitoring and control processes at some critical points that correspond to the temporal "phases."

Motivation at the Task × Person Level

Before starting the description of the various phases of the Task × Person level, it is important to point out that the MASRL model does not include motivation as a distinct component operating at this level. This does not mean that there is no motivation during task processing. It is rather that motivation arises in response to the metacognitive and affective experiences triggered by actual task demands, the content of the task (topic), the familiarity with the task, the situational/context factors that trigger interest in the task (Ainley, Hidi, & Berndorff, 2002), and expectancy-value considerations specific to the task (Nurmi & Aunola, 2005). However, expectancy-value considerations are based on the interactions among the person's ME. As the person processes the task, there is no reason to wonder if it is worth doing so; this decision has already been made. The "go ahead" decision is revisited only if task processing is interrupted or failed at some point or when performance does not meet the standards posited by the goal. In such cases, the person reconsiders the situation (expectancy-value) in order for one to be able to start a new round of task processing (a new SRL event) or to quit. However, this revision of decision making is again taking place at the Person level, that is, when the input comes from both the Task and the Person level—the latter enriched with information from the Task × Person level (e.g., too much effort vs. low feeling of confidence in the outcome of processing).

Specifically, during task processing motivation may take the form of intrinsic motivation (e.g., enjoyment of task processing) or of unpleasant affect (e.g., boredom) or state anxiety experienced as increased arousal, worry, and intruding thoughts (Eysenck, Derackshan, Santos, & Calvo, 2007; Sarason, 1988). There is also motivation arising from emotional states, such as surprise, because some unexpected/discrepant event has occurred or some new information has emerged (Teigen & Keren, 2002), or from curiosity because there is deprivation of information that should be there in order for one to be able to continue task processing (Litman, 2005). Consequently, there is intrinsic motivation, but it takes forms other than just interest or enjoyment as theories of intrinsic motivation posit (Ryan & Deci, 2000).

Metacognitive feelings are ME that particularly contribute to motivation at the Task × Person level (Koriat, 2000). For example, feeling of knowing and the tip-of-the-tongue experience (Metcalfe, 2000) create the expectation that the required information is available in memory, although at the moment it is inaccessible despite one's efforts. Hence, these metacognitive feelings motivate further memory search and use of control strategies (Koriat, 2000, 2007). Also, when a student is feeling difficulty during task processing, awareness of this feeling provides input for effort regulation (Efklides, Kourkoulou, Mitsiou, & Ziliaskopoulou, 2006), whereas feeling of confidence and feeling of satisfaction about the correctness of one's response (Efklides, 2002a, 2002b) are indicative of the monitoring of the outcome of task processing and motivate the decision to conclude task processing or start a new round of it. Finally, judgment of learning is motivating online control decisions such as time allocation.

Metacognitive feelings, besides their informational and motivational character, contribute to motivation through another route as well, namely, affect. They have an affective character (Efklides, 2001; Efklides & Petkaki, 2005; Schwarz & Clore, 1984; Winkielman & Cacioppo, 2001), that is, they have a pleasant or unpleasant quality. According to Carver and Scheier (1998; Carver, 2003) there is a feedback system based on constant monitoring of the outcomes of our activities vis-à-vis the goal set and a secondary meta-monitoring feedback system that monitors the rate with which we approach our goals (i.e., the progress according to a time schedule specified in advance). This meta-monitoring feedback system gives rise to affect (neutral, positive, or negative) and a vague expectation about the outcome of the activity. Feeling of difficulty, from this point of view, is an unpleasant feeling (Efklides, 2006; see also Winkielman & Cacioppo, 2001) because it denotes that the rate with which one progresses toward the goal set is not satisfactory. However, feeling of difficulty does not denote the source of the slow (or no) progress and, therefore, analytic processing is required (Alter, Oppenheimer, Epley, & Eyre, 2007) to overcome the difficulty experienced. Thus, the person is alerted through an unpleasant affective cue and, at the same time, attention is directed to the possible source (self-related factors, task or processing features, behavioral/environmental factors) that slowed down cognitive processing. Moreover, feeling of difficulty triggers control processes, such as strategy use (Efklides, Samara, & Petropoulou, 1999).

Metacognitive feelings also trigger attributions regarding the outcome of cognitive processing; for example, feeling of confidence leads to attribution of ability, whereas feeling of difficulty lead to attribution of task difficulty (Metallidou & Efklides, 2001). These attributions have implications for the expectancy of success and task value and may lead to the continuation of engagement or to the abandoning of the task at a next SRL cycle. Therefore, there are interactions between ME and affect, and it is these interactions that shape motivation as the person works on a task.

The Functioning of the Task × Person Level: The Three Phases of Task Processing

The MASRL model hypothesizes three phases in task processing: (a) Task Representation (beginning task processing), (b) Cognitive Processing (during task processing), and (c) Performance (after task processing, i.e, when the outcome of processing is manifested in one's behavior and attainment as well as in the effects of one's performance on the environment). These phases are depicted under the label Cognition (see Figure 1) because cognition is the medium and the determinant of task processing and performance. Monitoring and control processes are assumed to be present in all three temporal phases. Monitoring and control are depicted in a different column to demonstrate that they pervade task processing from the beginning to its end (viz., performance). However, the Performance phase differs from the Cognitive Processing phase because performance can be observed and explicitly evaluated, whereas monitoring and control during task representation and cognitive processing either is nonconscious or takes the form of inner subjective experiences, such as ME that constitute the contents of conscious awareness (Efklides, 2008).

