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*“Education is not the learning of facts
but the training of the mind to think.”*

Albert Einstein (1879 – 1955)

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List of Abbreviations

α	Alpha-coefficient by Cronbach
ADHD	Attention deficit hyperactivity disorder
ANCOVA	Analysis of covariance
ANOVA	Analysis of variance
ATI	Aptitude Treatment Interaction
autSRL intervention	SRL intervention in an autonomous learning environment
BE	Begriffe Erkennen Test (Engl. Recognizing Terms Test)
CBRS	Child Behaviour Rating Scale
C.Ind.Le	Cambridgeshire Independent Learning in the Foundation Stage
CHILD 3-5	Childrens' Independent Learning Development checklist (3 to 5 years)
d	Cohens d (effect size)
Ed.	Edition
EF	Executive functions
e.g.	Exempli gratia (for example)
et al.	Et alii (and others)
η^2	Eta-Square (effect size)
F	Test value of the F-Test
gSR	General self-regulation ability
HAWIVA-III	Hannover-Wechsler-Intelligenztest für das Vorschulalter III (Engl. Hannover-Wechsler Test of Intelligence for preschoolers III)
HTKS	Head-Toes-Knees-Shoulders Task
IB	Intervention-boosted
i.e.	Id est (that is to say)
intSRL intervention	SRL intervention in a social-interactive learning environment
ICC	Intra-class-correlation
LPA	Latent Profile Analysis
M	Mean

<i>p</i>	Probability
pp.	Pages
PW	Passiver Wortschatz Test (Engl. Passive Vocabulary Test)
SD	Standard Deviation
SRL	Self-regulated learning
<i>t</i>	Test Value of the t-Test
ToL	Tower of London Test
TTT	Train Track Task

List of Publications

The thesis is based on three scientific articles that were published in peer-reviewed journals. The articles can be found in the appendix of the dissertation and are accessible online.

1. Jacob, L., Dörrenbächer, S., & Perels, F. (2019). A pilot study of the online assessment of self-regulated learning in preschool children: Development of a direct, quantitative measurement tool. *International Electronical Journal of Elementary Education*, 12(2), 115-126. <http://dx.doi.org/10.26822/iejee.2019257655>
2. Jacob, L., Benick, M., Dörrenbächer, S., & Perels, F. (2020). Promoting self-regulated learning in preschoolers. *Journal of Childhood, Education and Society*, 1(2), 116-140. <https://doi.org/10.37291/2717638X.20201237>
3. Jacob, L., Dörrenbächer, S., & Perels, F. (2019). The influence of interindividual differences in precursor abilities for self-regulated learning in preschoolers. *Early Child Development and Care*, 1-17. <https://doi.org/10.1080/03004430.2019.1705799>

Summary

Self-regulated learning (SRL) is defined as the ability to learn through the autonomous and self-directed application of learning strategies. This interdisciplinary ability is evidentially linked to school and academic success. SRL should be fostered as early as possible to prevent disadvantageous learning habits. Preschool, as the first stage in the educational system, marks a sensitive time period in a person's life during which SRL-relevant abilities develop. These include progress in the general self-regulation ability (gSR), executive functions (EF), as well as speech competence, as a means to accompany learning actions. To date, only a limited number of research studies have explicitly dealt with SRL in preschool-age children. Therefore, the overarching goal of this thesis is to make a scientific contribution to the investigation of SRL in preschoolers. The development of valid measurement tools is a precondition for evaluating SRL interventions. There is, however, a lack of SRL measurement tools for preschoolers. Therefore, the first study for this thesis aimed to take the first steps to develop and evaluate a direct measurement tool to assess SRL "online" on the preschooler level. An adapted version of a process model of self-regulation served as the theoretical basis for the development of this tool. To examine its validity, cross-validation was realized with the aid of an external SRL rating of kindergarten teachers, as well as an established EF measurement tool. The statistical analysis indicated satisfactory reliability for the measurement tool as a whole. Validity was supported by (small) significant overall correlations with both selected comparative measures. Nevertheless, there is still a need to optimize the direct SRL measurement tool. There is empirical support for the effectiveness of SRL interventions across different age groups, such as pupils from elementary and secondary school and university students. However, only a few studies have considered fostering SRL in preschool children. The second study aimed to make a contribution to the research on SRL interventions by constructing and evaluating an SRL intervention for preschoolers and their kindergarten teachers. Similar to the first study, the intervention is based theoretically on an adapted version of a process model of self-regulation. The intervention aimed to foster particular learning strategies of the three phases of SRL (the forethought phase, the performance phase, and the self-reflection phase). The efficacy of the intervention was examined by a longitudinal control group design for preschoolers and kindergarten teachers. The intervention took place in two different learning environments, namely a) an autonomous

learning environment with no special focus on the stimulation of speech while practicing SRL learning strategies and b) a social-interactive learning environment where the SRL learning strategies were fostered with a focus on the stimulation of speech. In general, the results revealed an increase in SRL and gSR for preschoolers in all experimental conditions. Contrary to the assumption, preschoolers in the active control group showed a relatively higher increase in SRL (assessed by the external SRL rating) compared to the preschoolers in the intervention groups. Since SRL-relevant abilities develop further during the preschool years, interindividual differences between children should arise. Nevertheless, all children attending preschool have the transition to elementary school ahead of them. That is why the third study a) examined heterogeneity in the SRL-relevant abilities by identifying homogeneous subgroups (= profiles) of preschoolers and b) examined the impact of the profiles found on the benefits of an SRL intervention. The results revealed four clearly defined profiles. Due to deficits in the SRL intervention, no statements about the intervention's differential benefits were possible. Instead, an exploratory analysis of the (intervention-boosted) developmental time course of the four profiles was conducted. This revealed that high gSR and speech competence resulted in a larger increase in SRL. This result indicates the interrelationships between the three constructs. In conclusion, the present thesis makes a contribution to the assessment and fostering of SRL in preschool children and considers heterogeneity in SRL-relevant abilities among this special age cohort.

Zusammenfassung

Selbstreguliertes Lernen (SRL) wird definiert als Lernen durch die selbstständige und selbstgesteuerte Anwendung von Lernstrategien. Diese fächerübergreifende Fähigkeit steht nachweislich mit schulischem sowie akademischem Erfolg in Verbindung. SRL sollte so früh wie möglich gefördert werden, um die Etablierung von ungünstigem Lernverhalten zu verhindern. Die Vorschule, als erste Etappe des Bildungssystems, stellt dabei eine sensible Phase im Leben eines Individuums dar, in welcher sich für SRL relevante Fähigkeiten entwickeln. Zu diesen gehören die allgemeine Fähigkeit zur Selbstregulation (gSR), exekutive Funktionen (EF) sowie Sprachkompetenz als Mittel zur Begleitung von Lernhandlungen. Aktuell existiert eine begrenzte Anzahl von wissenschaftlichen Studien, die sich explizit mit SRL im Vorschulalter beschäftigen. Deshalb besteht das übergeordnete Ziel dieser Dissertation darin, einen wissenschaftlichen Beitrag zur Untersuchung von SRL bei Vorschulkindern zu leisten. Die Entwicklung valider Messinstrumente ist Voraussetzung, um SRL-Interventionen evaluieren zu können. Im Bereich von VorschülerInnen fehlt es an Messinstrumenten zur Erfassung von SRL. Deshalb zielt die erste Studie dieser Dissertation darauf ab, erste Schritte in Richtung der Entwicklung und Evaluation eines direkten Messinstruments zur 'online' Erfassung von SRL bei VorschülerInnen zu unternehmen. Eine adaptierte Version eines Prozessmodells der Selbstregulation diene dabei als theoretische Basis. Um die Validität zu untersuchen, wurde eine Kreuzvalidierung mithilfe eines externen SRL-Ratings (ausgefüllt durch die ErzieherInnen) sowie eines etablierten EF-Messinstruments vorgenommen. Die statistischen Analysen ergaben eine zufriedenstellende Reliabilität des gesamten direkten SRL Messinstruments. Die Validität wurde durch (kleine) signifikante Korrelationen mit beiden Vergleichs-Messungen gestützt. Trotzdem sind Optimierungen des direkten SRL Messinstruments für VorschülerInnen notwendig. Es existieren empirische Belege für die Effektivität von SRL-Interventionen für verschiedene Altersgruppen wie SchülerInnen der Primar- und Sekundarstufe sowie StudentInnen. Aber nur wenige Studien haben die Förderung von SRL bei VorschülerInnen untersucht. Die zweite Studie leistet einen Beitrag zur SRL-Interventionsforschung und zielt darauf ab, eine SRL-Intervention für VorschülerInnen und deren ErzieherInnen zu entwickeln und zu evaluieren. Ähnlich wie in der ersten Studie bildet eine adaptierte Version des Prozessmodells der Selbstregulation die theoretische Basis für die Intervention. Die Intervention beinhaltet die Förderung verschiedener Lernstrategien innerhalb der drei Phasen des SRL (Vorbereitungsphase,

Handlungsphase, Selbst-Reflexionsphase). Die Effektivität der Intervention wurde mithilfe eines längsschnittlichen Kontrollgruppen-Designs für VorschülerInnen und deren ErzieherInnen untersucht. Die Intervention fand in zwei verschiedenen Lernumgebungen statt, nämlich a) einer autonomen Lernumgebung ohne spezifischen Fokus auf der Anregung von Sprache während der Lernstrategie-Einübung und b) einer sozial-interaktiven Lernumgebung, in welcher SRL-Lernstrategien mit Fokus auf der Anregung von Sprache gefördert wurden. Allgemein zeigten die Ergebnisse der Studie eine Verbesserung von SRL und gSR bei allen VorschülerInnen der drei Experimentalgruppen. Entgegen der Annahmen zeigten VorschülerInnen der aktiven Kontrollgruppe eine größere Verbesserung in SRL (erfasst über die externalen SRL-Ratings) im Vergleich zu VorschülerInnen der beiden Interventionsgruppen. Da SRL-relevante Fähigkeiten sich während des Vorschulalters weiterentwickeln, sollten sich interindividuelle Unterschiede zwischen den Kindern zeigen. Dennoch haben alle Kinder der Vorschule den Übergang zur Grundschule vor sich. Deshalb untersuchte die dritte Studie a) die Heterogenität in SRL-relevanten Fähigkeiten durch die Bildung homogener Untergruppen (= Profile) und b) den Einfluss der gefundenen Profile auf den Nutzen einer SRL-Intervention. Die Ergebnisse ergaben vier gut definierte Profile. Aufgrund von Defiziten der SRL-Intervention konnten keine Aussagen bezüglich des differentiellen Interventionsnutzens getroffen werden. Stattdessen wurde der zeitliche Entwicklungsverlauf der vier Profile (angestoßen durch eine Intervention) explorativ untersucht. Es zeigte sich, dass hohe Ausprägungen in gSR und Sprachkompetenz in einem größeren Zuwachs von SRL resultieren. Dieses Ergebnis betont die Beziehungen zwischen den drei Konstrukten. Schlussfolgernd lässt sich festhalten, dass die vorliegende Dissertation einen Beitrag zur Erfassung und Förderung von SRL bei VorschülerInnen leistet und dabei die Heterogenität in SRL-relevanten Fähigkeiten dieser besonderen Altersgruppe berücksichtigt.

1 Introduction

The importance of early education in kindergarten is emphasized by current education policy developments in Germany, and especially in Saarland. In May 2019, the “Gute Kita Gesetz” (Engl. “Good Kindergarten law”) became legally binding (Bundesministerium für Familie, Senioren, Frauen und Jugend, 2019b). This reform law aims to ameliorate the quality of kindergarten as the first educational institution in the educational system. Saarland will invest EUR 65 million to equip kindergartens with more material and personnel resources and to create more care places. The former Minister of Education, Ulrich Commerçon, announced in a press release: “We must (therefore) do everything we can to ensure that inequality and social exclusion of children stops and that every child has the opportunity to attend kindergarten.” (Bundesministerium für Familien, Frauen, Senioren und Jugend, 2019c)

This reform law is a further step toward the recognition of kindergarten as a formative educational institution at which attendance is recommended for every child to give them a solid foundation to participate in the educational system and, consequently, in society. The educational program for kindergartens in Saarland looks at the kindergarten child as an individual who is capable of self-determination from birth and is intrinsically motivated to learn — with or without assistance (Der Minister für Bildung und Kultur, 2018). Furthermore, the program formulates educational objectives in the form of four basic abilities that should be achieved in kindergarten: self-competence, social competence, subject-specific competence, and learning competence. Within the framework of learning competence, the program postulates concrete abilities. These focus on the promotion of independence of learning and include, for example, the ability 1) to perceive and build on one’s own strengths and make progress where weaknesses exist, 2) to recognize the respective causes of successful and unsuccessful learning results, 3) to detect sources of error, 4) to order and systematize experiences and ideas, 5) to recognize that there are different ways to solve a problem, and 6) to acquire knowledge and information independently. These abilities are assignable to the concept of self-regulated learning (SRL), defined as the ability to learn through the autonomous and self-directed application of learning strategies (Sitzmann & Ely, 2011). SRL forms the centerpiece of this thesis. SRL is defined as a superordinate ability to learn through the autonomous and self-directed application of strategies (Sitzmann & Ely, 2011). SRL learning strategies capture, among others, precisely the

abilities listed previously. Therefore, SRL should already be fostered in the kindergarten years to implement the formulated objectives of the educational program for kindergartens in Saarland (Der Minister für Bildung und Kultur, 2018), as well as the educational objectives of the remaining federal states of Germany, in which an equal effort is made to improve the quality of early education (Bundesministerium für Familie, Senioren, Frauen und Jugend, 2019a).

This thesis takes up the political topicality of the issue of independence in learning in early education and aims to make a scientific contribution to the investigation of SRL in preschool children. The research findings that have been obtained in the field of SRL in recent years generally indicate a strong relationship between SRL and school success in different (older) populations: elementary school pupils (Cirino et al., 2017; Daniel et al., 2016; Dent & Koenka, 2016), secondary school pupils (Cleary & Kitsantas, 2017; Dent & Koenka, 2016; Perels, Dignath & Schmitz, 2009; Sadi & Uyar, 2013), and undergraduates (Mega et al., 2014; Sun et al., 2018). For the special age cohort of preschoolers, there is empirical evidence for the relationship between general self-regulatory abilities (gSR) as well. GSR is regarded as a superordinate to SRL and represents the precondition for a) the development of SRL (see Section 2.1.1) and b) later school success (McClelland et al., 2007; Rimm-Kaufman et al., 2009).

The first step toward the investigation of SRL in preschoolers is to identify reliable and valid assessment tools. For older age groups than preschoolers, there are various assessment possibilities (Schunk & Greene, 2018a). These include, among others, self-report questionnaires that query SRL behavior in common learning situations (McCardle & Hadwin, 2015; Pintrich et al., 1993) and think-aloud protocols (Winne & Perry, 2000), which assess SRL during the learning process. These would not be suitable for application with preschool children. Here, the challenge consists of applying measurement tools that fit the special characteristics of preschoolers, such as a) their restricted reading and writing abilities, (b) their fragile memory for past events, which may impede retrospective recall of strategy knowledge (Maylor & Logie, 2010), (c) misjudgment of their own performance (Schneider & Büttner, 2008), and (d) low test compliance with standard instructions (Stephenson & Hanley, 2010). Structured interviews, as well as observational inventories, have proven to be more suitable (Perels, Merget-Kullmann et al., 2009; Whitebread et al., 2009) and are able to assess

SRL while the learning process takes place. However, these assessment methods also have their weaknesses (see Section 2.4). Therefore, the development of a direct measurement tool to assess SRL “online” (i.e., during the learning process, Cazan, 2012) was the subject of the first study conducted for this thesis. This measurement tool should counteract the disadvantages of existing measurement instruments for preschoolers.

