Metacognitive Training

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Abstract Metacognition is usually defined as "thinking about thinking," and it refers to knowledge about factors that influence task performance and knowledge about strategies. Moreover, it includes metacognitive regulation processes such as planning and monitoring task performance as well as evaluating the efficiency of these planning and monitoring processes. Good metacognitive abilities are essential for academic success, and good metacognitive skills support a number of other cognitive processes that are necessary to perform a specific task. Thus, training of metacognitive skills has become an important element of different training programs in various domains. In the present chapter, we will give an overview of recent advancements in the knowledge about metacognitive training in the context of mathematical skills, reading abilities, and regarding executive function training. Research from all three domains reveals promising results, indicating that the integration of metacognitive training into more conventional training programs leads to greater improvements than conventional training alone. Metacognitive training is effective for many different age groups, via different methods, and in different contexts. At the same time, however, there are still a number of open questions like the question of interindividual differences or the question of long-term effects, indicating that the field of metacognitive training research is likely to keep in the future.

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Introduction

Metacognition is broadly defined as “thinking about thinking” (Flavell 1979). It is a multidimensional construct referring to any knowledge or cognitive process that monitors or controls cognition. Typically, metacognition is divided into two subcomponents, which are assumed to be correlated: *knowledge* of cognition and *regulation* of cognition (cf. Brown 1980; Flavell 1979; Veenman et al. 2006). Knowledge of cognition refers to the declarative knowledge about oneself as a learner or problem-solver, the knowledge about the task and possible strategies that can be used for solving the task, and the knowledge about how and when to use a given strategy. In contrast, regulation of cognition refers to a set of activities that help to control one’s thinking and learning processes such as planning, monitoring, and evaluation processes. Figure 1 gives an overview of the most important components of knowledge and regulation of cognition.

Metacognition improves consistently as a function of age and schooling (e.g., Justice 1986; Schneider 2008). It develops gradually in early childhood and becomes more and more explicit and effective the older a child gets (see also Kuhn 2000). For example, 3-year-old children begin to become aware of their own knowledge states when they start using verbs like “to think” and “to know” (Flavell 1999). Six-year-old children can already reflect with accuracy on their cognition (Schraw and Moshman 1995). The older the children are, the more accurately they can predict their future performance. This early metacognitive development serves as a basis for higher-order thinking processes that mature later. That is, individuals become more and more aware of their own knowledge and increasingly proficient in selecting the most efficient strategies to solve a specific task and manage demanding situations (e.g., Chen and Siegler 2000; Lemaire and Brun 2014).

Good metacognitive abilities seem to be especially essential for academic success as metacognitive skills support the cognitive skills that are necessary to perform a task. For example, the use of metacognitive strategies is related to enhanced learning outcomes (e.g., Jacobs and Paris 1987), and metacognitive regulation is a reliable predictor for student’s success in college (Everson and Tobias 1998). That is, people with good metacognitive awareness are able to think about their own thinking as they engage in academic tasks, and improved regulatory skills and an

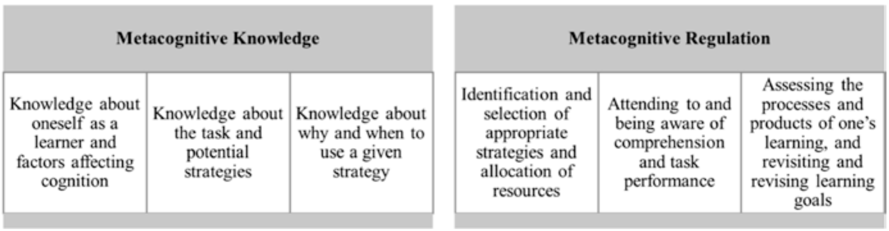

Fig. 1 Overview of the different components of metacognitive knowledge and metacognitive regulation

understanding of how to use these skills can evoke significant improvements in learning (Brown and Palincsar 1989; Cross and Paris 1988). A high level of metacognition can even compensate for IQ with regard to problem-solving (Swanson 1990). Thus, improving metacognitive skills has been the goal of numerous training studies. Even though metacognition is sometimes seen as a stable individual trait (e.g., Fleming et al. 2010; McCurdy et al. 2013), several studies demonstrated that metacognitive skills are malleable and trainable via different methods, in different contexts, and in different age groups. Moreover, intervention studies have shown not only that it is possible to train metacognition but also that these improvements benefit other cognitive skills drawing on metacognitive abilities.