Task representation phase. Task representation is guided by a closer inspection and representation of the specifics of the task at hand. It refines the initial overall perception of the task and leads to goal setting and planning, which are specific to the task and its requirements rather than an initial "go ahead" decision. There are two kinds of processes that can be involved in task representation. The first is automatic or overlearned processes, based on familiarity, which run fluently, effortlessly, and often out of conscious awareness; only their outcome is represented in consciousness. The second kind of processes is analytic and triggered by cognitive interruption due to task novelty, complexity, increased cognitive load, or lack of information and/or knowledge (Alter et al., 2007). In the latter case, there is mismatch between task features and the person's prior knowledge; this mismatch requires analytic and effortful processing for the building of the task representation.

In the case of automatic processing, the representation of task content is spontaneous, intuitive, and comes to awareness immediately (e.g., when one reads and comprehends what is being written automatically). Prospective ME that inform the fluency of task representation take the form of online task-specific knowledge (Efklides, 2001), feeling of familiarity (Whittlesea, 1993), rapid feeling of knowing (Reder & Schunn, 1996), or ease-of-learning judgment (Leonesio & Nelson, 1990). All of these ME denote fluency in processing and create an expectation of successful task processing. The person's affective state is neutral or moderately positive (Carver & Scheier, 1998) with no awareness of increased physiological activity. This implies that there is automatic modulation of affect and effort without the use of conscious control processes for their regulation.

In the case of analytic and effortful processing for task representation, there is metacognitive awareness of online task-specific knowledge accompanied with a sense that this knowledge is not coherent or does not make sense; that is, the representation of the task content is fragmented or the relations/paths between the data in the task and the required response are not evident. The principal prospective ME that arise are feeling of difficulty and/or lack of understanding. Feeling of difficulty denotes lack of fluency (Efklides, 2001, 2002a) and metacomprehension denotes failure in meaning making (Dunlonsky, Baker, Rawson, & Hertzog, 2006). The person's affective state turns negative, and there is awareness of increased attention and arousal—both of these processes are the outcome of automatic, spontaneous control processes. In this case the expectation is that task processing may not be successful (e.g., judgment of learning). Consequently, self-regulation becomes a data-driven bottom-up process; control processes that have already taken place and updated the person's awareness of effort inform the ensuing monitoring (judgment of learning; Koriat et al., 2006) and control. Thus, ME trigger metacognitive control processes such as active memory search for relevant information (Nelson & Narens, 1994) or orienting questions (Veenman & Elshout, 1999). Finally, estimates of effort and of time needed for task processing (Efklides, 2001, 2002a) can be made based on the feeling of difficulty experienced and the rate with which cognitive interruption is being restored. As a consequence, self-regulation can alternate between a top-down mode, in which the person's goal (or the self) guides monitoring and control processes (see also agenda-based self-regulation; Ariel et al., 2009), and a data-driven or bottom-up mode based on awareness of ME and affect.

Other emotions such as interest, surprise, curiosity, or anxiety may also be experienced at the Task Representation phase. All of these ME and emotions refocus attention on task processing, or memory, or contextual information. They can be pertinent to task representation and, thus, facilitate the representation of the task. This process also has effects on the person's affective state (e.g., positive or negative affect), which depends on the resolution of the uncertainty (Bar-Anan, Wilson, & Gilbert, 2009) or the restoring of the cognitive interruption that had occurred during task representation. For example, a positive outcome in meaning making and building of the task representation is associated with positive affect (Iran-Nejad, 1987; Winkielman & Cacioppo, 2001). Positive affect in turn increases the perceived relatedness between success expectancy, effort, and likely performance (expectancy motivation; Erez & Isen, 2002). If, on the other hand, negative affect (anxiety) is becoming too strong or interferes with the attempt to form the task representation (Eysenck et al., 2007) then regulation of affect can be attempted through, for example, relaxation, reappraisals, or expressive suppression (Dillon, Ritchey, Johnson, & LaBar, 2007). The conscious emotion regulation strategies, however, may adversely impact subsequent task processing depending on the regulation strategy opted (Dillon et al., 2007).

Cognitive processing phase. Cognitive processing can be based on nonanalytic processes following the automatic task representation and memory retrieval of the required response. In this case, the ME are denoting fluency in task processing and rapid, effortless generation of the response. The affective state remains neutral or positive, and no conscious effort regulation is needed.

In all other cases where task representation was based on effortful processes, the probability of interruption in cognitive processing and error occurrence is increased. Cognitive interruption may occur due to lack of ready-made schemas in memory and/or conflict of response (Touroutoglou & Efklides, 2010). Moreover, cognitive overload may occur due to working memory constraints, and error may occur during the assembly of processing schemas (Ayres, 2006). Feeling of difficulty and estimates of effort and time are triggered by the monitoring of cognitive load and/or interruption of cognitive processing (Touroutoglou & Efklides, 2010); these are ME that arise during cognitive processing. The tip-of-the-tongue experience (i.e., recall of part of the response; Hart, 1965), feeling of knowing (Koriat, 2007), as well as judgment of learning (Dunlonsky et al., 2006; Koriat & Ma'ayan, 2005) or error detection (Van Veen & Carter, 2002) are other ME based on the monitoring of cognitive processing. In turn, ME trigger deliberate control decisions for use of cognitive strategies and/or use of MS to guide and regulate cognitive processing.