Furthermore, the question of fostering SRL is crucial to research in educational psychology. There is empirical support for the effectiveness of SRL interventions in elementary school students (Dignath et al., 2008; Leidinger & Perels, 2012), secondary school students (Glaser & Brunstein, 2007; Souvignier & Mokhlesgerami, 2006; Torrance et al., 2007; Wagner et al., 2014) and university students (Dörrenbächer & Perels, 2016; Nückles et al., 2009; Shi et al., 2013). Some studies have already dealt with fostering SRL in preschoolers (Dörr & Perels, 2019b; Perels, Merget-Kullmann, et al., 2009; Venitz & Perels, 2019; Whitebread et al., 2005). The findings of these studies form the basis for the second aim of this study (see Section 3.2), namely, to design an SRL intervention for preschoolers and their kindergarten teachers.

When investigating young children, developmental processes and interindividual differences should receive attention (Nesselroade, 1991). From the point of view of developmental psychology, “older kindergartners” in particular—i.e., preschoolers—are indeed in a suitable phase for the development of SRL (Agina et al., 2011; Erb et al., 2017; Lockl et al., 2016; Shaul & Schwartz, 2014; Winsler et al., 2003; Zelazo, 2015). At this stage, it has been shown that there is important progress in abilities that show strong relationships to self-regulatory abilities: EF (see Section 2.2.2) and speech competence (see Section 2.3.2). However, there is accumulating evidence for interindividual heterogeneity in SRL and related abilities among preschoolers that arise because preschoolers’ strengths and difficulties interact differently with their environment (Stormont et al., 2005). Therefore, the third study for this thesis focuses on interindividual differences in SRL-related abilities and the necessity of differential support by SRL intervention programs.

In summary, this thesis pursues three aims: (1) the development and evaluation of a direct, quantitative SRL measurement tool that fits the requirements of children

of preschool age, (2) the development and evaluation of an SRL intervention for preschoolers and their kindergarten teachers, and (3) the investigation of heterogeneity in SRL-relevant abilities and the necessity of differential support.

2 Theoretical and Empirical Background

In the first section, the main construct of this thesis is defined and underlined with theoretical and empirical findings, with a special focus on the developmental aspects of SRL. In the second section, EF, as a construct related to SRL, is described. The nature of the relationship between EF and SRL is explained from theoretical and empirical points of view. In the third section, speech competence is introduced, which plays an important role in the development of SRL. The fourth and fifth sections give an overview of the assessment and fostering of SRL in preschool children.

2.1 Self-Regulated Learning

This section is subdivided into three parts. First, the construct of SRL is defined and differentiated from the construct of gSR. Second, two categories of SRL models are introduced, and Zimmerman’s (2000) process model—which forms the basis of this thesis—is explained and transferred to the preschooler age group. Third, the developmental aspects of SRL are illuminated.

2.1.1 Definition and Differentiation from a General Self-Regulation Ability

From a socio-cognitive perspective (Bandura, 1986)¹ (i.e., people acquire knowledge by observing others and through social interaction, Panadero, 2017), self-regulation is defined as “self-generated thoughts, feelings, and actions that are planned and cyclically adapted to the attainment of personal goals” (Zimmerman, 2000, p. 14). Self-regulation is about tracking goals adaptively — this requires maintaining goals over a certain period of time and adjusting them to changing conditions. Self-regulation enables the individual to provide an adjustment in all areas of life, such as social interaction (Williford et al., 2013) or learning behavior (Denham et al., 2012). Self-

¹ This thesis is related to the socio-cognitive perspective (Bandura, 1986) on self-regulation. There is also, however, a developmental psychology perspective on self-regulation, which refers to regulation of emotion as a characteristic of temperament (Rothbart & Ahadi, 1994). The latter perspective is not of importance in this thesis.

regulation comes into play on different levels: thinking processes (cognitive self-regulation, e.g., Modrek et al., 2019), emotions (emotional self-regulation, e.g., Day & Smith, 2013), and actions (behavioral self-regulation, e.g., Bono & Bizri, 2014).

In contrast, SRL means the domain-specific application of self-regulation in the context of learning (Schunk & Greene, 2018b). SRL can be defined as an active process in which the learner sets learning goals. Furthermore, the learner observes, regulates, and controls their cognition, motivation, and behavior in accordance with the predefined goals and the (environmental) conditions (Pintrich, 2000). This definition emphasizes important aspects that are also mentioned in other definitions of SRL: the autonomy of the learner concerning the arrangement, execution, and reflection of their own learning process.

To sum up, self-regulation means a superordinate ability — a more general self-regulation, which will be designated as gSR throughout this thesis. gSR is regarded as a prerequisite for the acquisition of a domain-specific application of self-regulation, namely SRL. SRL gains importance when individuals come into contact with the educational system, which happens first in preschool. SRL does not represent a classical academic ability like mathematics or literacy. It rather represents a “metability” that is useful in multiple school and academic disciplines.

2.1.2 Models of Self-Regulated Learning

In the course of SRL research, different theoretical models have been formulated (see Otto et al., 2011). These models can be divided into two categories (Winne & Perry, 2000): component models and process models. The theoretical foundation for this thesis was built on the latter.

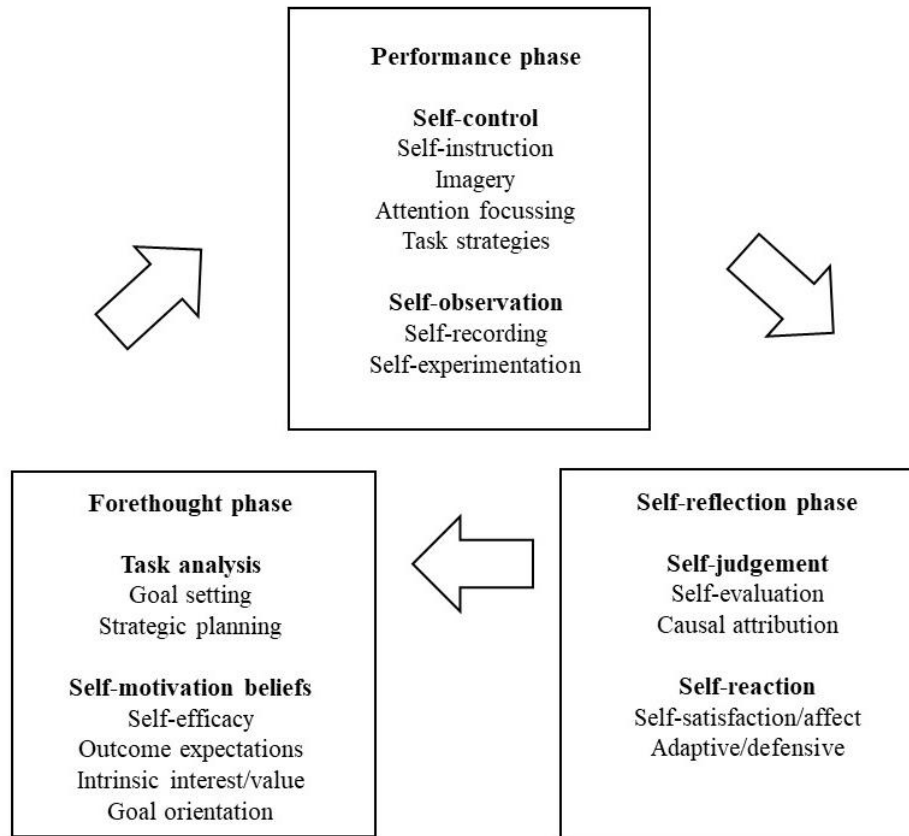
Nevertheless, component models are also highly relevant in the research field of SRL (Panadero, 2017) and therefore have to be mentioned in this thesis. These models focus on the structural dimension of SRL and deal with the definable components that make up SRL (Panadero, 2017). One of the most common component models is the “Three-layer-model” proposed by Boekaerts (1999), which postulates three different systems within SRL. The layer “regulation of processing mode” includes the selection of cognitive strategies (e.g., practicing, elaboration, structuring) to reach the predefined goal. The layer “regulation of learning process” includes metacognitive knowledge and ability (planning, execution, observation, and evaluation). The layer

“regulation of the self” covers the selection of goals and individual resources and encompasses the motivation process of SRL.

In contrast to component models, process models focus on the temporal dimension of SRL and are intended to explain the process of learning. The focus of this thesis is the process of SRL and forms the basis of a) the construction of a measurement instrument to assess SRL in preschoolers (see Section 5.1) and b) of the intervention program to foster SRL in preschoolers (see Section 5.2). Zimmerman’s (2000) model of self-regulation, which is initially a non-domain-specific model of self-regulatory processes, is well-suited to the context of learning in pedagogical-psychological research (Landmann et al., 2015). Transferred to learning processes, the model postulates three cyclically arranged phases: the forethought phase, the performance phase, and the self-reflection phase (see Figure 1). During the forethought phase, a task analysis takes place, which includes the definition of goals and the strategic planning of learning strategies that are used to solve a task. Also, motivational processes play a crucial role and are summarized under the term “self-motivation beliefs.” These are made up of self-efficacy beliefs (Bandura, 2001), outcome expectations (Conley, 2012), intrinsic interest or value (Schiefele, 1991), and goal orientation (Pintrich, 2000). During the performance phase, self-control and self-observation are important in continually adopting strategies aimed at goal attainment. Concerning self-control, Zimmerman (2000) cites a) general strategies such as self-instruction, imagery, and attention focusing, as well as b) task strategies that are specific to particular learning tasks. Self-observation takes place continuously and consists of self-recording of the learning behavior and self-experimentation with different ways of proceeding. During the self-reflection phase, the attainment of the predefined goals is evaluated and leads to self-judgment and self-reaction. Self-judgment summarizes the processes of self-evaluation and causal attribution, which are directly related to each other (Stiensmeier-Pelster & Heckhausen, 2010). Self-reaction results in self-judgment (success or failure) and comprises the affective states and self-satisfaction, as well as adaptive or defensive inferences that describe conclusions about necessary changes in future learning behavior. Consequently, the outcome of the self-reflection phase influences the forethought phase of further tasks in the sense of a personal feedback loop.

Figure 1

Zimmerman's (2000) model of self-regulation following Zimmerman and Moylan (2009)



2.1.3 Development

As mentioned in Section 2.1.1, gSR as a superordinate ability can be regarded as a prerequisite for the development of SRL. Therefore, this section focuses on important progress in self-regulatory abilities in childhood and, particularly during the preschool years.

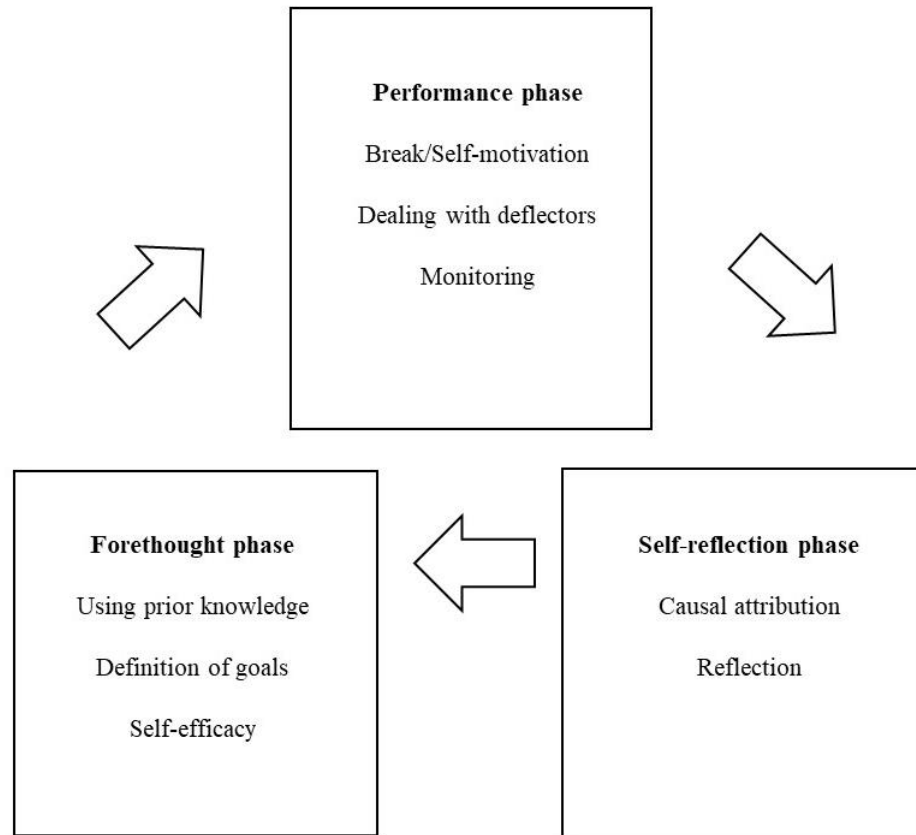
During the preschool years, important developmental steps take place. There appears to be a) a general shift from emotion-driven regulation to more cognitive regulation, upon which complex learning processes like SRL can be built (Zelazo, 2015). Moreover, b) a qualitative shift from external regulation to a more internally guided self-regulation style can be observed (see Montroy et al., 2016), which is essential to performing SRL actively. Also, c) preschoolers develop an elementary metacognitive understanding of their own learning processes (Lockl et al., 2016).

Although important progress is made during the preschool years, the self-regulatory abilities of young children still differ from those of older children or adults. There are also tasks that children at this stage are unable to solve or solve poorly in comparison to older children, which speaks in favor of the developmental potential of self-regulatory abilities around preschool age. Concerning the forethought phase of SRL, preschoolers and first-graders are unable to consider task difficulty when planning the time to solve a task, but older children from the age of ten are able to do so (Dufresne & Kobasigawa, 1989). However, preschoolers are evidentially able to set goals and adjust their thinking and acting toward goal attainment (Blaye & Chevalier, 2011; Hendry et al., 2016), which plays a crucial role in the forethought phase and the performance phase of SRL. Limitations in the performance phase are indicated by the findings that younger children are poorer in the monitoring of errors while solving tasks than older children, but show a successive amelioration in this ability from five to fourteen years of age (Ridderinkhof & van der Molen, 1995). Wiersema et al. (2007) found that sensitivity to detecting errors while solving tasks increases from seven years of age to young adulthood. However, importantly, current research also shows that preschoolers show good inhibitory control (Carlson, 2005; Lewis et al., 2017) and attention focusing abilities (Bronson, 2000; Lewis et al., 2017). Concerning the self-reflection phase of SRL, kindergartners are able to judge their learning progress (Zelazo, 2015), but do so less accurately than older pupils and adults (Schneider et al., 2000). It has also been shown that seven-year-olds are able to evaluate their learning process with the help of an intervention (Valkanova, 2004).

Figure 2 illustrates a version of Zimmerman's (2000) process model of self-regulation, which is adapted to the ability level of preschoolers. It captures SRL strategies that are regarded as appropriate to the preschooler age group (see Dörr & Perels, 2019b).

Figure 2

Zimmerman's (2000) process model of self-regulation adapted for preschoolers (Dörr & Perels, 2019b, Jacob et al., 2019a)



To sum up, empirical findings indicate that not all self-regulatory abilities are fully matured in preschool, but those who mature significantly in this age range gain space for further progress and fostering their self-regulatory abilities.

2.2 Executive Functions

This section is subdivided into three parts. First, the construct of EF is defined, and three core abilities are introduced. Second, the developmental pathways of the core abilities of EF are described. Third, the relationship between SRL and EF is discussed.

2.2.1 Definition

EF is a cluster of cognitive processes that enable individuals to coordinate and modulate thinking and behavior in different life areas (Best et al., 2011). Based on the current state of research, these cognitive processes are separable by factor analysis but

are correlated with each other (Miyake & Friedman, 2012). For that reason, Miyake and Friedman (2012) talk about the “unity and diversity” of EF.