In the following we will provide examples for training studies focusing on metacognitive training. Our ambition is not to provide an exhaustive review of the literature but instead an overview of recent advancements in the knowledge about metacognitive training based on intervention studies from three different fields. Specifically, we will start with evidence for the effects of metacognitive training on mathematical skills. Then, we will turn to recent studies about metacognitive training designed to improve reading skills. Finally, we will report recent research about metacognitive training aiming to improve executive functions. In all three domains we will especially focus on the training methods and its effectiveness.

Metacognitive Training and Mathematical Abilities

Basic mathematical abilities are usually acquired across preschool and elementary school age and comprise a wide set of abilities, among them are arithmetic, geometry, and mathematical problem-solving. Numerous studies showed that young children initially struggle performing math tasks that require multiple steps or the prediction of task outcomes, leading researchers many years ago to assume that metacognitive processes play a defining role in the development of mathematical skills. Lester (1982), for instance, suggested that metacognitive knowledge is of particular importance for mathematical problem-solving and that metacognitive knowledge, monitoring, and self-regulation are crucial before, during, and after solving mathematical problems. The metacognitive activities supporting task performance include mathematical skills and experience as well as the ability to separate relevant from irrelevant information and to use heuristics representing task-relevant components. Similarly, Verschaffel (1999) assumed that metacognition is important not only during initial stages of mathematical problem-solving, when an appropriate representation of the problem needs to be built, but also at the final stage, when outcomes have to be checked and evaluated.

Since these early studies linking metacognition and mathematical abilities, many studies have explored the relationship between both domains and have highlighted the predictive value of metacognitive abilities for mathematics performance (for reviews see Desoete and Veenman 2006; Schneider and Artelt 2010). For instance, Veenman (2006) examined the role of metacognitive skills (assessed by systematic observation) and cognitive ability for the development of mathematical learning performance (assessed by a math test). He found that both metacognitive and cognitive abilities were associated with mathematics performance but that metacognition was a more reliable predictor than cognitive ability. This and other findings demonstrate the importance of metacognitive skills for mathematical abilities (see, e.g., Desoete et al. 2001a, b; Garofalo and Lester 1985; Lucangeli et al. 1997). Thus, it is not surprising that many training programs focused on metacognition in order to improve mathematical skills (e.g., Lucangeli et al. 1998; Özsoy and Ataman 2017). In this section, we will detail a number of intervention studies designed to improve mathematical abilities by training metacognitive knowledge and skills.

Cornoldi et al. (1995) implemented a training focusing on metacognitive awareness and control processes. One of their studies focusing on healthy children indicated that improvements in metacognition were associated with improvements in problem-solving and logical reasoning but not in geometry. Another study on children with a learning disorder struggling in mathematics showed that these children benefitted even more from the program, even if their teachers perceived them as severely learning disabled.

More recently, a number of training studies have focused on the MASTER program (Mathematics Strategy Training for Educational Remediation; Van Luit and Kroesbergen 2006). This program was specifically designed for children with mathematical learning disabilities and targets self-instruction during mathematical problem-solving. Van Luit and Kroesbergen (2006) trained small groups of children with mathematical disabilities across 16 weeks and compared their performance to children participating in mathematics training based on the standard curriculum. Children in the training group received lessons in multiplication and division with a focus on problem orientation (planning), understanding of the number system, control activities (e.g., checking answers and solution strategies), and the memorization of multiplication and division facts <100. Children in both groups were tested on a standardized mathematics test before and after the intervention as well as at a follow-up session. Results showed larger gains from pretest to posttest in the training group as compared to the control group, and this effect was stable at follow-up.

Similarly, Desoete et al. (2003) investigated the effects of metacognitive strategy instruction (five sessions) on mathematical problem-solving in third graders. They assessed prediction and evaluation assessments before and after instruction and showed that participants in the training group significantly improved their metacognitive skills and their problem-solving knowledge at follow-up. Moreover, individual differences in metacognitive abilities were predictive of mathematics performance, allowing a differentiation between good and moderately performing students and those with learning disabilities (Desoete et al. 2001a, b).