At the same time, monitoring of interruption or conflict in cognitive processing is triggering affective reactions and awareness of increased physiological activity such as arousal and effort exertion in the form of intensive cognitive activity or physiological symptoms (e.g., exhaustion). Negative or positive affect depending on the fluency of processing and the rate of progress, as well as emotions, such as interest, fear, anger, excitement (Ainley, Corrigan, & Richardson, 2005), surprise, curiosity, or anxiety may also occur. Regulation of affect and effort is ensued if needed.

Performance phase. When cognitive processing is completed and the response is produced, ME that monitor the outcome of cognitive processing are triggered, such as estimate of solution correctness, feeling of confidence, and feeling of satisfaction (Efklides, 2002a, 2002b). Estimate of solution correctness is a rough judgment on the accuracy of response, whereas feeling of confidence is based on the estimate of solution correctness as well as on feeling of difficulty (Efklides, 2002b). Finally, feeling of satisfaction is related to the other two ME and is monitoring the extent to which the standards of the goal set are satisfied (Frijda, 1986). Positive or negative affect accompany the monitoring of the outcome of cognitive processing such as liking of the task (in the case of successful processing) or anxiety in the case of errors detected (Dina & Efklides, 2009a). In the latter case reiteration of cognitive processing is needed as well as conscious regulation of effort and affect. In case the ME and affect inform the person that the outcome of cognitive processing is what was expected, cognitive processing is terminated and attention turns to self-observation of performance.

Self-observation allows explicit evaluation of the accuracy of response and attainment. External feedback may also be provided contingent on performance. Self-reflection on the experiences (metacognitive and affective) the person has had during cognitive processing vis-à-vis the task and its context, as well as the external feedback, takes place and attributions are made (Metallidou & Efklides, 2001). Positive or negative affect depending on the evaluation of performance occurs (Pintrich, 2000; Zimmerman, 1998, 2008) as well as emotions such as pride or shame (Pekrun et al., 2006). Regulation of affect is implemented if maintenance or higher level of performance is needed in view of long-term goals.

To sum up, the close linkages of metacognition and affect with cognition are depicted in the MASRL model (see Figure 1) by putting metacognition and affect adjunct to cognition. What is further posited in the MASRL model is that affect impacts cognition directly; for example, positive or negative affect may enhance holistic or analytic processing modes, respectively (Kuhl, 2001; see also "hot thought" by Thagard, 2006). Moreover, affect (e.g., mood) is also taken to impact ME and their intensity (Efklides & Petkaki, 2005). On the other hand, monitoring and control of affect that arises in response to cognitive processing is depicted as a different regulatory loop. This loop involves both nonconscious modulation of affect and effort as well as conscious regulation based on deliberate strategy use for the control of affect and effort (Gross, 1998). Hence, monitoring of task processing, from the beginning to its end, can lead to regulation and control of both online cognition and affect (including effort).

Therefore, although online SRL (i.e., at the Task × Person level) can start as a top-down process guided by the self or one's goals in a proactive way (Zimmerman, 2008), as task processing takes place, data-driven monitoring of processing fluency or interruption occurs leading to bottom-up self-regulation. In this way self-regulation is responsive to task-processing features and is based on the ME and affective experiences that go with it. However, alternations between the two modes of self-regulation can be detected, because the subjective intrinsic feedback originating from ME and affect, as well as from performance and its evaluation, feed back onto the Person level; that is, the Person level is informed by the Task × Person level and is informing the subsequent online task processing and the ensued metacognitive and affective regulation in case of reiterated cognitive processing or future encounters with similar tasks (Efklides & Tsiora, 2002).

EMPIRICAL EVIDENCE IN SUPPORT OF THE MASRL MODEL

The basic tenets of the MASRL model are the following: (a) There are two identifiable levels of functioning in SRL, namely, the Person level and the Task × Person level, with the Task influencing both levels. Moreover, there are reciprocal effects between the two levels. (b) There are relations of metacognition with motivation and affect within and across the two levels. (c) Metacognition takes different forms at the two levels, with MK and MS occurring at both levels and ME being specific to the Task × Person level. Of them, ME, and particularly metacognitive feelings along with affective responses, are crucial for the short- and long-term regulation of motivation and SRL.

Consequently, empirical evidence that shows interactions among metacognition, motivation, and affect within and across the two levels can support the MASRL model. However, as extant research is not necessarily making the distinction between two levels in SRL, the following convention was adopted in the presentation of the research evidence. Self-reports on questionnaires tapping the person's beliefs, perceptions, and usual response to various subject matters (e.g., mathematics) or to task domains (e.g., writing) are taken as indicative of variables of the Person level. Self-ratings of one's metacognitive or affective response to a specific task which is to be (or was) carried out are taken as indicative of variables of the Task × Person level. Combinations of the two kinds of measures offer the database for the relations between the two levels. Moreover, because the various studies reviewed do not use the same terminology when dealing with the various facets of metacognition, the evidence they provide is interpreted in terms of the definitions of the various facets of metacognition given in the Introduction.