According to Miyake et al. (2000) and Miyake and Friedman (2012), EF can be subdivided into three core abilities, which are “working memory,” “inhibition,” and “shifting.” “Working memory” refers to the adaptation and maintenance of working memory representations, and “inhibition” refers to the ability to inhibit dominant, automatic responses. “Shifting” refers to the ability to shift between different perceptual attributes or thoughts based on feedback from changing surroundings (Mukhopadhyay et al., 2008).

2.2.2 Development

The development of EF extends over childhood to young adulthood (Best & Miller, 2010). The main difference between children and adults concerning EF is that the EF are not fully mature in children (Rueda et al., 2005). The age range between three- to six years of age marks a sensitive time during which relevant developmental steps are made (Erb et al., 2017; Shaul & Schwartz, 2014).

The three core abilities of EF follow different developmental pathways. Considering a) the developmental curve, current research indicates that “working memory” as well as “shifting” show a linear improvement from preschool through adolescence (Best & Miller, 2010). “Inhibition” shows a particularly strong improvement during the preschool years and develops slower in later years (Best & Miller, 2010). Concerning b) the speed of development, current research indicates that “inhibition” and “shifting” develop faster than “working memory.” The latter matures until late adolescence and shows the first of all age-related deficits (Karchach & Unger, 2014). These differences in developmental speed are connected to the maturation of the brain regions assigned to these functions, which are primarily in the prefrontal cortex, located in the frontal lobe. The frontal lobe matures, in general, more slowly than other brain regions and reaches a developmental stop in young adulthood (Romine & Reynolds, 2005). In research studies with adults, the three core functions of EF can be reliably separated using factor analyses. In research studies with young children, performance on EF tasks is determined by only one factor (Wiebe et al., 2008). In preschoolers and first-graders, “working memory” distills as a separate factor, while “inhibition” and “shifting” are still not separable (Lee et al., 2013).

2.2.3 *Relationship to Self-Regulated Learning*

For decades, the target-oriented regulation of thinking and behavior has been investigated using the term EF in research in the field of cognitive-developmental psychology and other related disciplines and SRL in research in the field of pedagogical psychology (Zimmerman, 2000). Current research stresses the need to bring together both constructs and to examine underlying similarities and differences (e.g., Hofmann et al., 2012; Garner, 2009; Gaskins et al., 2007).²

Garner (2009) postulated a categorization of research dealing with the connection between EF and SRL and assigned the research findings to four different approaches. (1) First, EF and SRL describe exactly the same construct, and the terms can be used interchangeably. In accordance with this approach, a) Blair & Razza (2007) use the terms EF and gSR interchangeably. They operationalized gSR by measuring common EF components like inhibition and shifting and found prominent correlations with academic performance in reading and mathematics. Also, b) Gaskins et al. (2007) provided a theoretical framework in which they localized EF in a psychological-pedagogical context and linked them with academic abilities. (2) Second, SRL can be considered a superordinate construct to EF because it is composed of many subcomponents like self-efficacy, task strategies, and self-satisfaction (see the model by Zimmerman, 2000; Section 2.1.2). These subcomponents are grounded in different abilities. EF represent one of these abilities (see Barkley, 2001). (3) Third, EF can be considered a superordinate construct while SRL represents a domain-specific application of EF in the context of learning. Blair and Ursache (2011), as well as Hoyle and Dent (2018), describe EF as the basis and prerequisite of gSR. Fourth, EF and SRL can be regarded as overlapping but distinct concepts that have similarities as well as unique characteristics. Effeney et al. (2013) conclude from their research findings that EF and SRL share a conceptual core. Also, Follmer and Sperling (2016) describe EF as a key process that predicts SRL — mediated by further constructs like metacognition. To summarize Garner's (2009) four approaches, two main perspectives are thinkable: on the one hand, it can be assumed that there is a hierarchical relationship between EF and SRL (Baumeister et al., 2007; Blair & Ursache, 2011; Hoyle & Dent, 2018); on

² In the following, findings from gSR research and SRL research are merged together to allow for conclusions concerning the relation of SRL and EF. As described in section 2.1.1, SRL is regarded as the domain-specific application of SR.

the other hand, an overlapping relationship between both constructs can be assumed, in which EF and SRL are connected by interactive processes (Garner, 2009; Hofmann et al., 2012; Kaplan & Berman, 2010).

The research findings of studies on children and adolescents indicate that the relationship between EF and SRL changes over the course of one's life. As described in the previous sections (Section 2.2.2 and 2.1.3), neither EF nor SRL are fully matured during the preschool years. Effeney et al. (2013) found stronger relationships between both constructs for male primary school pupils than for male secondary school pupils. Bryce et al. (2015) examined the correlation between EF components and (behavioral) gSR in preschoolers and primary school pupils and found a stronger correlation between both constructs in the younger age cohort. The "differentiation hypothesis" of Spearman (1927) can be used to explain these findings. This hypothesis postulates that the stronger the extent of covariance between (intellectual) abilities, the weaker the average (intellectual) ability level of the population. This means that correlations between cognitive abilities are particularly high in populations in which these abilities are generally poorly-developed. Consequently, it is to be expected that EF and SRL, which are not yet fully matured in preschoolers, show higher correlations in young children than in older children and adolescents (Bryce et al., 2015; Effeney et al., 2013).

This thesis is based on the assumption that there is a hierarchical relationship between EF and SRL such that EF is seen as a prerequisite for the acquisition of SRL (see Nigg, 2017). Simultaneously, it is taken into account that both constructs show a particularly high degree of correlation in the young age cohort of preschoolers (Lee et al., 2013; Wiebe et al., 2008). This has implications for the development and evaluation of the SRL measurement tool and the SRL intervention for preschoolers: a) an established EF measurement tool is suitable to validate the developed SRL measurement (see Study 1), and b) the level of maturation of EF in preschoolers could have an impact on the benefits of an SRL intervention (see Study 3).

2.3 Speech Competence

This section is subdivided into four parts. First, the construct of speech competence is defined, and the regulative function of speech is described. Second, the devel-

opmental aspects of speech competence are explained, with a special focus on the development of self-talk, which is regarded as crucial for the regulation of thinking processes during learning behavior. Third, the relationship between speech competence and SRL is further discussed. Fourth, the implications for the development of an SRL intervention in a speech-activating environment are described.

2.3.1 Definition

Speech competence is defined as an important means of communication, coding, and controlling that enables the individual to share and perceive information (Weinert, 2007). This definition implies three functions of speech: 1) a social function (“communication”), which plays an important role in the social interaction of the child with the environment; 2) a “translation” function (“coding”) by which information is coded by generating propositions, and 3) a regulative function (“controlling”), which stresses the opportunity to affect thinking and behavior by using speech. Furthermore, two different components of speech become apparent, namely the production of speech (“information sharing”) and reception of speech (“perceiving information”).

2.3.2 Development

Child development, in general, and that of the self-regulatory abilities in particular, happens in the context of verbal and communicative interaction of the child with the environment (Bronson, 2000). This is where “self-talk” plays a prominent role (Vygotsky, 1962). Self-talk means the voicing of mental processes (Clark, 2004) and can manifest in “social speech,” which is used by the child to share and synchronize thinking processes with others. Furthermore, self-talk can manifest itself in “private speech,” which is used by the child to verbalize thinking processes aloud that are not (yet) fully internalized. This represents a helpful tool to regulate thinking processes. As the ability to internalize thinking processes increases, private speech is increasingly covered (noiseless mouth movements are observable) and finally replaced by “inner speech.” When using “inner speech,” the child represents thinking processes completely internally without expressing them. Preschoolers are located at the transition from private speech to inner speech (Manfra & Winsler, 2006; Winsler et al., 2000; Winsler et al., 2003).

2.3.3 Relationship to Self-Regulated Learning

Empirical findings for the age group show that preschoolers are able to instruct themselves while going through tasks (Agina et al., 2011; Aro et al., 2015; Baars, 2003); furthermore, they show important progress in internalizing private speech (Winsler et al., 2003). Winsler et al. (2009) talk about a developmental peak in internalizing private speech during the preschool years.

The assumption that speech influences SRL activities in a positive manner is empirically supported by current findings in gSR research (Whitebread, 2015). Bono and Bizri (2014) demonstrated in their study with kindergartners (three to five years old) that the use of speech was positively related to gSR. Furthermore, their findings indicate that children with higher language skills tended to use more inner speech (than private speech) and showed higher levels of gSR according to an external rating. Also, Day and Smith (2013) examined kindergartners (four and a half to six years old) concerning their use of social and private speech during task execution and found that private speech significantly influences (emotional) gSR. Agina et al. (2011) conclude from the results of their study on preschoolers that gSR can be increased by using private speech.

To sum up, preschoolers dispose of speech competence, which allows them to verbally instruct themselves through self-talk. Empirical findings indicate that speech has a positive impact on gSR. Consequently, speech represents a useful means to regulate learning processes and is worth considering in the development of SRL interventions for preschoolers.

2.3.4 Implications for a Self-Regulated Learning Intervention

The use of self-talk can support the planning and monitoring of learning actions (Winsler et al., 1997). As described in the previous section, the development of self-talk in the form of inner speech is advanced but not yet terminated during the preschool years. To foster self-talk as an additional element of an SRL intervention, the training principle of “cognitive self-instruction” (Meichenbaum & Goodman, 1971) appears to be useful. Following this principle, first, a competent model (trainer) performs an action and verbalizes their action steps. Second, the child is instructed to perform the same action, and the trainer takes over the verbalization. Third, the child performs the action and verbalizes using private speech. In the following steps, the child covers

increasingly loud speaking and switches to using inner speech. The content of the verbalizations in learning actions is a) formulating the main questions concerning the requirements of the task, b) formulating responses to these main questions by repeating the task and action goals, as well as planning individual action steps, c) formulating self-instructions while performing the actions steps and, d) formulating self-praise when the task is completed. The procedure described is similar to that proposed in Zimmerman's (2000) model of self-regulation: during the forethought phase, a) "formulating main questions" and b) "formulating responses to the main questions" are required; during the performance phase, c) "formulating self-instructions while performing" is required and, during the self-reflection phase, d) "formulating self-praise" is needed.

Meichenbaum and Goodman (1971) examined the efficacy of using "cognitive self-instruction" to reduce impulsive behavior in kindergartners, first-graders, and second-graders. They found positive effects. Also, further research groups report an effective reduction in impulsive behavior (Bornstein & Quevillon, 1976) and increased accuracy during task performance (Bryant & Budd, 1982) by applying a self-instruction intervention in preschoolers. A more recent study by Rivera-Flores (2015) also showed that "cognitive self-instruction" is useful in reducing impulsiveness in a clinical sample of six to eight-year-old children with attention deficit hyperactivity disorder (ADHD).

To sum up, it can be said that self-instruction could represent an additional tool to support preschoolers in acquiring SRL. A speech-activating learning environment, in which self-instruction during task performance is taught, could represent a useful approach to foster SRL. This approach is investigated in the second study in this thesis, in which an SRL intervention in a speech-activating learning environment is compared with an SRL intervention in an autonomous learning environment without any focus on speech stimulation.

2.4 Assessment of Self-Regulated Learning in Preschoolers

The valid assessment of SRL represents the precondition for investigating SRL in preschool children (Dörr & Perels, 2019b; Perels, Merget-Kullmann, et al., 2009;

Venitz & Perels, 2019). In this section, an overview of SRL assessments is given. Furthermore, the applicability of these SRL assessments in preschool children is considered.

There are two major approaches to assessing SRL in preschoolers, namely *offline* and *online* measurement (Cleary & Callan, 2018; Winne & Perry, 2000). Offline measurements aim to assess SRL as an aptitude. An aptitude is a stable trait of an individual, and the measurement of this trait can gather information about future behavior (Cazan, 2012). Mostly, SRL is measured offline by using quantitative measurement tools like (1) self-report questionnaires, (2) structured interviews, and (3) external assessments.

(1) Self-report questionnaires are not feasible for use with preschoolers because they are not yet able to read. In contrast, preschoolers can verbally be asked about their SRL behavior by using (2) structured interviews. Here, SRL can be enquired about in a retrospective way: the child is asked how he/she behaved in past situations where SRL was required. Alternatively, SRL can be enquired about in a prospective way: the child is asked how he/she would behave in the future in hypothetical situations where SRL would be required. Structured interviews are rarely used to assess SRL in preschool children. One example of the use of structured interviews, however, is the study by Perels, Merget-Kullmann et al. (2009). The authors conducted the interviews with the aid of a puppet to enhance children's compliance. An important limitation of data gained by structured interviews is preschoolers' tendency to overestimate their own abilities (Schneider & Büttner, 2008). Furthermore, the data depend on verbal proficiency, which is still being developed during the preschool years (see Section 2.3.2) and the ability to verbalize introspective processes, which has not yet fully matured at this stage (Chatzipanteli et al., 2014). (3) External ratings of pedagogical specialists are widely used to assess self-regulation in preschoolers (Winne & Perry, 2000). Common rating scales are the CHILD Checklist (Whitebread et al., 2009) and the Child Behavior Rating Scale (CBRS, Bronson, 1994). One limitation of external rating scales is that external ratings depend on the subjective perception and interpretation of the rater (e.g., Mashburn & Henry, 2004). Therefore, an alignment with the data of more objective measurements would be essential. Unfortunately, there is a lack of direct, objective measurement tools to assess SRL in preschoolers.

The second approach to assess SRL is online measurement. Here, SRL is regarded as an event in a certain situation. Consequently, SRL is to be assessed in real-time while the learning process takes place (Cazan, 2012). The most common methods of assessing SRL as an event are a) learning journals, b) think-aloud protocols, and c) observational inventories. Learning journals (a) are not feasible for use with preschoolers because they are not yet able to read and write. The application of think-aloud protocols is thinkable. Preschoolers are shown to be capable of articulating their own thoughts while viewing a picture book (Paris & Paris, 2003; Tompkins et al., 2013). However, think-aloud protocols would be very demanding, and the results would suffer from limitations similar to those mentioned for structured interviews: the dependency on (productive) verbal proficiency and introspective processes. Observational inventories (c) are applicable in preschoolers. As part of the Cambridgeshire Independent Learning in the Foundation stage (C.Ind.Le), a project that examined the development of metacognitive and self-regulatory abilities in kindergartners in the educational setting, two systemic observational inventories were designed by Whitebread et al. (2009): the C.Ind.Le Coding Framework and the CHILD 3-5. Furthermore, Bryce and Whitebread (2012) observed SRL behavior by using the train track task (TTT). However, an essential disadvantage of observational data is that learning strategies, which are known implicitly but not demonstrated during observation, may not be captured (Landmann et al., 2015).

In conclusion, the assessment of SRL in preschoolers is demanding, and existing measurement tools show limitations. This thesis aims to develop and evaluate a direct measurement tool for preschoolers that does not suffer from the disadvantages of existing measurement tools. This measurement tool assesses SRL “online,” which may limit bias due to preschoolers’ inaccurate self-estimation (Schneider & Büttner, 2008).

2.5 Fostering Self-Regulated Learning in Preschoolers

This section is subdivided into two parts. First, the central findings on fostering SRL in preschoolers are collected, and important limitations of these findings are discussed. Second, concrete implications for the SRL intervention in this thesis are derived from the current state of research.

2.5.1 Findings on Fostering Self-Regulated Learning in Preschoolers

Intervention programs for preschoolers that aim to foster SRL or SRL-related abilities differ concerning the starting point of the intervention (see Friedrich & Mandl, 1997). On the one hand, direct interventions start with the learner and aim to optimize their learning behavior. Indirect interventions start with the environment in which learning takes place. Transferred to preschoolers, indirect interventions start with the people who have a significant impact on their learning environment. Most of all, kindergarten teachers and parents belong to this group (Otto et al., 2011). The effect of indirect interventions manifests itself through a) explicit mediation of learning contents by reference persons and through b) a model function of the reference persons for the learner (Bandura, 1991) or c) the establishment of an environment characterized by a high level of demand for self-determination (Landmann et al., 2015).