Other training studies were based on the IMPROVE program (Introducing new concepts, Metacognitive questioning, Practicing, Reviewing, Obtaining mastery on higher and lower cognitive processes, Verification, and Enrichment and remedial; Kramarski and Mevarech 2003; Mevarech and Kramarski 1997). The metacognitive instructions included several metacognitive strategies: (1) comprehension questions (“What am I supposed to do in this task?”), (2) connecting questions (“What are the differences and similarities between . . . and . . .?”), (3) strategic questions (“What strategy, tactic, or principle can be used to solve the problem or to complete the task? Why is this strategy, tactic, or principle most appropriate for this problem or task?”), and (4) reflection questions (“Does the result make sense? Can the problem be solved differently?”). In one of the intervention studies, Mevarech et al. (2006) trained students (8th grade) in learning settings either with or without cooperative learning environments. They found that the IMPROVE training on top of the cooperative environment resulted in better mathematical problem-solving than the cooperative environments alone. Moreover, students participating in IMPROVE showed increased planning and comprehension processes as well as better reflection skills.

Some intervention programs have also adopted computer-based approaches. Teong (2003), for instance, investigated the effects of metacognitive training on mathematical word problems. Results from low-achieving students (11–12 years of age) showed superior performance compared to controls on mathematics tests as well as more appropriate metacognitive decision-making. Focusing on younger children, Pennequin et al. (2010) tested whether metacognitive training improved metacognitive knowledge and skills as well as mathematical problem-solving in third graders. The interactive training program included five training sessions. Results showed higher metacognitive knowledge, metacognitive skills, and mathematical problem-solving scores in the training group compared to the control group. Interestingly, low-achieving children benefitted most and improved up to the level of normal achievers.

In sum, evidence for the effects of metacognitive training on mathematical abilities is limited, but existing findings suggest that metacognitive knowledge and regulation are associated with mathematics performance over and above cognitive ability. Results from intervention studies indicated that metacognitive training can effectively enhance different aspects of metacognition and mathematical abilities, especially mathematical problem-solving. However, more intervention-based research is needed in order to disentangle the effects of different types of metacognitive trainings as well as individual differences in training-induced gains. As much more research has focused on the effects of metacognitive training on language and reading comprehension, we illustrate important findings in this domain in the next section.

Metacognitive Training and Reading Comprehension

Reading comprehension is a complex task that requires execution of several mental processes. One of the most influential models to date depicting these processes is the Construction-Integration (CI) model (Kintsch 1988). According to this model the reader first recognizes words and understands the syntactic links between them, then generates meaning through the integration of propositions, and finally integrates textual information with additional information from the reader’s prior knowledge (i.e., situational model). Although these processes are generally assumed to be automatic, studies have shown that efficient readers are able to consciously coordinate and strategically solve problems when comprehension breaks down (Baker and Brown 1984; Coté et al. 1998). This is often referred to as metacognitive control or comprehension monitoring, which involves evaluating one's understanding and taking appropriate steps to correct errors that are detected (Baker et al. 2015).

Thus, extensive research has been conducted on the relationship between metacognition and reading, using various measures of metacognition such as self-reports (Roeschl-Heils et al. 2003), interviews (Eme et al. 2006), and questionnaires (Kolić-Vehovec et al. 2014; Memiş and Bozkurt 2013; Van Kraayenoord et al. 2012). One of the first studies was the study by Myers and Paris (1978). They showed differences in metacognitive strategies between younger and older children. Older children tended to have greater understanding and awareness of strategies that they use when encountering unknown words or sentences or of effective ways to skim through a text for rapid comprehension. However, children who lag behind their peers in metacognitive knowledge and cognition in primary grades continue to do so in middle school (Roeschl-Heils et al. 2003).