Interactions of Metacognition With Motivation and Affect at the Person Level

A key component of the Person level that is closely connected to SRL is self-concept (Dermitzaki & Efklides, 2000). As predicted in the MASRL model, self-concept should be connected to MK, affect, and motivation, and these interactions would affect SRL. Moreover, interactions would be evident in different person profiles.

In the very informative title of their work "I Like to Do It, I'm Able, and I Know I Am," Denissen, Zarrett, and Eccles (2007) epitomized the close relations between affect (liking and interest), cognitive ability (as captured in one's school achievement in a subject matter), and MK in the form of awareness of one's strengths or weaknesses (conceptualized as self-concept of competence in a specific knowledge domain). Goetz, Frenzel, Hall, and Pekrun (2008) also showed that academic achievement predicted students' self-concept and the latter predicted enjoyment of learning as a person characteristic. Of course, self-concept is not associated only with positive affect. Pomerantz and Rudolph (2003) showed that negative affect (e.g., emotional distress) predicted the person's negative beliefs (i.e., MK) about the self and the world; these beliefs, in turn, led to an underestimation of competence, that is, of self-concept. Thus, it seems that self-concept influences affect and affect influences self-concept.

On the other hand, self-concept and affect are related to achievement goal orientations. Specifically, Dina and Efklides (2009b) used questionnaires on self-concept in mathematics, attitude toward mathematics, anxiety trait, and achievement goal orientations along with measures of ability in mathematics. They identified eight student profiles. The profiles differed in the person characteristics they involved. Of particular interest are five of the profiles that involved, as distinctive features, self-concept in mathematics and attitudes toward mathematics. High self-concept was associated with high positive attitude and low self-concept with low attitude. Moreover, self-concept and attitude were associated with different manifestations of achievement goal orientations in the various profiles. For example, one of the highest achieving profiles involved high self-concept, high positive attitude toward mathematics, and high mastery and performance-approach goal orientations; another profile—similarly successful in school—comprised high self-concept, high positive attitude toward mathematics, low anxiety trait, and low performance-avoidance goal orientation. Low self-concept and low positive attitude toward mathematics were associated with low mastery goal orientation in one profile, or with high performance goal orientations (both approach and avoidance) in another profile. It is worth noting that anxiety trait and ability in mathematics were not necessary constituents of the various profiles. They coexisted with self-concept in some profiles, but they defined other profiles by themselves. For example, high ability in mathematics was associated only with anxiety trait in one profile, and low anxiety trait was the only defining characteristic of another profile. This evidence suggests that the various person characteristics tend to interact in various ways and have differential effects on school performance as well as on task performance. However, ability and emotions, such as anxiety trait, may have independent effects as well.

Relations between goal orientations, self-concept, self-efficacy for outcome and for self-regulation, and negative affect (apprehension) were also shown by Pajares et al. (2000). Specifically, they showed that task (or mastery) goal orientation positively correlated with self-concept and self-efficacy and negatively with apprehension. Performance-approach goal orientation correlated only with self-concept, whereas performance-avoidance correlated negatively with self-concept and self-efficacy and positively with apprehension. Therefore, there is substantial evidence on interrelations of self-concept with affect and motivation, although there is scarcity of research on MK of the self as such, independently of self-concept.

The MASRL model also predicts that self-concept along with motivation should be related to MS. Skaalvik and Skaalvik (2005) found that self-concept in mathematics of adult students, which was related to their achievement through the school years, predicted their goal orientations, intrinsic motivation, and use of learning strategies as adults. Shell and Husman (2008) identified three constellations of person characteristics that involved self-efficacy, affect, and goal orientations. They found that high self-efficacy, high outcome expectations, effort attribution, positive affect, and mastery and performance-approach goal orientations were associated with strategy use and study effort. In a similar vein, Turner, Thorpe, and Meyer (1998) identified four clusters of students when goal orientations were measured along with self-efficacy, affect after failure, and self-regulatory beliefs and behaviors. The latter included students' beliefs about themselves in relation to mathematics (i.e., MK of the self), preferred task difficulty (i.e., MK of task), and usual action (i.e., MK of strategies) after failure. They found that negative affect after failure mediated the effect of performance goals on self-regulatory beliefs and behaviors. Pekrun, , Elliot, and Maier (2009) also found that affect, in the form of positive academic emotions, mediates the effect of achievement goals on performance attainment. This is possibly done through the effect of academic emotions on strategy use (Pekrun, Goetz, Titz, & Perry, 2002). This evidence suggests that affect might have a direct effect on MS as well as an indirect one via motivation.

Moreover, the effect of motivation or affect on MS can be mediated by MK. Vrugt and Oort (2008) showed that it is metacognition (measured as self-reported MK, ME, and MS) that mediates the effect of mastery goals on (cognitive/metacognitive) strategy use and, through strategy use, on performance. No mediation was found for performance-approach goals, although a negative relationship was found between performance-avoidance goal orientation and strategy use. Unfortunately, the authors did not include measures of affect to be able to show whether affect exerts its effects on strategy use through metacognition (i.e., MK and MS). Spada, Nikcevic, Moneta, and Ireson (2006), however, showed that metacognition does mediate the effects of affect on strategy use. Specifically, metacognition was found to mediate the effect of anxiety trait on use of surface strategies.