When reviewing the empirical evidence for SRL interventions, some studies can be found that explicitly deal with the construct of SRL as defined in this work, such as the study by Whitebread et al. (2005). The authors observed and analyzed “independent learning” in kindergartners (3–5 years of age). “Independent learning” describes the ability to “take control of, and responsibility for the own learning” (Whitebread, 2012, p. 5). Here, the strong overlap with SRL, as defined by Sitzmann and Ely (2011), becomes apparent: SRL is also made up of the ability to learn through the independent application of learning strategies. Whitebread et al. (2005) investigated the efficacy of different teacher-applied pedagogical practices to support independent learning. They found that “independent learning” can be fostered effectively via four channels of independent learning: emotional, prosocial, cognitive, and motivational (see Bronson, 2000). The corresponding pedagogical practices are, for example, fostering attention control and dealing with deflectors (emotional channel), allowing for cooperative activities with peers (prosocial channel), inviting to verbalize the learning process (cognitive channel), and supporting the learners in initiating learning activities on their own (motivational channel).

Also, Perels, Merget-Kullman et al. (2009) focused on improving SRL in preschoolers. The indirect intervention was theoretically based on the process model of SRL (Zimmerman, 2000). The intervention consisted of five sessions: an introduction session, three sessions in which SRL learning strategies for the three phases (forethought, performance, self-reflection) of SRL were taught, and a summarizing session.

The study showed a significant intervention benefit for kindergarten teachers (assessed via self-report) and preschoolers (assessed via a structured interview using a puppet). However, the authors state that the results at the level of preschoolers may be limited because the SRL assessed via interviews may be a) influenced by children's level of speech, which was not controlled for in the study and b) because the knowledge about SRL, enquired about in the interview, may differ from the active application of SRL strategies. Further, Venitz and Perels (2019) applied an indirect intervention to foster SRL in preschoolers. With recourse to the process model of SRL (Zimmerman, 2000), the authors trained reference persons, namely parents and kindergarten teachers, in the use of SRL learning strategies over three intervention sessions. In the first session, they taught SRL learning strategies for the forethought phase; in the second session, those of the performance phase; and in the third session, those of the self-reflection phase. The authors examined an intervention effect on the level of preschoolers (assessed by using an external rating to assess preschoolers' SRL) and an intervention effect on the level of reference persons (assessed by using a self-report questionnaire to assess kindergarten teachers' SRL). The authors found a significant intervention benefit concerning the application of supportive methods on a reference person level. The expected intervention effect on the level of preschoolers could not be confirmed. Venitz and Perels (2019) discussed different aspects that could have led to the failure of the intervention on the level of preschoolers. They mentioned difficulties of the applied SRL measurement tool (CHILD Checklist), which assesses general characteristics rather than explicit SRL learning strategies. Furthermore, they stated that the intervention period of three intervention sessions may have been too short to allow preschoolers to internalize the SRL strategies that were modeled and taught by the reference persons.

Dörr and Perels (2019b) aimed to improve SRL in preschool children, using a combination of direct intervention and indirect intervention. The direct training for preschoolers consisted of ten sessions in which SRL learning strategies according to the process model of SRL (Zimmerman, 2000) were taught. The teacher intervention was designed similarly. The authors did not find a significant intervention effect: there was no amelioration in preschoolers' SRL (assessed by using an external SRL rating and a direct and an observational tool, TTT) after the intervention. The authors critically considered the use of the TTT as a performance measure of SRL but point out

that they had few alternatives to assess SRL in this age group. They recommend scientific studies that focus on developing age-appropriate SRL measurement tools that assess SRL “online.” In a second study by Dörr and Perels (2019a), they examined whether the intervention (described above) led to an improvement in preschoolers’ metacognitive abilities (assessed by using the TTT). These metacognitive abilities were regarded as a prerequisite of SRL. They found a significant increase in one component of metacognition, namely “control activities.” The authors interpreted the results in such a way that preschoolers definitely possess (precursor) abilities that build the foundation for the development and fostering of SRL.

To sum up, empirical evidence for the successful implementation of SRL is incomplete. Whitebread et al. (2005) identified pedagogical approaches to foster independent learning in preschoolers, and Perels, Merget-Kullmann et al. (2009) developed an effective SRL intervention for preschoolers, which fostered SRL on the direct and indirect level. However, neither Venitz and Perels (2019) nor Dörr and Perels (2019b)—both also using a combination of direct and indirect interventions—could show a significant increase in SRL in preschoolers after participation in an SRL intervention. At least, Dörr and Perels (2019b) could demonstrate that a prerequisite of SRL could be prompted by an intervention. A highly relevant limitation in all reported SRL intervention studies is the valid assessment of SRL in preschoolers. Because of this reason, this thesis also focuses on the development of an age-appropriate SRL measurement tool (Aim 1), which aims to allow for the evaluation of the developed SRL intervention within this thesis (Aim 2). A further limitation described was the lack in control of speech competence (Perels, Merget-Kullmann, et al., 2009), which was considered in this thesis by a) assessing speech competence in a pre-test and b) by comparing two different learning environments (with and without speech simulation) in which the SRL intervention took place (for an overview, see Section 5).

2.5.2 Implications for a Self-Regulated Learning Intervention

As indicated above, this thesis considers the results and limitations of previous studies that dealt with fostering SRL in preschool children (e.g., Dörr & Perels, 2019b; Perels, Merget-Kullmann, et al., 2009; Venitz & Perels, 2019). Also, further empirical evidence on designing interventions for young children is considered (e.g., Dignath et al., 2008; Pickl, 2004; Sturzbecher, 2008).

Combination of direct and indirect interventions. As practiced in the current research landscape with a focus on fostering SRL in preschoolers, a combination of a direct and an indirect intervention is useful (Landmann et al. 2015). Even if there is evidence for the superiority of direct intervention in older children (Otto, 2007), reference persons (like parents and kindergarten teachers) play a very important role in the development of preschoolers in general and the acquisition of abilities connected to SRL in particular. Social-interactive processes are crucial and affect components of SRL (see Section 2.3.2). In this thesis, a direct intervention for preschoolers is combined with an indirect intervention for their kindergarten teachers to improve preschoolers' SRL abilities.

Special characteristics of the preschoolers' intervention. Concerning the structure of the intervention, it was central to select SRL learning strategies that are appropriate to the developmental status of preschoolers (see Section 2.1.3) and well-founded within an established theoretical framework (see Zimmerman, 2000). Focusing on speech represents a fruitful research direction (Perels, Merget-Kullmann, et al., 2009). Research indicates that the use of self-talk can support the development of SRL (see Section 2.3.2). Furthermore, the mediation of knowledge has to be made in a childish and playful manner (Bronson, 2000; Sturzbecher, 2008) to produce compliance in preschoolers. Moreover, the conception of the intervention should include elements that enable the transfer of learned SRL strategies to everyday life (Pickl, 2004). These elements could be outsourced in the indirect intervention on the level of kindergarten teachers because they create a high proportion of the everyday life of preschoolers (Otto et al., 2011). Additionally, the results of a meta-analysis with a focus on elementary school pupils indicate that SRL interventions are more effective when executed by external trainers (Dignath et al., 2008).

3 Research Aims

Based on the theoretical assumptions and empirical findings that are described in Section 2, this thesis aims to make a contribution to the investigation of SRL among the special cohort of preschoolers.

3.1 Aim 1

The aim of the first study is to develop and evaluate a measurement tool to assess SRL in preschool children. It does not suffer from the disadvantages of established measurement instruments like structured interviews (Perels, Merget-Kullmann, et al., 2009) and external rating scales (Bronson, 1994; Goodman, 1997; Whitebread et al., 2009) (see Section 2.4). The online character of the measurement tool may limit bias due to the insufficient self-estimation skills of preschoolers (Schneider & Büttner, 2008). It allows for direct measurement on the child level, requires little productive language skills, captures a set of SRL learning strategies which are considered important for preschoolers, and provides quantitatively interpretable data based on a standardized evaluation protocol. The measurement tool is evaluated by realizing cross-validation against an external SRL rating and a direct EF measurement tool.

3.2 Aim 2

The aim of the second study is to develop and evaluate an SRL intervention for preschool children that is theoretically based on Zimmerman's (2000) process model, adapted for preschoolers. A direct intervention on the child level is combined with an indirect intervention on the kindergarten teacher level (Landmann et al., 2015). Since the use of self-talk may have a positive impact on SRL (Agina et al., 2011; Bono & Bizri, 2014; Bronson, 2000; Day & Smith, 2013), an SRL intervention in an autonomous learning environment is compared to an SRL intervention in a social-interactive learning environment in which the use of speech is additionally stimulated. The intervention benefit is measured by using an external SRL rating, an SRL measurement tool (see aim 1), as well as a gSR measurement tool, both applied directly on the child level.

3.3 Aim 3

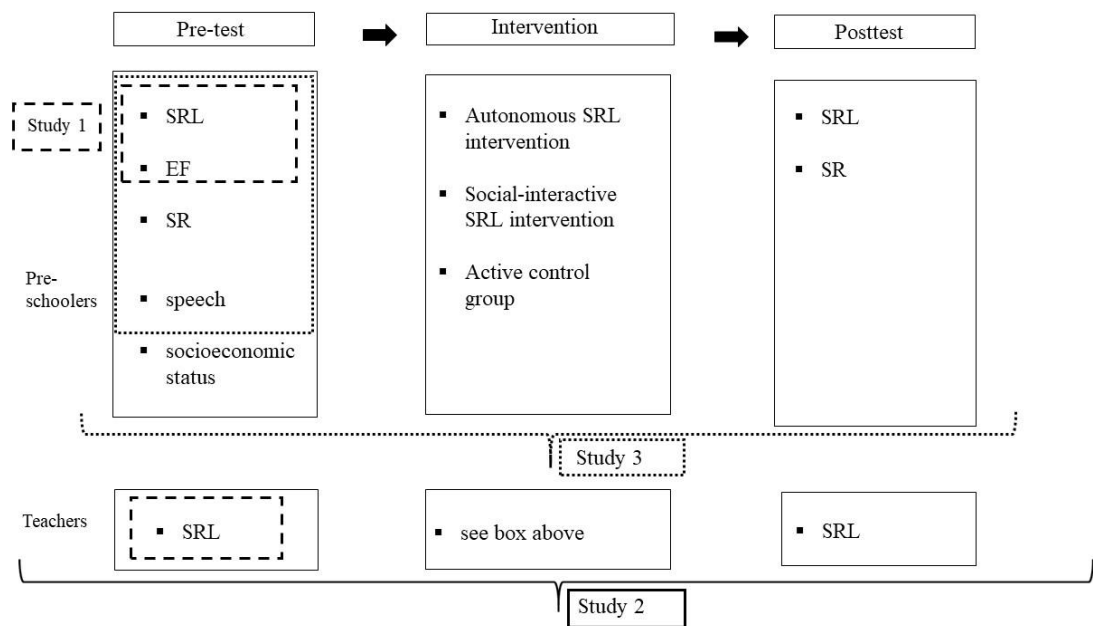
The aim of the third study is a) to identify homogenous subgroups of preschoolers with different ability levels in gSR, EF, and speech competency (i.e., SRL precursor abilities). These abilities mature during the preschool years in different pathways (MacPherson et al., 2019; Winsler et al., 2000) and are shaped by reciprocal interactions of individual and contextual factors (Stormont et al., 2005). This is why quantitative differences between the profiles are expected. Further, the study aims to b) explore if the profiles found vary in their response to the SRL intervention because of their varying ability levels (Snow, 1989).

4 Procedure

As described in Section 3, this thesis includes three studies that aimed to investigate SRL in preschoolers. Figure 3 illustrates the overarching research design in which the three studies were embedded.

Figure 3

Overarching research design of the three studies of this thesis



A total of 18 kindergartens in Saarland (Germany) participated in the research project. It included a longitudinal quasi-experimental design, sectioned into three phases: pre-test, intervention, and post-test. In the pre-test, the baseline assessment took place over two sessions. On the level of the preschoolers, multiple measures were assessed. First, SRL was assessed by an external rating scale (filled in by the teachers) and additionally, a newly developed direct SRL measurement tool, which was validated in Study 1, was applied. Besides a detailed reliability analysis, cross-validation analyses were realized by using further pre-test data: a) the related EF measure, which consists of an objective, established measurement tool, and b) the external SRL rating. In the pre-test, further baseline measures were assessed on the preschoolers' level: speech competence by using two objective tests measuring speech comprehension and speech production, respectively, as well as socioeconomic status. On the level of the

kindergarten teachers, SRL was assessed using a self-report questionnaire. After the pre-test was finished, the intervention phase started. On the level of the preschoolers, the intervention consisted of nine sessions in which age-appropriate SRL learning strategies were introduced and exercised by two (external) trainers. The theoretical basis for the intervention was the adapted SRL phase model of Zimmerman (2000, see Section 2.1.2). The intervention was applied in two different learning environments: an autonomous learning environment with no special focus on speech stimulation and a social-interactive learning environment with a special focus on speech stimulation as a supportive element of the intervention (see Section 2.3.2). Additionally, a control group was realized, which did not participate in any intervention. In all three groups, SRL case vignettes (to verify SRL strategy knowledge) were applied as manipulation checks and as an active part of the session for preschoolers in the control group. On the kindergarten teachers' level, the intervention consisted of a workshop and the handing over of transfer materials for the preschoolers to consolidate SRL knowledge and competence in everyday kindergarten life. Kindergarten teachers who participated in the autonomous SRL intervention were taught to foster SRL in preschoolers with no special focus on speech stimulation, and kindergarten teachers of the social-interactive intervention group were taught to foster SRL by stimulating the use of speech while learning. The control group on the kindergarten teacher level was passive, meaning that the participants did not receive any input or intervention. The post-test followed after the intervention phase. On the level of the preschoolers, SRL and gSR were assessed in parallel to the pre-test. On the level of the kindergarten teachers, SRL was assessed again using the self-report questionnaire that was also used in the pre-test. In Study 2, the general effectiveness of the intervention applied was assessed by using SRL and gSR as performance measures. Finally, in Study 3, a differential perspective was taken: preschoolers were examined regarding their heterogeneity in SRL-related abilities and differential intervention benefits.

5 Overview of the Studies

This thesis aims to make a contribution to the investigation of SRL among the special cohort of preschoolers. The following three studies deal with the assessment and fostering of SRL in preschoolers as well as the heterogeneity in SRL precursors and the resulting influences on the development of SRL.

5.1 Study I

Jacob, L., Dörrenbächer, S., & Perels, F. (2019). A pilot study of the online assessment of self-regulated learning in preschool children: Development of a direct, quantitative measurement tool. *International Electronic Journal of Elementary Education*, *12*(2), 115–126. <http://dx.doi.org/10.26822/iejee.2019257655>

The study is about the development and evaluation of a direct, quantitative SRL measurement tool for preschoolers that assesses SRL “online.”

5.1.1 Theoretical Background

As mentioned above (Section 2.1.3 and Section 2.2.2), the preschool years mark a sensitive period for the maturation of gSR and related abilities like EF (Hofmann et al., 2012; Lockl & Schneider, 2007; Zelazo, 2015). Over these years, relevant changes in gSR happen: a) a shift from emotion-driven regulation to more cognitive regulation (Zelazo, 2015) and b) a shift from external regulation by others to a more internally guided self-regulation (see Montroy et al., 2016). Both gSR and EF represent an important foundation on which complex processes like SRL can be built.

As a theoretical basis to conceptualize SRL in preschoolers, Zimmerman’s (2000) model of self-regulation is used, which describes self-regulation processes as following a dynamic cycle of three phases: the forethought phase, the performance phase, and the self-reflection phase. This model can be transferred to the particular context of learning. Preschoolers are capable of goal setting and adjustment of thinking and acting toward predefined goals (Blaye & Chevalier, 2011; Hendry et al., 2016), which represent important abilities for the forethought and performance phase of SRL. Additionally, preschoolers show inhibitory control (Carlson, 2005; Lewis et al., 2017) and are capable of focusing their attention (Bronson, 2000; Lewis et al., 2017). Both abilities are essential for the performance phase. Lastly, preschoolers are able to reflect on their own learning process (Zelazo, 2015) — an ability that is needed during the self-reflection phase.