Given the abundance of evidence suggesting a link between metacognition and reading comprehension, researchers increasingly examined whether metacognitively oriented interventions promote reading comprehension, especially among younger to older children. Torgesen (1977), for example, found that receiving strategy instruction on picture recall increased children's score on reading comprehension. Since then, several metacognitive methods and strategy trainings have been introduced in the literature in the hope of developing reading comprehension. These interventions involve practices of knowing what factors are influential, knowing how strategies and functions are applied, and knowing when, where, and why to apply strategies in reading (Paris et al. 1984), so that such training, if successful, enables children to better evaluate purposes and strategies in reading, plan relevant strategies to be applied, and constantly monitor their performance during problem-solving within reading tasks (Wright and Jacobs 2003).

Different methods and approaches such as self-questioning (Chan 1991; Palinscar and Brown 1984), creating a cognitive map (Boyle 1996), and comprehension monitoring (Lubliner and Smetana 2005) were investigated. Incorporated reciprocal teaching (Palinscar and Brown 1984) is an influential instructional approach that is still used to date, involving training of four different strategies: (1) predicting upcoming text, (2) clarifying unknown words and concepts, (3) summarizing the text, and (4) generating questions about the material. Intervention studies which employed reciprocal teaching have largely yielded positive results, stimulating many successful multiple-strategies interventions in the 1990s and early 2000s (Gajria and Salvia 1992; Klingner and Vaughn 1996; Moore and Scevak 1995; Souvignier and Mokhlesgerami 2006). For instance, Souvignier and Mokhlesgerami (2006) conducted metacognitive trainings with German fifth graders, which comprised of 20 lessons (45 minutes each). In these lessons, the pupils were taught to actively use metacognitive strategies such as summarizing a text and elaborating on its content. Upon pre-, post-, and delayed-posttest assessments, the findings revealed that pupils in the strategy-oriented instructional programs better improved their reading comprehension than the control group. In another large-scale study by Van Keer and Verhaeghe (2005), word-level and passage-level comprehension monitoring was taught to second and fifth graders in three conditions: (a) teacher-led instructions, (b) same-age peer tutoring, and (c) cross-age tutoring between second and fifth graders. The findings showed that second graders benefitted from teacher-led instructions and cross-age tutoring but not same-age peer tutoring, and the effects did not last 6 months after program instruction. The fifth graders, however, all improved their reading comprehension in the posttest, and the effect prolonged for 6 months (except for the cross-age tutoring group).

Given the sheer number of metacognitive intervention studies over the past 35–40 years, several comprehensive meta-analyses have been undertaken (Dignath and Büttner 2008; Haller et al. 1988; National Reading Panel 2000). The findings of these meta-analyses highlight three main points in regard to metacognition and reading (Baker et al. 2015). First, older children (in secondary levels) benefit more from metacognitive training than younger, primary level children, perhaps due to the fact that older children have already acquired basic reading skills, and therefore can better build on prior experiences. Second, metacognitive trainings are more effective with longer periods of training sessions, increasing the likelihood of transfer of strategies to new contexts. Third, children benefit from metacognitive training when it is provided by researchers rather than classroom teachers, emphasizing the need to also educate and instruct the teachers on how to implement metacognitive trainings in their classroom teaching.

In summary, past work on metacognitive training in the context of improving reading skills has produced promising results, especially when readers are introduced to multiple metacognitive strategies. However, the strength of effects was modulated by several different factors such as the age, length of intervention, and the context in which the strategies were practiced (e.g., who implements trainings, classroom or individual training, etc.). Although the effects of metacognitive training have been overwhelmingly successful, as noted earlier, metacognition is not the sole solution to enhancing one's reading comprehension, rather there seems to be a complex interplay of several factors such as working memory, vocabulary, and motivation that play a crucial role in addressing how effective comprehension and learning of a text could be supported among children and adolescents. Moreover, reading comprehension is also influenced by executive functions, which are in turn closely related to metacognition, as will be shown in the following section.

Metacognition and Executive Functions

Executive functions (EF) refer to the set of neurocognitive processes that ensure the goal-directed, effortful regulation of attention, thoughts, actions, and emotions. They are supported by a wide neural network including the prefrontal cortex, and they enable flexible and adaptive behaviors. Although the unity and diversity of EF is still debated, EF are generally thought to reflect a set of partially separable functions including inhibition of task-irrelevant information or actions, information maintenance and updating in working memory, and shifting between task sets or representations (Miyake et al. 2000; Miyake and Friedman 2012; see also Karbach and Kray, this volume).