On the other hand, there is another aspect of MK that has been associated with motivation. It is MK in the form of theories of intelligence (i.e., an incremental or entity theory of intelligence) and of epistemological beliefs. Bråten and Strømsø (2005) found that one of the dimensions of epistemological beliefs, namely, control of knowledge acquisition (representing the fixed vs. malleable ability conception), moderately correlated with theories of intelligence. Moreover, epistemological beliefs and, particularly, beliefs about "speed" (i.e., that learning is quick) negatively correlated with mastery goal orientation, although there was no consistency in these relations in the various groups of the sample. There was, however, a consistent relationship between the epistemological belief "construction" (i.e., beliefs that knowledge is constructed and modified through various means) and strategy use. Bråten and Strømsø also found no consistent relationship between theories of intelligence and achievement goal orientations or strategy use. On the contrary, in a study by Blackwell, Trzesniewski, and Dweck (2007), incremental theory of intelligence was found to be predictive of learning goals and, through them, of strategy use and of performance. Therefore, metacognition in the form of theories of intelligence and epistemological beliefs may impact motivation, and motivation, in turn, through affect and metacognition in the form of MK and MS may impact strategy use and performance.

To sum up, although there is growing research evidence on the interactions among metacognition, motivation, and affect at the Person level and their effects on school achievement, still the mechanism that connects them with performance is not clear. It is also not clear how the various person characteristics are orchestrated in SRL. The MASRL model posits that performance is controlled by cognition and its interactions with affect and metacognition at the Task × Person level. Therefore, the components at the Person level by themselves or through their interactions should exert effects on processes at the Task × Person level and through them on performance. Evidence indicating such effects is presented in what follows. However, first, evidence on the interactions of cognition, metacognition (i.e., ME and use of control strategies) with motivation and affect at the Task × Person level is presented.

Relations of Cognition, Metacognition, and Motivation/Affect at the Task × Person Level

As already mentioned, the MASRL model posits that at the Task × Person level motivation is inherent in the affect and ME experienced during task processing. Both affect and ME are influenced by the task (its features and context) and its processing (i.e., cognition). One major task variable is the demands the task makes on cognitive resources (e.g., prior knowledge, cognitive skills) and, particularly, on working memory and attention. A task-processing factor that influences affect and ME is fluency of processing or cognitive interruption. Affect and ME, in turn, motivate control processes in a bottom-up mode.

Effects of Task and Cognition on ME

As regards task demands on working memory, Touroutoglou and Efklides (2010) found that increases in working memory load, even in familiar tasks (e.g., arithmetic operations), lead to increase in processing time and self-reported feeling of difficulty. Conceptual demands of mathematical tasks as well as task complexity have also been shown to differentiate performance and self-reported feeling of difficulty (Efklides, 2002a; Efklides et al., 1997, 1998).

Interruption of task processing is another factor that influences ME. It occurs in everyday life when the person is working on a task but is interrupted, for instance, to answer questions or do some other work, irrelevant to the main task. Interruption requires that the person keeps in memory the goal of the interrupted action and reactivates the goal-related action and relevant knowledge to restart the interrupted task processing later on (Dodhia & Dismukes, 2009). Hence, interruptions increase the demands on working memory, leaving few resources for task processing, particularly when task processing is not automatic (see Speier, Valacich, & Vessey, 1999). This decrease in resources leads to more errors and decrements in performance.

However, besides interruptions caused by external sources, there is also cognitive interruption that occurs at (a) the beginning of task processing in the case, for example, of a novel task, when there are no prior schemas to accommodate it; (b) during cognitive processing when the prevalent cognitive schema cannot account for all the data of the task; and (c) in the case of conflict between responses (Touroutoglou & Efklides, 2010). In all these cases, interruption of cognitive processing decreases the fluency in task processing and increases the probability that an error occurs; as a result closer monitoring and control occurs (van Veen & Carter, 2002). People become aware of cognitive interruption and/or lack of fluency in task processing through their ME such as feeling of difficulty (Touroutoglou & Efklides, 2010).

Awareness of increased time on task processing or increased attention and cognitive activity (Metallidou & Efklides, 2001), as well as proprioceptive cues (e.g., contraction of corrugator muscle) that are associated with effortful task processing contribute to the awareness of effort exertion (Hrubes & Feldman, 2001; Stepper & Strack, 1993). It has been found that fluency and proprioceptive cues unconsciously influence self-ratings of exerted effort (Stepper & Strack, 1993) and the latter impact judgment of learning, that is, the prediction of future learning (Koriat & Nussinson, 2009) in a bottom-up self-regulation mode. In turn, judgment of learning is motivating voluntary strategy use and further allocation of study time. Thus, cognitive interruption is a critical condition for the switching of goal-driven or top-down self-regulation to data-driven or bottom-up self-regulation.

Effects of Task Processing on Affect

Although the aforementioned studies on cognitive interruption did not include measures of affect, there is evidence that fluency in task processing (i.e., lack of interruptions) is "putting a smile on the face" (Winkielman & Cacioppo, 2001, p. 989), that is, triggers positive affect. Considering that fluency is a cue for ME, such as feeling of familiarity (Whittlesea, 1993), and lack of fluency is a cue for feeling of difficulty (Efklides, 2002a), it is evident that fluency (or lack of it) is critical for both ME and affect. This implies that the regulation of cognition is motivated by both the ME and the concomitant affect.