Despite these indications in favor of the possibility of developing SRL already in preschoolers, there is little research concerning measurement tools to assess SRL for this age group. This is in contrast to EF research, where established instruments such as the Tower of London Test (ToL; Shallice, 1982) exist.

5.1.2 Method

In the following section, the preschooler sample as well as the measures of interest are reported.

Sample. The sample consisted of $n = 164$ preschoolers (51.5 % female, 47.3% male; mean age: 5.9 years, age range: 4.9–6.7). Each child was tested individually in a quiet room in kindergarten facilities. First, SRL was assessed. Second, preschoolers worked on an established EF test. The kindergarten teachers evaluated the SRL abilities of the preschoolers using an external SRL rating scale.

Measures. The newly developed SRL measurement tool for preschoolers is a storybook in which the main character, “Lennie the Lion,” is confronted with everyday problems and tries to solve them by using different learning strategies. The story is adapted from the study by Perels, Merget-Kullmann et al. (2009). The general structure of the measurement tool is inspired by Lockl et al. (2016). The preschoolers’ task is to assist “Lennie” in planning, performing, and reflecting (see Zimmerman, 2000) his acting and thinking toward an overarching goal (i.e., to find a present for his friend Ellie the Duck for her first day of primary school). While the administrator reads the story out loud, the preschoolers have to rate the usefulness of the learning strategies which Lennie employed to solve his problems. In a dichotomous response format, children have to rate strategies as “not very beneficial” by tapping an unhappy face in the storybook or as “highly beneficial” by tapping a happy face. In sum, 24 learning strategies are presented in the storybook, all of which are accompanied by colorful drawings. Twelve strategies are non-SRL strategies (“SRL-” items) and 12 strategies are SRL strategies (“SRL+” items). A total score over all items is calculated by following the signal detection theory (Swets, 1996): + 1 point for hits [hit = preschooler taps happy face in SRL+ item] or correct rejections [correct rejection = preschooler taps unhappy face in SRL- items] and -1 point for misses [misses = preschooler taps unhappy face in SRL+ item] or false alarms [false alarm = preschooler taps happy face in SRL- item]. This procedure should prevent distortions due to guessing or systematic response bias (Arthur et al., 2012). The total score ranges from -24 to +24.

The external SRL rating scale is a composed questionnaire with items used in previous studies (Merget-Kullmann & Wende, 2004; Otto, 2007), as well as items used in established measurement tools, namely the CHILD 3-5 (Whitebread et al., 2009)

and the Child Behavioral Rating Scale (Rowley, 2015). The rating consists of 35 items that are assignable to nine subscales (i.e., nine SRL learning strategies). The SRL of preschoolers is rated on a Four-Point Likert Scale (1 = never to 4 = always) by their kindergarten teachers. The external rating shows an overall reliability of $\alpha = .78$. The reliability for the nine subscales is between $\alpha = .50$ and $\alpha = .87$.

EF is assessed by using a shortened version of ToL (Shallice, 1982). The preschoolers' task is to rearrange three different-colored balls on three different-sized bars so that a presented target configuration turns out. The number of ball-movements is defined at the forefront, so the preschoolers have to plan their actions. The range is between 0 to 10 (1 point = problem is correctly solved, 0 = not solved). The reliability in the sample was $\alpha = .57$.

5.1.3 Statistical Procedure

The internal consistency of the SRL measurement tool for preschoolers was estimated using the Kuder-Richardson formula. Concurrent validity was estimated by correlating a) an indicator of an external measurement tool of the domain of SRL, i.e., the scores of the SRL external rating scale and b) an indicator of a measurement tool of the related domain of EF that is also applied on the child level, i.e., performance and planning time in the ToL Test.

5.1.4 Results

In the first step, an item analysis was executed. In eight SRL+ items, a ceiling effect appeared ($P_i > 80$); one SRL- item showed a floor effect ($P_i < 20$). Of the remaining fifteen items, four SRL+ items showed a low (negative) item-scale correlation. Consequently, 12 SRL+ items and one SRL- item had to be dropped for further analysis. In the second step, the 11 remaining items, which still captured all intended SRL strategies, were analyzed concerning their reliability. An α of .72 was found. The corrected item-total correlation varied between $r_{it} = .17$ and $r_{it} = .55$. In the third step, "near cross-validation" was executed by correlating the overall score of the measurement tool for preschoolers ($M = 6.6$, $SD = 5.6$) and the score of the external SRL rating scale ($M = 85.5$, $SD = 10.01$). This resulted in $r = .20$, $p = .03$. In the fourth step, "far cross-validation" was executed by correlating the overall score of the measurement tool for preschoolers and the score for ToL ($M = 6.81$, $SD = 1.90$). This resulted in $r = .18$, $p = .018$.

5.1.5 Discussion

The statistical analysis indicated satisfactory reliability of the adapted overall scale with 11 items. Importantly, the SRL- items turned out to be of appropriate item difficulty in contrast to the SRL+ items, of which many showed ceiling effects. This finding could be explained by the acquiescence phenomenon (Arthur et al., 2012), which may have led to “hits” on the SRL+ items, but not in the SRL- items. Contrary to the assumptions, the reliability of the three subscales (forethought phase, performance phase, self-reflection phase) was not satisfied. One explanation could be that children of preschool age have only just started to apply SRL learning strategies. The developmental occurrence of these learning strategies may have crossed the assumed sequential order in Zimmerman’s (2000) process model. It should be stressed that this does not mean that preschoolers are necessarily unable to integrate the learning strategies in a holistic process, but perhaps that they need special support to do so. Validity analysis indicates that the developed measurement tool measures SRL-like abilities. The results show significant positive correlations between the overall score of the SRL measurement tool and a) the external SRL rating as well as b) the ToL, the applied EF test.

The limiting factors are a) that data were assessed at only one measurement point, b) the response behavior of the kindergarten teachers could have influenced the outcome in the external SRL rating, c) lack of knowledge about (observable) SRL on the part of the kindergarten teachers even though they had participated in instruction on the topic of SRL, and d) it was not possible to control for how long kindergarten teachers knew the children they rated, and, lastly, e) the age range of the preschoolers was quite broad.

Further research is needed to a) make valid statements about the fit of Zimmerman’s (2000) process model for preschoolers, b) to justify an appropriate selection of SRL learning strategies, c) to optimize test instruction and item construction.

5.2 Study II

Jacob, L., Benick, M., Dörrenbächer, S., & Perels, F. (2020). Promoting self-regulated learning in preschoolers. *Journal of Childhood, Education and Society*, 1(2), 116-140. <https://doi.org/10.37291/2717638X.20201237>

The study aimed to examine the efficacy of a combined SRL intervention for preschoolers and their kindergarten teachers in a longitudinal control group design. Two different learning environments were compared: an autonomous learning environment and a social-interactive learning environment.

5.2.1 Theoretical Background

Empirical evidence suggests that SRL and associated skills are trainable in preschool age (Blaye & Chevalier, 2011; Carlson, 2005; Hendry et al., 2016; Lockl et al., 2016; Whitebread et al., 2005; Zelazo, 2015).

There are some studies that explicitly deal with fostering SRL in preschoolers. First, Whitebread et al. (2005) observed “independent learning” and analyzed pedagogical practices to foster this ability. Perels, Merget-Kullmann et al. (2009) successfully fostered SRL on the level of kindergarten teachers and preschoolers. Additionally, Venitz and Perels (2019) effectively fostered SRL in reference persons to enable them to support preschoolers in the acquisition of SRL. Dörr and Perels (2019a) aimed to improve the metacognitive abilities (conceptualized as a prerequisite of SRL; Dinsmore et al., 2008) of preschool children and kindergarten teachers and found significant intervention effects for the domain of “control activities” in preschoolers. In a further study, Dörr and Perels (2019b) failed to prove the efficacy of a combination of indirect and direct SRL interventions for preschoolers.

Speech processes are shown to be highly relevant for gSR (Camp et al., 1977; Gaskins et al., 2007; Meichenbaum & Goodman, 1971; Salmon et al., 2016). With the aid of self-talk (Vygotsky, 1962), actions can be planned, initiated, and monitored (Winsler et al., 1997). Studies that fostered gSR by activating action accompanying speech (Camp et al., 1977; Gaskins et al., 2007; Meichenbaum & Goodman, 1971; Salmon et al., 2016) mainly built upon the learning principle of Meichenbaum and Goodman (1971). This principle postulates that, in the first step, adult models execute actions and verbalize aloud. In the second step, children execute the actions observed and verbalize in parallel. While training, children are fostered to increasingly internalize their verbalizations. Due to the empirical findings mentioned, it is reasonable to suppose that a speech-stimulating social-interactive learning environment could additionally support the acquisition of SRL in preschoolers.

5.2.2 Method

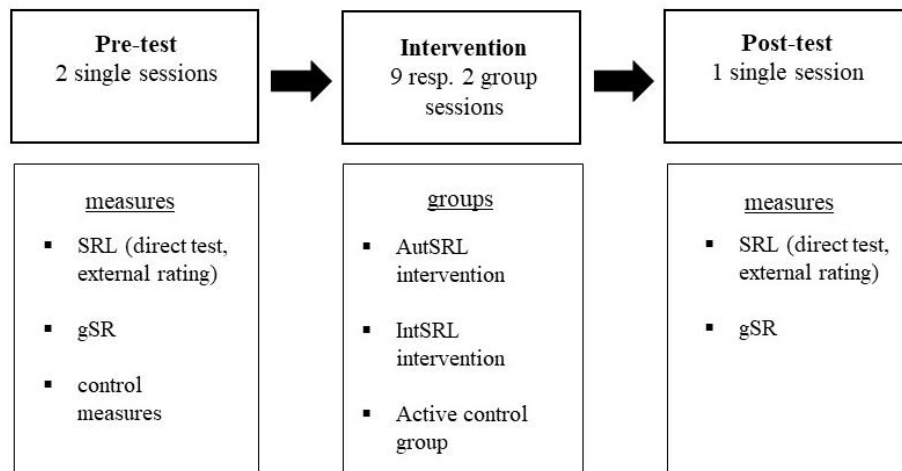
In the following section, the methodological aspects on the level of the preschoolers are reported first. Secondly, the methodological aspects on the level of the kindergarten teachers are described.

Sample: Preschoolers. The child sample consisted of $N = 227$ preschoolers from 18 German kindergartens. Two hundred and fifteen preschoolers participated in the pre-test, whereas 189 preschoolers participated in both the pre-test and the post-test, hence representing the effective sample size. The children were five to six years old ($M = 5.60$, $SD = .51$). One hundred and six children were female, and 108 were male.

Study design: Preschoolers. The intervention on the preschoolers' level was implemented in a group setting and instructed by two trainers using a standardized manual. Importantly, there were two different learning environments for the SRL intervention: one group trained in an autonomous learning environment ("autSRL intervention"), while the second trained in a social-interactive learning environment ("intSRL intervention"). A third group served as an active control group, which only performed SRL case vignettes. In the pre-test, SRL, gSR, and the control measures (socioeconomic status, speech competency) were assessed. The intervention consisted of nine sessions. In the post-test, SRL and gSR were assessed again. The study design for the intervention on the child level is illustrated in Figure 4.

Figure 4

Study design on the level of preschoolers (Jacob et al., 2020)



The intervention: Preschoolers. On the preschoolers' level, the intervention consisted of nine group sessions of 45 minutes each. In the first session, preschoolers and trainers got to know each other, and an introduction to the story of "Mulle the Mole" was given. The story extended over all subsequent sessions. In sessions two to eight, the SRL learning strategies were taught and rehearsed. In sessions two and three, SRL learning strategies for the forethought phase were taught ("using prior knowledge," "definition of goals," and "self-efficacy"). In sessions four to six, SRL learning strategies for the performance phase were practiced ("breaks and self-motivation," "dealing with deflectors," "monitoring") and sessions seven and eight were about SRL strategies for the self-reflection phase ("causal attribution," "reflection"). The ninth and last session served for the repetition of the SRL learning strategies. The structure of each intervention session was as follows: welcoming ritual — a recap of the SRL learning strategy from the previous session — the introduction of an SRL learning strategy with the aid of a narrative part — exercise(s) to practice the new SRL learning strategy — manipulation check (case vignettes) — reward — goodbye ritual.

Manipulation of the intervention: Preschoolers. Differences between the "autSRL intervention" and the "intSRL intervention" exist a) in the frame story. The "autSRL intervention" included little spoken speech, whereas the "intSRL intervention" included a lot of speech. This was realized by using verbatim speech and speci-

fication of guiding principles and key questions as used by Meichenbaum and Goodman (1971). Furthermore, differences between the “autSRL intervention” and the “intSRL intervention” exist in b) the SRL strategy exercises. In the autonomous learning environment, children were instructed by the trainers and subsequently performed the exercise independently. In the social-interactive learning environment, the execution of SRL learning strategies was shown off by two trainers and afterward practiced in peer interaction between the children. The children asked each other key questions or verbalized guiding principles, following Meichenbaum and Goodman (1971).

The “intervention” in the active control group consisted of two sessions within which the children worked on the case vignettes, which served as a manipulation check in the SRL intervention conditions. This means that no SRL learning strategies were explicitly taught to the preschoolers.

Measures: Preschoolers. SRL on the preschoolers’ level was assessed by a) a direct SRL measurement tool, which was developed and evaluated in Study 1 (i.e., a storybook consisting of 11 items with a dichotomous response format). The range of total performance ranged from -11 (all items were answered incorrectly) to +11 (all items were answered correctly). In the present study, the internal consistency was $\alpha = .65$. It was also assessed b) by an external rating scale filled out by the kindergarten teachers. The external SRL rating scale contains 35 items, which are grouped into three scales and nine subscales, operationalizing the SRL learning strategies. All items of the measurement tool were rated on a Four-Point Likert Scale that ranges from 1 (never) to 4 (always). The range of total performance was between 35 and 140. The reliability of the total score was .80. GSR was assessed using the German version of the Head-Toes-Knees-Shoulders (HTKS) (Cameron Ponitz et al., 2008). Action performance and naming of the body part touched were rated separately and formed a total score. The range of total performance was between 0 and 80 (0 = incorrect response, 1 = initially incorrect response that was spontaneously corrected, 2 = correct response). In the sample of the current study, an internal consistency of $\alpha = .95$ was found. As a manipulation check, SRL case vignettes were used to document whether the preschoolers had learned something new during the SRL intervention.

Control measures: Preschoolers. On the one hand, socioeconomic status (SES) was operationalized using the “book question” (Bos et al., 2003), by which children were asked about the domestic book inventory. To answer, they had to tap on one out of three bookshelves. The total range is between 1 and 3 (1 = none or very few, 2 = enough to fill a bookshelf, 3 = more than 200). On the other hand, speech competence was operationalized by two facts of speech, namely a) speech production and b) speech comprehension. Speech production was measured by a shortened version of the Recognizing Terms Test (in German: “Begriffe Erkennen Test,” BE), which is a subtest of the German intelligence test battery Hannover-Wechsler-Intelligenztest III (HAWIVA-III, Ricken et al., 2007). The children’s task was to find words that fit the test leaders’ description (e.g., “Guess what I’m thinking of: it’s an animal that makes a meow.”). The range of total performance is from 0 to 12 (0 = incorrect response, 1 = correct response). In our preschool sample, we found a split-half reliability of $r = .59$. Speech comprehension was measured by a shortened version of the Passive Vocabulary Test (in German; “Passiver Wortschatz Test,” PW), which is also a subtest of HAWIVA-III (Ricken et al., 2007). The children’s task was to point to a picture that fit the test leaders’ description (e.g., “Show me the curly tail.” Correct image: pig). The range of total performance is between 0 and 18 points (0 = incorrect response, 1 = correct response). In our preschool sample, we found a split-half reliability of $r = .55$.