Recently, attempts have been made to train executive functions in combination with metacognitive training due to the close conceptual ties between EF and metacognition. Not only is metacognitive control strikingly similar, if not identical, to the type of cognitive control supported by EF, but also is monitoring, especially of conflict and performance, considered as a central aspect of executive functioning (e.g., Botvinick et al. 2001). To flexibly tailor EF engagement to the specific demands of the to-be-performed task, individuals need to represent and use information about (a) cognitive demands, (b) available control strategies (and how much effort they require), and (c) likelihood of success of each strategy. Unlike adults who strategically avoid unnecessary cognitive effort when given the choice between higher and lower task demands (e.g., Kool et al. 2010; McGuire and Botvinick 2010), younger children seem oblivious to variations in task demands (Niebaum et al. 2019) but can strategically avoid cognitive effort when made aware of task-demand differences and provided feedback (O'Leary and Sloutsky 2017, 2019). Similarly, they engage EF in a more mature manner when prompted to reflect on their own performance (Hadley et al. 2019a).

Therefore, facilitating metacognitive reflection on EF engagement can successfully improve EF performance, at least in children, which has important implications for EF training. First, incorporating metacognitive reflection in EF training programs should promote near transfer by enhancing flexible EF engagement across task demands. Second, and perhaps most importantly, metacognitive reflection training may support generalization of training-elicited gains to novel situations and facilitate far transfer through metacognitive awareness of one's own skills as well as reflection on task demands and how to best respond to them (Zelazo et al. 2018). If so, it may help the field move beyond the limits of extent EF training programs, which show no consistent far-transfer effects (e.g., Kassai et al. 2019; see also Guye et al. this volume; Karbach and Kray, this volume; Könen et al., this volume). Consistently, greater EF performance is observed after preschoolers briefly practice for 15–30-minutes reflection on task rules by either decomposing the elements of these rules (Espinet et al. 2013) or teaching them to a puppet (Moriguchi et al. 2015). Importantly, behavioral improvement is accompanied by more mature neural activity. Specifically, one study showed reduced N2 amplitude in the EEG data, an event-related component associated with activity in the anterior cingulate cortex (ACC; Espinet et al. 2013). Reduced N2 may indicate greater conflict detection by the ACC, which would facilitate signaling to lateral prefrontal cortex (lPFC) the need for greater EF engagement. Consistently, metacognitive reflection was associated with greater lPFC activation in the other study (Moriguchi et al. 2015).

Metacognitive reflection and awareness have also been trained through contemplation and mindfulness, a practice consisting in attending to and reflecting on one's moment-to-moment experiences in a nonjudgmental manner. A growing body of research has shown EF improvement after such practice in both children and adults (see Shapiro et al. 2014, for a review; Verhaeghen, this volume). For instance, 2-month mindfulness training at school enhanced inhibition performance in preschoolers, and these benefits, relative to literacy training or business-as-usual classes, strengthened between the immediate posttest and follow-up session a month later (Zelazo et al. 2018). In another study, students with the initially lowest EF performance benefitted the most from mindfulness training at school in terms of both EF and metacognition (Flook et al. 2010), a notable finding given that these students are at greater risk for academic failure. Mindfulness may benefit EF through repeated practice of turning of attention inwards, sustaining attention, and increased awareness of attention lapses (Shapiro et al. 2014; Zelazo et al. 2018).

Metacognition training may be especially powerful when focused on reflection on how to best engage EF and combined with training of EF processes per se. Three recent studies, which have been conducted independently, have adopted this innovative approach with children ranging in age from 5 to 14 years (Hadley et al. 2019b; Jones et al. 2019; Pozuelos et al. 2019). In Pozuelos et al.'s study, 5-year-olds were trained on a broad range of tasks tapping multiple aspects of EF in 10 sessions over a month in Spain. In an ongoing study, we trained 7- to 11-year-olds on multiple tasks tapping working memory, inhibition, and set-shifting in 16 sessions over 2 months in the UK and Germany (see Hadley et al. 2019b, for the preliminary findings). Finally, in Jones et al., 9- to 14-year-olds were trained on working memory tasks in 20–25 sessions over 6–7 weeks in the UK. Importantly, all three studies compared EF-and-metacognitive-reflection training (MetaEF) to EF training alone (BasicEF) and included an active control group. Although metacognitive reflection activities (see Fig. 2 for an example) differed across the three studies, they all fostered reflection on task demands, generation and use of control strategies, and performance monitoring.