However, there is another route through which cognitive interruption can impact self-regulation of cognition. It is through online emotions such as surprise and curiosity. Unexpected interruption of task processing gives rise to surprise because it denotes a discrepancy from what was expected (Touroutoglou & Efklides, 2010). At the same time cognitive interruption increases feeling of difficulty. Thus, surprise strongly correlates with feeling of difficulty, and both of them refocus attention to handle the unexpected interruption.

Curiosity is another emotion that is also triggered by a discrepant cognitive state. Curiosity arises in situations in which one feels uncertain because there is lack of information needed to make sense of a situation (Bar-Anan et al., 2009; Litman, 2005). This state of deprivation of information is metacognitively represented as feeling of knowing or as the tip-of-the-tongue experience (Litman, 2005). These ME inform the person of the lack of information and of the possibility to find it because it is available in memory. Curiosity, in turn, motivates seeking of information to reduce uncertainty. Curiosity can also motivate exploratory behavior that leads to discovering of new information. In this case, curiosity is not aiming at reducing uncertainty, but at increasing arousal, interest, avoidance of boredom, and finally positive affect. Thus, curiosity motivates the person to regulate his or her affect as well.

Effects of Affect on ME

Independently of the effects of fluency and cognitive interruption on ME and affect, affect may directly impact ME as in the case of mood. Mood, for example, is a factor that is connected to the context of the task rather than to task processing. The person may enter a learning situation being in a particular mood state for reasons totally independent of the task. Efklides and Petkaki (2005) manipulated the mood state of students and then gave them mathematical problems to solve. There were measures of mood state before and after problem solving as well as measures of ME. Negative mood was found to predict feeling of difficulty. This finding is consistent with evidence that mood has an informational function (Schwarz, 2002), because it reflects the state of our environment (problematic vs. benign situation) and alerts us on situational requirements. Hence, when one is in a negative mood state, attention is driven to task or to processing features that are indicative of a potential problem, thus leading to an increase of feeling of difficulty. At the same time, because negative affect is an aversive state (Eysenck et al., 2007) both negative mood and feeling of difficulty motivate control processes in a bottom-up mode.

Positive mood, on the other hand, facilitates top-down task processing (Schwarz, 2002) or top-down attention control (Eysenck et al., 2007) as well as expectancy (motivation) that effort exertion will result in good performance (Erez & Isen, 2002). This leads to decreased feeling of difficulty (Efklides & Petkaki, 2005) and less need for bottom-up self-regulation. At the same time, Efklides and Petkaki (2005) found that students reported increased estimate of effort, probably because positive affect acts as a resource for effort. Other ME, such as feeling of confidence, were found to be influenced by both positive and negative mood, whereas feeling of satisfaction only by positive mood.

Summing up, there is evidence that cognitive states (e.g., fluency, interruptions, discrepancies, unexpectedness, or uncertainty), affective states (e.g., mood), and proprioceptive cues have an impact on ME which, in turn, change the self-regulation mode from top down to bottom up and vice versa. Moreover, the same cognitive states give rise to affect that further motivates, additively to ME, behavior or use of strategies for the regulation of cognition and affect.

Relations Between the Person and the Task × Person Levels

The MASRL model posits that there are reciprocal relations between the Person level and the Task × Person level. I first focus on the effects of components of the Person level on ME and affect at the Task × Person level and, second, on how the Task × Person level feeds back and updates the components of the Person level.

Effects of the Person Level on the Task × Person Level

Achievement goal orientations as person characteristics are theoretically associated with affect at the Task × Person level. Specifically, mastery goal orientation is associated with interest, and performance goal orientation (mainly performance-avoidance) with anxiety (Harackiewicz, Barron, Pintrich, Elliot, & Thrash, 2002). Moreover, goal orientations are associated with effort exertion (in mastery goal orientation and withdrawing of effort in performance-avoidance goal orientation); yet, no association has been made between goal orientations and ME. There is no theoretical basis for inferring such a direct relationship, except for the estimate of effort. Dermitzaki and Efklides (2003), using measures of task and ego goal-orientations (Nicholls, 1984), found that ego orientation[2] had a very small negative effect on the prospective estimate of effort at the Task × Person level; ego orientation, however, predicted students' perceptions of how others view them, which is an aspect of self-concept (or MK of the self). Through this aspect of self-concept, ego orientation influenced strategy use as reported at the Task × Person level. Task-specific strategy use was, however, directly predicted by task orientation. This finding implies that task orientation facilitates a data-driven or bottom-up self-regulation, whereas ego orientation a top-down or goal-driven self-regulation.

Berger (2009), on the other hand, did find a relationship between achievement goal orientations and estimate of effort at the Task × Person level. Mastery-approach goal orientation negatively predicted estimates of effort, whereas performance-avoidance goal orientation positively predicted estimates of effort. This finding means that performance-avoidance goal orientation is associated with an overestimation of the exerted effort and the opposite is true for mastery-approach. Moreover, mastery-approach goal orientation was positively related to the intention to work on the

[2]Task orientation is equivalent to mastery goal orientation, and ego orientation to performance goal orientation.

task and through it to the estimate of effort. This finding implies that mastery approach can also be associated with top-down self-regulation, that is, the intention to invest effort on the task, but as effort regulation is determined by bottom-up processes as well, the actual effort invested is judged as low. Performance-approach goal orientation, however, in Berger's study was not related to any ME or MS, and this seems to be in accordance with what Dermitzaki and Efklides (2003) found. However, Efklides and Dina (2007) found that mastery and performance-approach goal orientations correlated with outcome-related ME such as feeling of confidence or estimate of solution correctness, whereas performance-avoidance goal orientation did not. This evidence suggests that performance-avoidance goal orientation is not conducive to accurate self-monitoring, as also suggested by the overestimated effort expenditure found by Berger.