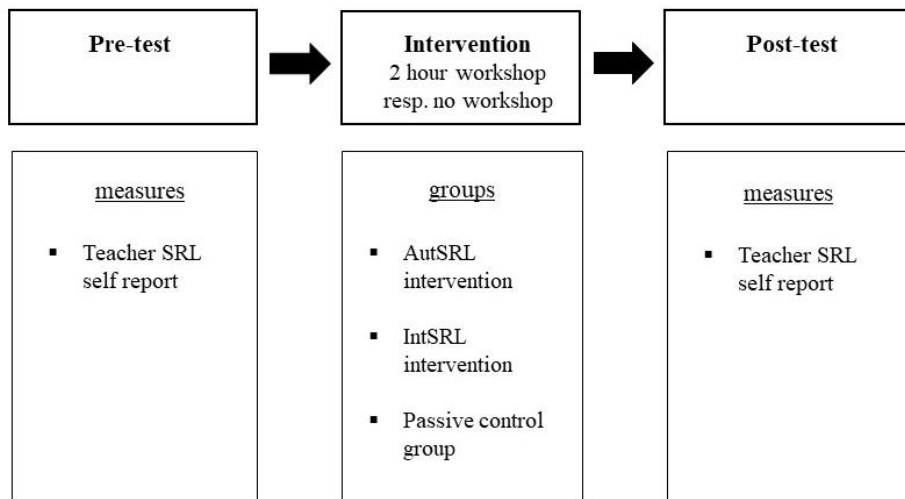
Sample: Kindergarten teachers. The kindergarten teacher sample consisted of $N = 81$ kindergarten teachers from the same 18 German kindergartens where the preschool sample was recruited. Seventy-six kindergarten teachers participated in the pre-test, while 36 kindergarten teachers participated in the post-test. The effective sample consisted of $n = 30$ kindergarten teachers for whom both pre-test *and* post-test data were available.

Study design: Kindergarten teachers. The intervention on the kindergarten teachers’ level was realized as a pre-test–post-test design with two intervention conditions (“autSRL intervention,” “intSRL intervention”) and a passive control group. The pre-test consisted of an SRL self-report filled in by the kindergarten teachers. The intervention consisted of an SRL workshop and the concerted application of workshop transfer materials in the regular everyday kindergarten program by the kindergarten teachers in parallel with the preschoolers’ intervention period. The post-test (including

self-report measurements similar to the pre-test) on the teacher level followed the intervention period on the child level. The study design for the intervention on the teacher level is illustrated in Figure 5.

Figure 5

Study design on the level of kindergarten teachers (Jacob et al., 2020)



The intervention: Kindergarten teachers. On the level of kindergarten teachers, the intervention consisted of an SRL workshop and transfer materials. The interactive workshop was held shortly before the preschooler intervention started. Contentwise, the workshop comprised a theoretical introduction to SRL, experiences of the participants, and the presentation of child-centered learning strategies. In addition, the teachers were introduced to the transfer material for each of the strategies that were to be used in everyday kindergarten life.

Manipulation of the teacher intervention. Differences between the “autSRL intervention” and the “intSRL intervention” on the level of the kindergarten teachers existed in a) speech orientation: Instructions and transfer materials for kindergarten routine in the “intSRL intervention” focused on verbalization. Furthermore, b) the role of speech in SRL was solely taught in the “intSRL intervention.” In both intervention groups, short questionnaires that captured the frequency and benefits of the transfer materials were used as “manipulation checks.” There was no intervention (i.e. SRL workshop) in the control group.

Measures: Kindergarten teachers. To assess SRL at teachers' level, they filled out a self-report questionnaire consisting of 75 items and two subscales: "SRL behavior" and "SRL mediation." The questionnaire consisted of established items from other research projects (Krixel, Merget-Kullmann & Wende, 2004; SELE-F, Leidinger, 2014; SELVES, Otto, 2007) and some newly developed ones. All items were rated on a Four-Point Likert Scale ranging from 1 to 4 (not true / rather not true / rather true / true); the range of total performance is 75 – 300). The reliability of the total score was $\alpha = .93$. As a manipulation check, kindergarten teachers were asked with the aid of a questionnaire a) how often they used the handed out transfer materials on a Three-Point Likert Scale (0 = not at all / 1 = 1x / 2 = more than 1x) and b) how helpful these were on a Four-Point Likert Scale (0 = not helpful / 1 = rather not helpful / 2 = rather helpful / 3 = helpful).

5.2.3 Statistical Procedure

To realize pre-test–post-test comparisons, the pre-test scores of each child group ("autSRL intervention," "intSRL intervention," "active control group") were compared to the post-test scores by using paired t-tests. The scores achieved on the SRL measurement tool, the external SRL rating (overall, subscales), and the HTKS, as a measure of gSR, served as dependent variables.

Furthermore, whether the child groups would differ significantly in their improvement from pre-test to post-test in their scores on the SRL measurement tool, the external SRL rating (overall, subscales), and the HTKS was analyzed. In the repeated measures analyses of variance (ANOVAs), measurement time (pre-test/post-test) was the repeated measures factor, and group membership (autSRL intervention, intSRL intervention, active control group) was the between-subjects factor. SES, speech production, speech comprehension, as well as the children's ages, were controlled as covariates. After that, directed orthogonal contrast analyses were realized to specify any group differences: a first set of contrasts tested whether both intervention groups (autSRL intervention and intSRL intervention) showed a larger improvement than the active control group on the SRL outcome measures. A second set of contrasts tested whether the intSRL intervention group improved significantly more than the autSRL intervention group. As dependent variables, the difference values (score post-test - score pre-test) were used. Age, speech production, speech comprehension, and socio-economic status were controlled. Additionally, the scores of the manipulation checks

were compared between all child groups using univariate ANOVAs to examine whether the intervention was successful.

To analyze the benefit of the intervention on the teacher level, the pre-test scores for each teacher group (“autSRL intervention,” “intSRL intervention,” “active control group”) were compared to the post-test scores using the non-parametric Wilcoxon Test (due to small sample sizes). The score of the teacher SRL self-report (overall, subscales) served as the dependent variable. Additionally, the scores of the manipulation checks were compared between the teacher groups on a descriptive level to examine if the intervention was successful. In order to avoid false-positive results, a Bonferroni-adjusted significance level of .006 was applied for all statistical analyses on the level of the nine subscales of the external SRL rating scale (Armstrong, 2014).

5.2.4 Results

In the following section, the results for preschoolers and kindergarten teachers are reported separately.

Results of the preschooler intervention. The data indicate that all three groups showed better results in the post-test compared to the pre-test on the SRL measurement tool (“autSRL intervention” group: $t(61) = -11.04, p < .001, d = .18$; “intSRL intervention” group: $t(63) = -9.57, p < .001, d = .15$; active control group: $t(49) = -9.86, p < .001, d = .20$). Furthermore, the “autSRL intervention” group and the active control group showed better results in the post-test compared to the pre-test in the HTKS (“autSRL intervention” group: $t(44) = 2.43, p = .019, d = .05$; active control group: $t(46) = -4.03, p < .001, d = .09$). Additionally, the “autSRL intervention” group and the active control showed better results on some subscales of the external SRL rating (“autSRL intervention” group: external SRL rating subscale “using prior knowledge,” $t(48) = -4.46, p < .001$; active control group: external SRL rating subscales “definition of goals,” $t(46) = -4.84, p < .001, d = .10$, “using prior knowledge,” $t(46) = -6.04, p < .001, d = .13$, “monitoring,” $t(43) = -3.82, p < .001, d = .09$, “reflection,” $t(42) = -4.32, p < .001$). The three groups (“autSRL intervention” group, “intSRL intervention” group, active control group) did not significantly differ in their performance in the case vignettes that served as a manipulation check ($F(2, 84) = .67, p = .514$).

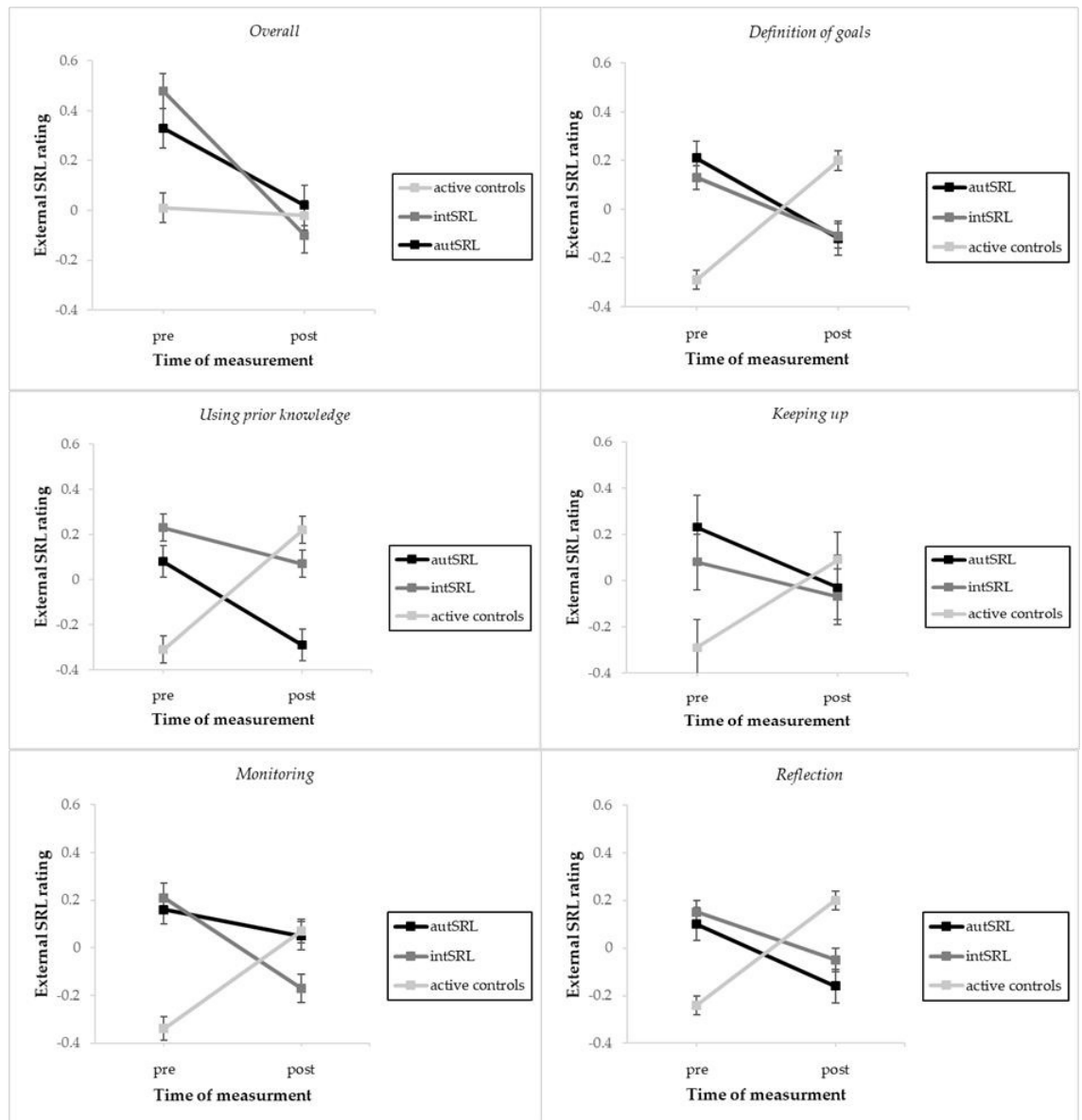
The learning growth from pre-test to post-test did not differ statistically between the three groups in the SRL score ($F(2, 123) = .84, p = .43$) or in the HTKS score ($F(2, 78) = .43, p = .65$). However, the groups differed significantly in their learning growth from pre-test to post-test in the overall score of the external SRL rating ($F(2, 108) = 6.76, p = .002$, partial $\eta^2 = .11$). Furthermore, they differed in four subscales of the external SRL rating: “Definition of goals and planning” ($F(2, 70) = 6.16, p = .003$, partial $\eta^2 = .15$), “Using prior knowledge” ($F(2, 70) = 6.15, p = .003$, partial $\eta^2 = .15$), “Keeping up” ($F(2, 70) = 3.24, p = .045$, partial $\eta^2 = .09$), “Monitoring” ($F(2, 70) = 5.40, p = .007$, partial $\eta^2 = .13$), and “Reflection” ($F(2, 70) = 6.56, p = .002$, partial $\eta^2 = .16$).

Planned contrasts revealed that the intervention groups (“autSRL intervention” group, “intSRL intervention” group) differed significantly from the active control group regarding learning growth (albeit in the opposite direction to what was expected) in a) the overall score of the external SRL rating (contrast value of -1.51 ($SE = .35$), $p < .001$), and b) the relevant subscales (“Definition of goals and planning”: contrast value of -1.27 ($SE = .27$), $p < .001$; “Using prior knowledge”: contrast value of -1.69 ($SE = .26$), $p < .001$; “Keeping up”: contrast value of -1.29 ($SE = .65$), $p = .05$; “Monitoring”: contrast value of -1.14 ($SE = .30$), $p < .001$; “Reflection”: contrast value of -1.06 ($SE = .29$), $p < .001$)³. The results concerning differences in learning growth in the external SRL rating score between the three groups are illustrated in Figure 6.

³ There was no statistical difference between the two intervention groups in the overall score on the external SRL rating and the subscales mentioned.

Figure 6

Differences in learning growth between groups for the external SRL rating score (Jacob et al., 2020)



Results of teacher intervention. The data indicate that none of the three groups (“autSRL intervention” group, “intSRL intervention” group, passive control group) differed between the pre-test and the post-test either in the overall SRL self-report score (“autSRL intervention” group: $Z = -.68$, $p = .50$; “intSRL intervention” group: $Z = -1.26$, $p = .21$; passive control group: $Z = -.56$, $p = .58$) or in the scores on the subscales “SRL behavior” (“autSRL intervention” group: $Z = -.14$, $p = .89$;

“intSRL intervention” group: $Z = -.71$, $p = .48$; passive control group: $Z = -.51$, $p = .61$) and “SRL mediation” (“autSRL intervention” group: $Z = -.98$, $p = .33$, “intSRL intervention” group: $Z = -1.86$, $p = .60$; passive control group: $Z = -1.25$, $p = .21$). Because of missing data, a comparison of the manipulation check between the three groups was not possible.

5.2.5 Discussion

For preschoolers and kindergarten teachers, two intervention groups and a control group were compared. The results of the longitudinal analyses showed an increase in SRL and gSR in all groups of preschoolers. The manipulation check used indicated no effects of the SRL intervention in general. Surprisingly, significant differences between the groups in favor of the active control group were found. For kindergarten teachers, no significant differences between groups in the scores on the assessed SRL self-report were found.

Lacking intervention benefit in preschoolers: Advantage of the active control group. The children in the active control group were rated better at SRL by their kindergarten teachers than those in the SRL intervention groups. In contrast, no differences in performance between groups in the (objective) SRL measurement tool and the HTKS (gSR) were found. One explanation could be justified by a) the measurement instruments. The SRL measurement tool showed a deficient internal consistency in the current study. Consequently, it is questionable whether the data generated by the SRL measurement tool are appropriate for detecting an intervention benefit. Furthermore, the use of external (SRL) ratings rated by kindergarten teachers, who work closely with the preschoolers, involves the risk of limited accuracy (An et al., 2018; Mashburn & Henry, 2004). Second, reactivity effects (Foroughi et al., 2016) in the active control group may have emerged. Third, it is reasonable to suppose that the kindergarten teachers in the intervention groups had become sensitized to SRL after completing the workshop. This could have led to a stricter rating of SRL ability in the preschoolers in the post-test in contrast to their SRL rating in the pre-test, which would appear in the data as a decrease in SRL (see Figure 6). Conversely, the kindergarten teachers who were part of the active control group did not become sensitized to SRL and showed, therefore, more consistency in their “rating severity.”