Together, the findings from the three studies largely converged toward a coherent set of conclusions. First of all, none of the studies showed any specific behavioral advantage of metacognitive reflection training at immediate posttest. Specifically, although both MetaEF and BasicEF groups showed greater behavioral gains than the active control group, there were no differences between MetaEF and BasicEF. Therefore, metacognitive reflection training did not elicit greater near transfer at the behavioral level. However, 5-year-olds in Pozuelos et al.'s study showed neural changes at immediate posttest, with more adultlike EEG markers in the MetaEF than the BasicEF group. Thus, metacognitive reflection training already yielded important changes in the way children approached the task even though these changes did not yet translate into behavioral benefits. Indeed, MetaEF training was associated with greater working memory performance than BasicEF training in a 3-month follow-up posttest in Jones et al.'s study (the only one to include a follow-up session), which is consistent with the previously reported sustained effect of mindfulness on EF over time (Zelazo et al. 2018). Therefore, metacognitive reflection training may set children on a virtuous trajectory, installing the habit of reflecting on task demands and how to respond to them. This may not necessarily facilitate performance on tasks relatively close to the trained tasks immediately after training

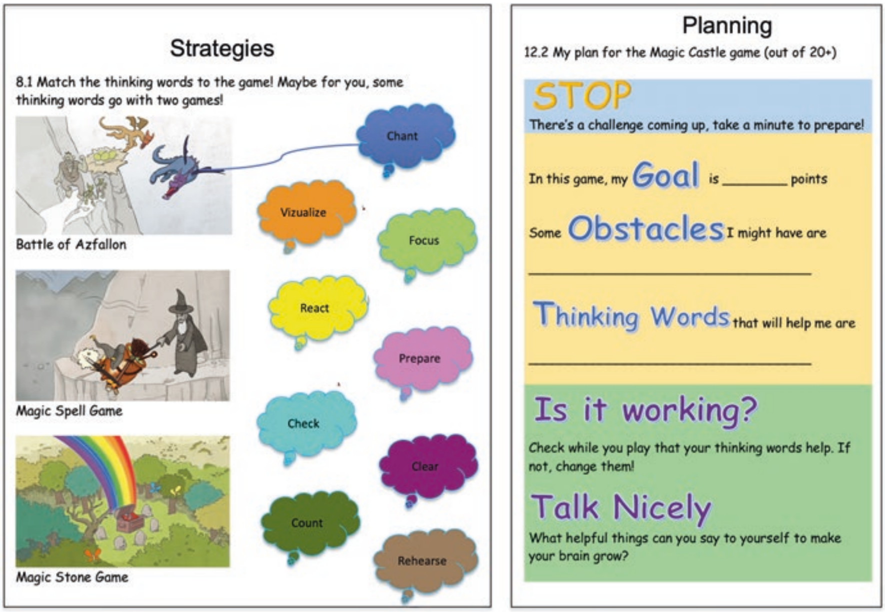

Fig. 2 Examples of an activity in which children had to identify what they found tricky in a specific game and discuss it with their partner. The activity on the left helped children think about strategy formats that could be applied to different games. The activity on the right helped children to prepare for an upcoming executive control task (Hadley et al. 2019b)

(relative to BasicEF), but the effect may build and strengthen over time and experiences, hence becoming more easily detectable after several months. Critically, although MetaEF did not yield immediately greater near transfer than BasicEF, it did elicit greater far transfer to nonverbal reasoning (progressive matrices; Pozuelos et al. 2019; Hadley et al. 2019b) as well as reading comprehension (Hadley et al. 2019b) at immediate posttest. The advantage of MetaEF over BasicEF may be immediately detectable for far-transfer tasks because these tasks are much less similar to the trained tasks than near-transfer tasks are, and thus, performance may better reflect the greater generalization of newly acquired skills that metacognitive reflection training instilled.