To conclude, achievement goal orientations seem to have small effects on ME and MS at the Task × Person level, although they have an effect on the intention to work on the task. This is in accordance with the MASRL model that predicts effects of the Person level components mainly on the decision to go on with task processing. Then, bottom-up self-regulation takes precedence. However, there might be indirect effects of goal orientations on ME through the selective focusing of attention on some ME rather than others and their interpretation.

Feedback From the Task × Person Level on the Person Level

As already mentioned, the idea that subjective experiences (e.g., mastery experiences or awareness of physiological states of effort exertion) contribute to self-efficacy beliefs is present in Bandura's (1986) theory. Usher (2009) showed that such experiences are indeed reported by students and account for their self-efficacy beliefs.

In a longitudinal study, Efklides and Tsiora (2002) showed the mechanism through which ME update self-concept, including self-efficacy. They found that cognitive ability and self-concept at the Person level influenced ME (e.g., feeling of difficulty and feeling of confidence) at the Task × Person level. It was also shown that ME that convey information about one's competence, such as feeling of confidence, feeling of difficulty, and estimate of effort, at one testing occasion influenced the task-specific self-concept and through it the domain-specific self-concept of the subsequent testing occasion. Thus, repeated engagement with similar tasks and awareness of task-specific ME provides consistent information about the self and self-efficacy in a task-domain and updates the domain-specific self-concept (e.g., mathematics self-concept).

The previous evidence suggests one route through which ME update self-concept and/or self-efficacy beliefs. Another possible route is through causal attributions about the outcome of task processing following engagement with a specific task. Indeed, Metallidou and Efklides (2001) showed that self-ratings of feeling of confidence and estimate of solution correctness of mathematical problems predicted attributions of ability; attribution of task difficulty was associated with feeling of difficulty, whereas attribution of effort was mainly predicted by students' ratings of the cognitive strategies reportedly used for tackling the problems rather than by the estimate of effort. These findings imply that awareness of increased cognitive activity such as use of metacognitive control during task processing (see also Berger, 2009) constitutes a critical cue for the effort attribution.

Self-confidence is another person characteristic associated with ME (Kleitman & Moscrop, 2010). Self-confidence is related to self-efficacy but is defined as a trait reflecting beliefs about one's own competence to deal with uncertainty in a specific domain. Self-confidence is based, besides other factors, on feeling of confidence the person experiences in various tasks. However, self-confidence being a person characteristic (e.g., "a confident" person), along with various task characteristics, also influences feeling of confidence (Weaver & Keleman, 2002). Moreover, self-confidence in one's own response to specific tasks has also been implicated in the updating of knowledge of strategies (Hertzog, Price, & Dunlonsky, 2008). This finding implies that ME contribute not only to self-related knowledge and sense of competence but also to MK of strategies, for example, their applicability to various situations and effectiveness. Finally, Nussinson and Koriat (2008) found that subjective experiences (i.e., ME) on a task do not only convey information about one's self but also, through attributions, allow predictions of the difficulty others will have on a specific task. (The same was found by Salonen, Vauras, and Efklides, 2005.) Thus, ME contribute to MK of persons and not only of the self at the Person level.

Therefore, although research on reciprocal effects between the two functioning levels of SRL is sparse, there is preliminary evidence suggesting that ME capture the specificities of task processing and have implications that go beyond the Task × Person level, that is, to components of the Person level.

CONCLUSION

Implications for Theory and Research

The present article aimed to delimit *interactions* among metacognition, motivation, and affect in SRL. These three components of SRL were embedded in a broader model, the MASRL model, which posits two levels of functioning of SRL, namely, the Person level and the Task × Person level.[3]

[3]I would like to thank the anonymous reviewer who pointed out that the term "interaction" can have a different meaning when it refers to the Person level than when it refers to the Task × Person level. Specifically, at the Person

The Person level sets goal-directed, top-down self-regulation, whereas the Task × Person level is mainly functioning in a data-driven, bottom-up self-regulation. The model emphasizes the role of subjective experiences, particularly of ME, which are manifestation of online monitoring and trigger control processes. However, ME play a broader role in SRL because of their interactions with affect and motivation at the Task × Person level. Also, ME mediate effects of person characteristics at the Person level on task processing and self-regulation at the Task × Person level, and vice versa. Moreover, the MASRL model posits relations of MK and MS with cognitive ability, self-concept, and motivational and affective person characteristics as well as with control beliefs at the Person level. The MASRL model builds on previous models of SRL and extends them by showing the possible interactions among metacognition, motivation, and affect. At the same time, it underscores the mechanisms underlying the functioning of SRL rather than simply the components of SRL and their sequencing.

As regards the interactions of metacognition, motivation, and affect, the MASRL model makes predictions for each of the two levels of functioning in SRL. There is evidence supporting at least some of the hypothesized theoretical relations. More research, however, is needed if the whole network of the proposed interactions and effects is to be investigated. This investigation presupposes use of multiple measures and methodologies including measures of general person characteristics and of the dynamics of subjective experiences and online self-regulation at the Task × Person level.