Another critical aspect that could have led to the missing intervention benefit is b) the implementation of the active control group. Lipsey (1990) emphasizes the role of the weakest possible control condition in achieving design sensitivity. Even though the trainers did not explain or practice SRL learning strategies with the active control group, those in the control group were exposed to them as part of the manipulation checks applied. Possibly, the sole and compact presentation of SRL learning strategies may have suggested implicit conclusions and learning effects (Christiansen, 2019; Goujon et al., 2015; Perruchet & Pacton, 2006). A further critical aspect is that the time interval between intervention and post-test may have been too small to detect an intervention benefit. Lastly, the lack of intervention benefits in the kindergarten teachers, which will be discussed below, could have resulted in too little support for SRL during the kindergarten routine.

Lacking intervention benefit in kindergarten teachers. On the teacher level, an intervention benefit could also not be proven statistically. It is possible that kindergarten teachers did not profit as much from the workshop as expected at the outset of the study. In particular, the bad return of the manipulation check can be regarded as an indicator of the missing implementation of the transfer materials. This could have led to missing support for the preschoolers by their kindergarten teachers. Another, opposite explanation could be that the SRL workshop was useful for the teachers and helped them to generate knowledge about SRL. The sensitization to SRL could have covered the intervention benefit due to more negative self-reports in the post-test (similar to the explanation in the section above).

Limitations. The limiting factors of the current study are a) the initial hierarchical structure of the data examined. However, statistical findings (calculation of intra-class-correlation, ICC) indicated that the hierarchical structure does not have to be considered on the kindergarten level. Moreover, b) the selection of kindergartens was based on geographical position — factors such as pedagogical orientation, size of kindergarten, or allocation of staff were not considered. Also, c) speech competence was measured by assessing two facets of speech. A more detailed assessment of speech is conceivable. Also, d) the validity of the SES measure must be queried because of the increasing digitalization of books.

5.3 Study III

Jacob, L., Dörrenbächer, S., & Perels, F. (2019). The influence of interindividual differences in precursor abilities for self-regulated learning in preschoolers. *Early Child Development and Care*, 1-17. <https://doi.org/10.1080/03004430.2019.1705799>

This study aimed to examine heterogeneity in SRL precursors by identifying profiles of preschoolers (Aim a) and the influence of precursor profile membership on SRL intervention benefit (Aim b).

5.3.1 Theoretical Background

The preschool years represent a sensitive developmental period for learning relevant abilities such as EF (Hofmann et al., 2012; Lockl & Schneider, 2007), gSR (Montroy et al., 2016; Zelazo, 2015), and speech competence (Shaffer & Kipp, 2014). These can be regarded as precursor abilities that may promote better SRL (Montroy et al., 2016; Perry et al., 2018; Winsler et al., 2000).

GSR provides an adjustment in all life areas, such as learning behavior (Denham et al., 2012), where the overlap with SRL becomes apparent. Speech competence is important to “verbally monitor” and adapt the learning process to predefined goals and current framework conditions (Vygotsky, 1988). EF, including “updating,” “inhibition,” and “shifting,” enable the individual to perform complex cognitive functions such as planning and problem-solving (Miyake et al., 2000), which are also required in SRL.

There is accumulating evidence for large interindividual heterogeneity in SRL and its precursors among preschoolers, which likely arises because preschoolers’ strengths and difficulties interact differently with their environment (Stormont et al., 2005). Consequently, it is plausible that preschoolers need differential support to prepare them adequately for the transition to elementary school.

5.3.2 Method

In the following section, the preschooler sample, the study design and the intervention as well as the measures of interest are reported.

Sample. Preschoolers were recruited from 18 kindergartens in Germany. To pursue aim (a), a *cluster sample* of 230 preschoolers (43.7 % female, 56.3 % male,

mean age: 73.2 months, age range: 59–84 months) was analyzed via latent profile analysis to find subgroups. To pursue aim (b), an *intervention sample* of 191 preschoolers (48.9 % female, 51.1 % male, mean age: 72.63, age range: 59–84 months) was analyzed regarding differential SRL intervention benefit depending on profile membership.

Study Design and Intervention. Data for the *intervention sample* came from an experimental design with two experimental groups and one active control group. The intervention consisted of nine sessions of 45 minutes, in which seven SRL learning strategies were taught and exercised. Both intervention groups differed concerning the SRL exercises: in intervention group 1, the exercises were demonstrated by the trainers and afterward, the children performed exercises *independently*. In intervention group 2, the exercise was modeled by two trainers and afterward, the preschoolers performed the exercises in *peer interaction*. Preschoolers in the active control group participated in an SRL strategy quiz without receiving any SRL intervention.

Measures. GSR was measured by the HTKS Task (Cameron Ponitz et al., 2008), in which the preschoolers had to learn rules and inhibit automatic responses. The range of total performance is between 0 and 80 (0 = incorrect, 1 = initially incorrect response that was spontaneously corrected, 2 = correct response). The reliability in the cluster sample was $\alpha = .95$. Speech competence was operationalized by facets of speech: speech production and speech comprehension. Speech production was measured by the “Begriffe Erkennen Test” (Recognizing Terms Test, BE), which is a subtest of the intelligence battery “Hannover-Wechsler-Intelligenztest III” (HAW-IVA-III; Ricken et al., 2007). The applied shortened version consists of 12 items; total performance range is between 0 and 12 (0 = incorrect, 1 = correct). The split-half reliability in our cluster sample was $r = .63$. Speech comprehension was measured by the “Passiver Wortschatz Test” (Passive Vocabulary Test, PW), which is also a subtest of HAWIVA-III (Ricken et al., 2007). The test consists of 18 items and 1 example item. The score of total performance is between 0 and 18 (0 = incorrect, 1 = correct). The split-half reliability was $r = .56$. EF was measured using the ToL Test (Shallice, 1982). The shortened version applied in the study consisted of 10 items, with a total performance score between 0 and 10 (0 = incorrect, 1 = correct). The reliability was $\alpha = .57$. SRL, as assessed using the SRL measurement tool developed in Study 1 (Jacob et al., 2019a). The tool consisted of 11 items. The total score is built with the aid of the signal

detection theory (Swets, 1996). The total performance score is between -11 and +11. In the cluster sample, the reliability was $\alpha = .65$.

5.3.3 Statistical Procedure

In the following, the intended statistical procedure as well as realized post-hoc statistical procedures are described.

Intended Statistical Procedure. To classify individuals in the *cluster sample* into homogenous subgroups, a latent profile analysis (LPA), using MPlus 8 (Muthén & Muthén, 2017), was conducted. The subgroups should be homogenous with respect to the three precursor abilities: gSR, speech competence, and EF. Thus, these variables were entered into the analysis as indicator variables. LPA is a clustering method that matches participants to certain classes in a way that maximizes differences between classes. Because there were no formal hypotheses about how many classes would be identified in the sample, an exploratory analysis was conducted by calculating and comparing five different latent profile models (Stanley et al., 2017). Model fit statistics form a crucial advantage of LPA and help to decide which model fits the data best. After deciding on the best latent profile model, between-profile comparisons were calculated by using univariate ANOVAs with profile membership as an independent variable and each indicator variable serving as separate dependent variables. The results of the between-profile comparisons were used to label the profiles.

A discriminant analysis was conducted to assign participants of the *intervention sample* to the classes found in LPA based on the *cluster sample*. In order to check the general effectiveness of the SRL interventions applied, baseline differences between the intervention groups and the active control group were explored. When there were baseline differences, ANOVAs were implemented with post-test scores as a dependent measure (HTKS, ToL and SRL measurement tool), with pre-test scores as covariate (HTKS, ToL and SRL measurement tool). Membership in the SRL intervention group was entered as a fixed factor (intervention group 1, intervention group 2, active control group). If there were no baseline differences, repeated measures ANOVAs were run with a repeated measure factor “time” (pre-test, post-test), within-subject-factor “outcome measure” (HTKS, ToL, and SRL measurement tool), and between-subject-factor “SRL intervention group” (intervention group 1, intervention group 2, active control group).

Post hoc Statistical Procedure. In the event that the SRL interventions applied were ineffective, the intervention-boosted developmental time course⁴ (IB developmental time course) was to be investigated. Consequently, whether an overall improvement in the outcome measures (HTKS, ToL, and SRL measurement tool) took place was explored. Thus, paired t-tests were run to compare the pre-test scores with the corresponding post-test scores.

5.3.4 Results

An LPA resulted in four homogenous subgroups of preschoolers. The subgroups differed significantly concerning gSR, speech production, and speech comprehension. The four subgroups were named as follows: the first subgroup, “high self-regulators with low speech competency” (n = 39), was characterized by children with very high levels of gSR (HTKS) and very low speech competency (PW, BE). The second subgroup, “high self-regulators with high speech competency” (n = 128), was characterized by children with very high gSR (HTKS) and very high speech competency. The third subgroup, “moderate self-regulators with high speech competency” (n = 34), was characterized by children with moderate gSR (HTKS) and middle to high speech competency, especially in the field of speech comprehension (PW). The fourth subgroup, “low self-regulators with low speech competency” (n = 29), was characterized by children with low gSR (HTKS) and low speech competency (PW, BE).

The general effectiveness of the SRL intervention applied could not be proven statistically (HTKS: Wilks- $\lambda = .99$, $F(2,145) = .92$, $p = .40$; ToL: $F(2,151) = 2.08$, $p = .13$; SRL Test: $F(2, 153) = 0.51$, $p = .60$). That is why the intervention-boosted developmental time course (IB developmental time course)⁵ was analyzed in post hoc analyses. The three experimental groups were merged into one intervention sample and whether there were significant changes from pre-test to post-test in the merged sample was calculated.

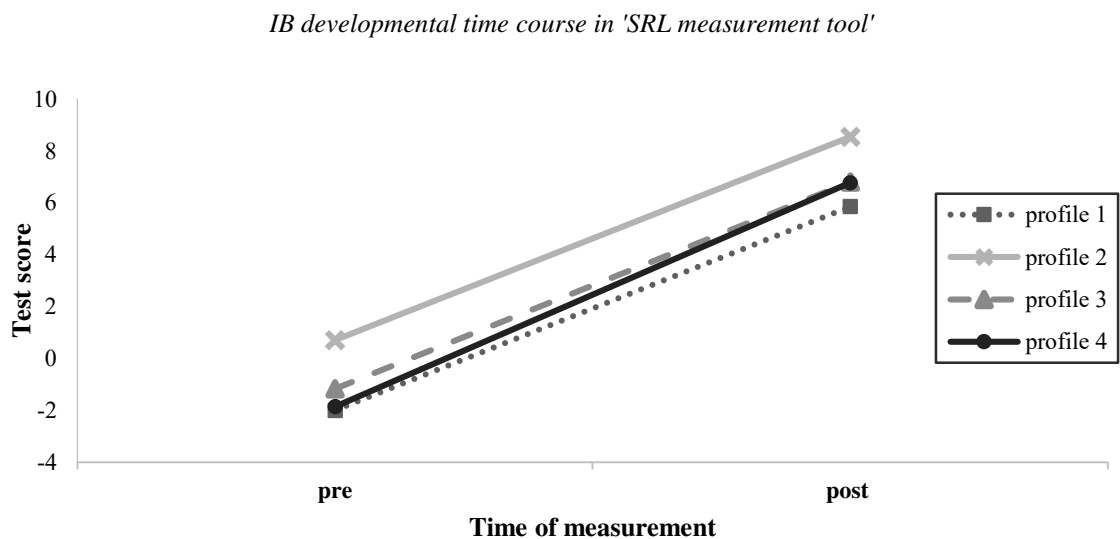
⁴ Because of the SRL interventions applied and the *active* nature of the control group, we chose the term “intervention-boosted” developmental course to differentiate it from a “natural” developmental time course without the influence of any kind of intervention.

⁵ The term “intervention-boosted” should express the idea that all preschoolers in the sample had contact with some kind of SRL content, including the active control group. Thus, a distinction must be made regarding a natural developmental time course without any kind of boost.

At first, the preschoolers in the intervention sample were classified into four profiles using discriminant analysis. To examine the IB developmental time course, an analysis of covariance (ANCOVA) was run with the HTKS score, ToL score, and SRL score as dependent variables, pre-test scores of these as covariates (due to baseline differences in the subgroups) and the four subgroups as a fixed factor. The ANCOVAs revealed significant differences between the four profiles within the intervention sample concerning the SRL measurement tool ($F(3,152) = 5.75, p = .001, \eta^2 = .10$). Post hoc comparisons revealed lower levels of SRL in Profile 1 (“high self-regulators with low speech competency”) compared to Profile 2 (“high self-regulators with high speech competency”). The IB developmental time course of the SRL measurement tool is illustrated in Figure 7. No significant differences were found for the HTKS measure ($F(3,138) = 1.51, p = .22$) and the ToL measure ($F(3,150) = 1.54, p = .21$).

Figure 7

IB developmental time courses of the outcome measures (Jacob et al., 2019b)



5.3.5 Discussion

Following a person-centered approach (Bergman et al., 2003), the findings of the study revealed four subgroups of preschoolers that differed regarding their gSR and speech competence, which are assumed to be precursors of SRL. More than half of the sample (56%) was assigned to Profile 2, which showed high performance in

gSR and speech competency. This is in accordance with the findings of Mägi et al. (2016). The smallest proportion of the sample (13%) was assigned to the underperforming Profile 4 (low general self-regulation ability and low speech competency) — this subgroup of preschoolers is of high practical relevance because this group may need special support for a successful transition to primary school. Future research should a) replicate the four-profile solution in preschoolers and b) further examine the underachieving preschoolers in Profile 4.

Following the Aptitude Treatment Interaction (ATI) approach (Snow, 1989), the study initially aimed to examine differential intervention benefits in an SRL intervention. Due to the lack of general effectiveness of the interventions applied, the study conducted an exploratory examination of the IB developmental time course of SRL in the four subgroups of preschoolers. Significant differences could be found between the four profiles, which were produced by a steeper progression curve of the high-performance Profile 2 compared to Profile 1 (“high self-regulators with low speech competency”). Consequently, high speech competence coming together with gSR play a crucial role in the acquisition of SRL. The main limitations regarding the finding are a) that the IB developmental time course is only based on two time points and b) that it was not possible to relate the IB developmental time course to a (natural) developmental time course of SRL without any “boost” by an SRL intervention. Future longitudinal studies could focus on the connection between speech competency and SRL in preschoolers and collect data for multiple assessment points. Furthermore, the examination of an IB developmental time course should be related to a natural developmental time course.

6 General Discussion

This last section is subdivided into three parts. First, the empirical findings of the thesis are discussed and related to the findings of other research groups. In accordance with the three studies in the thesis, the following topics will be considered: assessing SRL, fostering SRL, and interindividual differences in SRL precursors. Second, the limitations of the three studies in this thesis are reflected on in detail. Third, the practical and empirical implications are presented, which indicate the importance of this work. Fourth, general conclusions are drawn to round off this thesis.

6.1 Discussion of Empirical Findings

This thesis aimed to investigate SRL in preschool children. The first study focused on the assessment of SRL. Therefore, a direct “online” measurement tool was developed on the basis of an adapted version of Zimmerman’s (2000) SRL model and evaluated by item analysis and two kinds of cross-validation strategies. The second study dealt with fostering SRL in preschoolers. The effectiveness of an SRL intervention in two different learning environments was evaluated within a longitudinal control group design. The learning environments differed concerning the amount of stimulation of speech while practicing SRL strategies. The third study focused on interindividual differences. Differences in SRL precursor abilities (gSR, EF, and speech competency) were analyzed, and homogeneous profiles of preschoolers with a similar ability level were built. Furthermore, whether the profiles identified differ concerning the intervention benefit of the SRL intervention of the second study was examined.