Therefore, training metacognitive reflection in conjunction with EF seems to be especially powerful to enhance EF in children. The clear far transfer to both nonverbal reasoning and academic skills (reading comprehension) and the sustained and even strengthening effects of metacognitive over time are very promising for the viability of this type of intervention. Indeed, in Pozuelos et al.'s study, 5-year-olds with lower EF skills at pretest showed the greatest gains from metacognitive reflection training, hence suggesting that children at risk may benefit the most from this type of intervention. That said, despite these promises, metacognitive reflection training is still in its early days, and much more research is needed to probe its efficacy in other populations, including young and older adults as well as children with developmental disorders such as autism and ADHD.

Conclusion and Outlook

To summarize, the present chapter demonstrates that integrating metacognitive training into common training methods leads to promising results across three different fields (training of mathematics, reading comprehension, and EF). Findings from all three domains correspond in several aspects that allow first conclusions regarding the efficiency of metacognitive training and also highlight implications for further research. Findings from all three domains indicate that metacognitive training is applicable across a wide range of children. Specifically, evidence for positive effects of metacognitive training has been found for children of many different age groups, ranging from preschoolers to adolescents, for healthy children, children with reduced skills in one specific domain (e.g., Pozuelos et al. 2019), or even for children with specific learning disorders (e.g., Cornoldi et al. 1995). However, it has to be noted that results across domains also provide first evidence for interindividual differences. For example, research on mathematical skills shows that children with learning disorders profit more from metacognitive training than healthy children, research on reading comprehension indicates age-related differences (cf., Baker et al. 2015), and research on math (Pennequin et al. 2010) as well as on EF training (Pozuelos et al. 2019) demonstrates that low-achieving children profit more from metacognitive training than high-achieving children. Thus, one important issue for further research might be the evaluation of different training programs for different groups of children in order to maximize gains after metacognitive training for each group.

Moreover, it has to be mentioned that existing findings are sometimes hard to compare due to considerable differences across studies – within and between the different domains. For example, the number of training sessions varies broadly, ranging from 5 sessions (e.g., Desoete et al. 2003) to 20–25 sessions (e.g., Jones et al. 2019), and also the length of the training period differs considerably, resulting in differing training intensity. Furthermore, also the training settings show a large variety of different possibilities. There are interventions taking place individually for each participant in a quiet room (e.g., Pozuelos et al. 2019), training sessions together with a training partner (Hadley et al. 2019b), training in small groups (e.g., Van Luit and Kroesbergen 2006), or even training within the classroom (e.g., Cornoldi et al. 2015). Thus, inconsistent findings might be due to these methodological differences. Hence, a systematic comparison might be an important subject of further research in order to gain further insights into the specific effects resulting from different methodological approaches.

Another subject of further research should be the investigation of long-term effects of metacognitive training. As reviewed above, there are indices that positive effects remain or even strengthen over time in all three domains. For example, in the context of mathematical problem-solving, it has been shown that improved performance from pre- to posttest can still be found at follow-up tests (e.g., Van Luit and Kroesbergen 2006). Regarding reading comprehension, Van Keer and Verhaeghe (2005) found improved reading comprehension 6 months after training, and Jones et al. (2019) demonstrated that MetaEF training was associated with greater working memory performance than BasicEF training in a 3-month follow-up posttest. So far, however, long-term effects of metacognitive training are only poorly explored, and findings are partly inconsistent. Long-term effects in the study by Van Keer and Verhaeghe (2005), for example, were only found for fifth graders but not for second graders, and in the context of executive function training, the only study including follow-up tests so far is the study by Jones et al. (2019). Thus, even though there are first promising results regarding long-term effects of metacognitive training from all three domains, further research is required in order to further clarify this issue.

Finally, we can say that there is compelling evidence indicating that training of metacognitive abilities is effective in different contexts, for different age groups, and via different methods. Moreover, improving metacognition has positive effects on other cognitive skills, so that the integration of metacognitive training into common training methods represents a promising approach. At the same time, however, it has to be said that research on metacognitive training is still scarce, and it will have to keep growing in order to further understand the complex interplay of the key influencing factors.

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