Some of the challenges for future research in SRL are already obvious in the MASRL model. Starting from the Person level, it makes sense from a theoretical point of view to extend the constituents of MK that have a motivational power beyond epistemological beliefs (Hofer & Pintrich, 1997; Pintrich, 2000; Winne, 2004) and connect metacognitive person (including self) knowledge with self-efficacy beliefs and self-concept. The challenge for future research is, first, to define the boundaries between MK and self-concept, their common ground as well as their differential characteristics. Within the same rationale, it is important to conceptually analyze the notion of self-confidence and its relations to self-efficacy and self-concept as well as to other motivational constructs such as uncertainty motivation (Sorrentino, Walker, Hodson, & Roney, 2001). A second challenge regards the identification of relations of MK and MS with control beliefs and action control tendencies (Kuhl, 2001) as well as with affect in order to locate the sources and efficiency of metacognitive control at both the Person and the Task × Person level. A third challenge regards the identification of constellations of person characteristics/profiles and their effects on SRL and behavior. Profiles may represent different pathways through which the components of the Person level impact self-regulation at the two levels of functioning in SRL.

Other challenges are more specific to the Task × Person level. The MASRL model posits that motivation at the Task × Person level is connected to affect (e.g., intrinsic motivation) and to ME and it is the input from these two sources that affects explicit expectancy-value considerations. The reason for this claim is that, according to the Rubicon model (Heckhausen, 1991), motivation withdraws after action has been decided in favor of action control. After action, and based on its outcomes, motivation is then reconsidered. According to the MASRL model during action (i.e., task processing) ME and affect motivate control processes so that action is successful. Besides this function, ME and particularly feeling of difficulty, awareness of high effort exertion, and low feeling of confidence presumably provide expectancy-value information in the sense of high cost and low expectancy. It is possible that these ME motivate a bottom-up reconsideration of one's initial expectancy-value beliefs and revision of the initial go/no-go decision. This prediction, however, has to be tested in future research.

Another challenge regards the role of emotions in SRL. The MASRL model stresses the role of "cognitive" emotions (i.e., interest, surprise, curiosity) that have an immediate impact on cognition and supplement the role of ME in SRL. However, there are achievement-related emotions, such as pride or shame, that are not crucial from an informational point of view but important for SRL. The possible relations of these emotions with ME is also an issue for future research.

The distinction between the two levels of functioning in SRL and the assumption of reciprocal effects between the two levels poses further challenges. For example, are there always mutual effects between the two levels, or can each of them override the other? Under which conditions are the interactions among metacognition, motivation, and affect functional and promote short- and long-term SRL, or are dysfunctional and lead to increased rumination, under/overconfidence, dysfunctional attributions, etc. As Paris (2002) pointed out, metacognition in the form of reflection on one's thinking (e.g., at the Person level) can be totally irrelevant to learning if the person is asked about strategies that she or he is not aware of having used possibly because of automatic cognitive processing. Or, there can be "illusions" of feeling of difficulty that can misdirect the regulatory process when the student is using help (ready-made answers) from others to solve a problem without monitoring his or her thinking and ME (Eklides, 2002a). Also, one may ruminate and make conjectures on what she or he will feel or do in a particular learning situation (based on information from the Person level), and these ruminations lead to ignoring the actual task demands and information from ME.

level interaction can be defined in a statistical sense such that the value of one variable in a group of people is conditional to the value of another variable. However, at the Task × Person level, where task processing takes place as a sequence of events, interaction may denote the temporal dynamics of processing within a single person.

Finally, the role of control beliefs in SRL merits further research. Specifically, the source of control beliefs could be traced back to ME (Metcalfe & Greene, 2007) as well as to MK of the self and others as users of strategies, or to MS. Their interaction with affect is also unclear. These and many more challenges are made explicit if the MASRL model is to be tested, enriched, confirmed, or rejected.

The MASRL model has also implications for teaching practices in the classroom and for collaborative learning. The question in both of these cases is at which level is the instructor or the collaborator providing information and feedback: at the Person level, trying to influence the student's MK (or motivation/affect), or at the Task × Person level, trying to regulate the student's ME and affect? As Salonen et al. (2005) pointed out, teachers may have a different conception of what their students feel (i.e., ME during task processing) than what students themselves report; this might have implications for what teachers expect their students to do and the regulatory advice they give. For example, a weak student, who is unaware of task demands, may find the task easy and exert little effort whereas the teacher believes that the student is aware of task demands and feels difficulty and, therefore, the student should exert more effort. Finding out that the student is not exerting effort is frustrating for the teacher who can get angry with the student and his or her behavior with consequences for both the teacher's and student's self-regulation.

Also, when students collaborate on task processing, emotions may arise due to personal and social relations between the collaborating students, thus influencing their mood state and, consequently, the accuracy of their ME and the effectiveness of their coregulation. The rationale presented earlier could be also applied to the relations between parents and children when, for example, parents try to informally teach their children or supervise their homework.

To conclude, the MASRL model with its emphasis on interactions among metacognitive, motivational, and affective factors in SRL can be a useful framework for understanding the complex processes involved in learning, the dynamic character of self-regulation as the person is working on a task, and the more stable patterns of SRL distinguished over time.

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