6.1.1 Assessing Self-Regulated Learning in Preschoolers

The first study makes a contribution to the direct assessment of SRL in the special age cohort of preschoolers, for which little scientific effort has been made so far. At the same time, the valid assessment of SRL represents the precondition for judging the effectiveness of intervention studies. The results of the item analysis indicated that many of the initial 24 items suffered from poor item difficulty — especially the items that captured SRL strategies (SRL+ items). The reliability of the remaining 11 items was satisfactory. No reliable subscales, based on Zimmerman’s (2000) three phases of SRL, could be formed. The cross-validation by using an external SRL rating and a well-established EF measure showed small, significant correlations and indicated that the developed SRL measurement tool assesses SRL-like abilities.

One important aspect to discuss is that the measurement tool failed to reach an adequate item difficulty in all items representing an SRL strategy. Response sets and response biases of the sample could play an important role. On the one hand, acquiescence (the tendency to answer with “Yes”; Bortz & Döring, 2006, p. 236) is a common phenomenon in this age group (Arthur et al., 2012) which may have led to the children tending to rate all strategies presented as helpful in solving certain problems. Due to the evaluation method chosen, positive responses on the SRL+ items led to positive scores for the children. On the other hand, it is reasonable that children did not have

the problem scenarios in mind when rating the two corresponding SRL learning strategies that were proposed by the protagonist in the course of the story. This could have led to a positive rating of the strategies out of social desirability toward the protagonist, which was selected in such a manner that a high degree of identification in preschool children was reached. Social desirability was found to occur in testing situations from the ages of five to six (Levine, 2019). Furthermore, the measurement tool did not include elements to check for the cognitive presence of the problem scenario to which the presented solution strategies referred. Consequently, it was the test leaders' task to guarantee that the child was able to listen actively throughout the whole story.

However, it is important to note that Lockl et al. (2016) report a good psychometric quality for their developed measurement tool for assessing metacognition. The authors' measurement tool is of a similar structure to the SRL measurement tool developed in this study. Lockl et al. (2016) evaluated their tool with the aid of a sample of first-graders. Therefore, the question arises of whether the sample in Study 1 was too young to comply with this kind of test format.

A further important aspect is that the underlying theoretical model of SRL (Zimmerman, 2000) may not be fully valid for preschoolers. Preschoolers evidentially bring along important abilities on which SRL can build. These include, for example, goal setting and adjustment of thinking and acting (Blaye & Chevalier, 2011; Hendry et al., 2016), inhibitory control (Carlson, 2005; Lewis et al., 2017), and reflecting learning outcomes (Valkanova, 2004), but to some extent, they perform poorer than older children or adults (Dufresne & Kobasigawa, 1989; Lewis et al., 2017; Schneider et al., 2000; Valkanova, 2004; see Section 2.1.3). These findings indicate that the abilities mentioned are still in progress and are not yet fully developed among children in this age group. It is reasonable that preschoolers know single SRL strategies of the adapted SRL model of Zimmerman (2000), but not all of them and not necessarily in the cyclical order assumed. This could have given rise to the psychometric difficulties of the measurement tool.

6.1.2 Fostering Self-Regulated Learning in Preschoolers

The second study makes a contribution to fostering SRL in preschoolers. Therefore, a direct SRL intervention on the child level was combined with an indirect intervention on the teacher level. The SRL intervention was placed in two different

learning environments: an autonomous and a social-interactive learning environment. The intervention groups were compared with an active control group (child level) and a passive control group (teacher level). The results of the longitudinal analysis indicated an improvement in SRL and gSR in all groups of preschoolers; the manipulation check indicated that the intervention was not effective. Contrary to the assumptions, the results showed significant differences between the groups in SRL in favor of the active control group.

Aspects that have to be discussed concerning intervention Study 2 are the deficiencies and weaknesses of the measurement tools used for preschoolers. As described in the previous section, the assessment of SRL in preschoolers is highly demanding. A multi-methodological approach is highly recommended (see also Büniger et al., 2019; Phillips & Lonigan, 2010). At the same time, valid measurement tools to evaluate the quality of an SRL intervention for preschoolers are lacking. Besides the reliable external SRL rating, the newly developed measurement tool of Study 1 was employed and suffered from deficits. The external SRL rating involved, by nature, special risks like a lack of accuracy in teacher ratings (An et al., 2018; Mashburn & Henry, 2004). Therefore, a gSR measure was additionally used to evaluate the intervention. Despite the conceptual overlap between SRL and gSR (Denham et al., 2012), it must be queried whether this very specific intervention to foster the use of SRL learning strategies is really able to impact immediately superordinate constructs like gSR. If so, it must be queried if the time interval between the last intervention session of the SRL intervention applied and the post-test session was sufficient to effect an immediate increase in SRL and gSR. Interventions can have a learning-inhibiting effect on participants, which is known as mathemathantic effect (Clark, 1989). This effect describes the cognitive interference between known problem-solving strategies and newly learned strategies. Participants in an intervention need some time to overcome this inhibition effect. Preschool children who do not have elaborate SRL learning strategies may need more time and opportunities to exercise the newly learned strategies to give up a more intuitive problem-solving behavior. Besides increasing the time interval of the intervention, a follow-up measure may have provided important information if a mathemathantic effect had occurred.

A further important aspect is the application of appropriate and (simultaneously) implementable research designs. The study design has to be sensitive enough

to detect a potential intervention benefit. This sensitivity can be achieved by using a control group that either does not participate in an intervention or participates in the weakest possible intervention (Lipsey, 1990). The design of Study 2 included an active control group on the child level, which worked on the SRL case vignettes (= manipulation check in the intervention groups) without any information or exercises to train SRL learning strategies. When considering the results of the study (differences between groups in the external SRL rating in favor of the active control group), it is reasonable to suppose that the active control group was too active to allow for the detection of intervention benefits. Going one step further, it is also reasonable to suppose that the case vignettes had an impact on the preschoolers' knowledge of SRL learning strategies and, contrary to what was intended, may have represented a form of intervention that was more effective than the extensive intervention sessions performed in the intervention groups. If regarding the case vignettes as a means of specific and compact demonstration of positive and negative SRL learning strategies, these may have led to implicit conclusions and learning effects in the preschoolers (Christiansen, 2019; Goujon et al., 2015; Perruchet & Pacton, 2006). This assumption can only be shown to hold true if the study is replicated with a weaker, even a passive control group.

Study 2 also illustrates the difficulty of establishing compliance with scientific interventions in caregivers, such as kindergarten teachers in this case. The evaluation of the manipulation checks within the teacher sample is strongly limited, which leads to the questions a) how often teachers really used the intervention materials in the kindergarten routine and b) how useful these materials were for them. The return rate was so low that it must be assumed that preschoolers were rarely supported in the acquisition of SRL during kindergarten routine. However, this would have been an important part of the combined intervention program (direct and indirect interventions). There were also no differences between the SRL self-report for kindergarten teachers from the pre-test to the post-test. This indicates that the teachers themselves did not use more SRL learning strategies after the intervention than before the intervention. Also, Venitz (2019) and Dörr (2019) examined the efficacy of a combined SRL intervention for preschoolers and reference persons (parents and kindergarten teachers), and both authors address the problem that reference persons were rather unwilling or unable to actively participate in the intervention study.

For the case in which the SRL interventions had an impact on the kindergarten teachers, it is possible that a sensitization to SRL, mediated by the intervention applied, could have led to biases in the rating of the preschoolers' SRL performance, which may have been stricter in the intervention group. This could have covered an objective increase in preschoolers' SRL. Such biases due to sensitization could also have impacted the teachers' SRL self-report in the post-test. Similarly to the SRL assessment in preschoolers, a multi-methodological assessment (Bünger et al., 2019; Desoete, 2008; Phillips & Lonigan, 2010) in kindergarten teachers may also be advisable to increase the quality of the data. At the same time, economy in the use of time, as well as the compliance of subjects, have to be kept in mind when doing field research. Both would have been targeted if different assessment methods had been used.

6.1.3 Interindividual Differences in Precursors of Self-Regulated Learning

The third study examined (a) heterogeneity in SRL-relevant precursor abilities in preschool children. Four well-defined preschooler profiles were found, which differed concerning their performance in tests measuring gSR as well as speech competence. A further SRL-relevant precursor, namely EF, did not make a significant contribution to differentiating the four profiles, which may be attributed to measurement-based limitations.

Furthermore, the study intended to analyze (b) the differential intervention effect of the four profiles: (1) high self-regulators with low speech competency, (2) high self-regulators with high speech competency, (3) moderate self-regulators with high speech competency and (4) low self-regulators with low speech competency. Unfortunately, the general effectiveness of the interventions could not be proven (see Study 2). Therefore, an explorative research question was investigated: Are the four preschooler profiles differentiated with respect to the developmental time course boosted by an SRL intervention (IB developmental time course) in the three outcome measures (gSR, SRL, EF)? Significant differences showed up between Profile 1 and Profile 2 concerning the IB developmental time course in SRL: preschoolers matching Profile 2 showed a stronger increase in SRL from pre-test to post-test compared to those matching Profile 1.

An aspect to discuss is the distribution of the sample among the four profiles. The largest proportion (53%) of the preschoolers were assigned to the high-achieving

Profile 2. Together with the preschoolers assigned to Profile 1 (17%), the proportion of children with high gSR was in accordance with the proportion of highly self-regulated first-graders reported in the study by Mägi et al. (2016). It is remarkable that 17% of the preschoolers still belong to Profile 1, which is characterized by high self-regulation and, at the same time, low speech competence because speech competence is regarded as an important indicator of gSR (Bohlmann et al., 2015). Also, the results of Montroy et al. (2016) emphasize the positive relationship between speech competence and gSR: the authors found that kindergartners (three to seven years old) with high speech competence develop faster in gSR. The underachieving Profile 4 is relatively small in size (14%), but all the more important concerning its practical and scientific implications (see Section 6.3, 6.4). Preschoolers matching Profile 4 may need adapted interventions that consider the necessity of special support.

A further aspect to discuss is that the high-achieving Profile 2 showed a significant advantage in comparison to Profile 1. First of all, it is plausible that a high gSR serves a precondition for the development of SRL. The combination of high gSR and high speech competence, as present in preschoolers of Profile 2, results in greater progress in SRL compared to the combination of high gSR and low speech competence. This finding again supports the assumed relationship between SRL and speech processes, which is based on the explanation that self-talk is useful in planning and monitoring learning actions (Winsler et al., 1997).

6.2 Limitations

Some of the limitations of the studies in this thesis will be presented universally because they impact all three studies. Limitations that refer exclusively to one study are identified accordingly.

A first general limitation concerns the selection of kindergartens for the studies. The selection criteria were the geographical position (and the willingness to participate). This means that the findings of the three studies are representative of a certain geographical region in Germany, but are not generalizable to other regions or countries with different preschool systems. Further variables such as the pedagogical orientation of the institution, the size of kindergarten, or the allocation of the teachers could not be considered because the aim was to attract as many kindergartens in the region as possible to the research project. Under optimal conditions and given a free choice of

kindergartens, the sample would consist of comparable kindergartens with, for example, a similar pedagogical orientation, which has an effect on the structure of kindergartens in terms of whether they use free or fixed groups. Kindergartens with free groups focus more on autonomy, which may influence the SRL abilities of the preschoolers.

A second general limitation concerns the measurement tools that were used to assess SRL. To measure SRL directly in preschoolers, no well-established instruments have been developed so far. Therefore, a newly developed direct measurement tool had to be used, which suffered from different weaknesses, as discussed in Section 6.1.1. To cross-validate the new measurement tool, (a) a reliable external SRL rating as well as (b) a well-established EF measurement tool were used. Although the measures of all three instruments tended to be related, the validity of the SRL measurement tool has to be designated as limited. Generally speaking, (a) the external ratings of people who interact directly with the children, have to be rated as suffering from difficulties (An et al., 2018; Mashburn & Henry, 2004). Response behavior (Bortz & Döring, 2006, p. 236), sensitization due to the participation in an SRL intervention, as well as the reactivity of the raters of the control group (Foroughi et al., 2016), could have influenced the rating results. Furthermore, the external rating is based on multiple observations, whereas the direct measurement tool developed only delivers data from one point in time. Using data from only one point in time is risky because preschoolers' performance in the SRL measurement tool could be influenced by different individual-related variables like mood, shyness, tiredness, and motivation in the moment of testing (Crozier & Hostettler, 2003; Matthews et al., 2002; Wigfield & Cambria, 2010) — a risk which was also taken in account when building homogeneous profiles of preschoolers (Study 3). The (b) well-established EF measurement tool (Tower of London; Shallice, 1982) showed questionable reliability in our sample. This may be because a shortened version of the tool was used to allow for a time-efficient assessment of different constructs within a battery of tests (SRL, gSR, EF, speech competence). To sum up, a direct SRL measurement tool with higher psychometric quality, external ratings by neutral observers, several survey dates, and the use of the original (long) version of the ToL may have resulted in more solid findings.

A third limitation concerns the operationalization of speech competence and socioeconomic status. For the special age group of preschoolers, a time-economic assessment is necessary because of their limited and heterogeneous attention skills (Rhoades et al., 2011). An aggravating factor was that the assessment took place “in field,” where disruptive factors like noise and interruptions could not be fully controlled. Given the considerations of time economy, it was impossible to depict all facets of the complex construct of speech competence. The focus was actually on two facets that were of special relevance to the studies: speech comprehension and speech production (Lohaus & Vierhaus, 2015). Furthermore, the “book question” (Bos et al., 2003) was used to directly assess the socioeconomic status (SES) of the preschoolers. This procedure has to be regarded critically because, in the current time of digitalization and e-book readers, the use of the “book question” one its one is questionable. The use of multiple informants would have ameliorated the explanatory power of the assessed SES. A possible solution may have been the creation of an SES index that displays multiple data from multiple informants (children and parents), such as the book question, hobbies, household income, and parents’ educational qualifications and professions (Bradley & Corwyn, 2002).

A fourth limitation refers to the second study in which an SRL intervention for preschoolers and their kindergarten teachers was developed and evaluated. Initially, the data gained were of a hierarchical structure with three different levels: preschoolers, kindergarten teachers, and kindergartens. Unfortunately, a statistical evaluation using multilevel analysis (Snijders, 2011) could not be implemented because a clear assignment of preschoolers and kindergarten teachers was not possible due to the structure of kindergarten institutions. However, preschoolers are clearly assignable to the kindergarten institutions. Here, post hoc analyses indicated that the impact of kindergartens on the performance of the preschoolers was small (between 2% and 7% for the performance measures). Furthermore, within the field of study of this thesis, a randomized assignment of preschoolers to experimental conditions was not feasible for practical reasons. It was only possible to randomly assign kindergartens to experimental conditions. However, as mentioned above, the kindergarten as an institution did not have that much influence.

A fifth limitation concerns the third study, which focused on interindividual differences. In an exploratory manner, the examined “IB developmental time course”

of the four profiles was based on data from two measurement time points. It would be desirable to add further time points to draw valid conclusions about the developmental course of SRL in preschoolers with a certain combination of precursor abilities (Ployhart & Vandenberg, 2010).

6.3 Scientific Implications

The results of this thesis provide several implications for future research studies in the area of SRL in preschool children. Further scientific effort is needed to make a valid assessment of SRL on the child level to allow for a multimethod assessment of SRL. Besides external ratings with good psychometric quality, there remains a lack of direct “online” measurement tools.

The first study in this thesis took the first steps toward the development of a direct SRL measurement tool aimed at assessing SRL during the learning process. Various improvements need to be made to the current measurement tool. (1) A first improvement could be the implementation of SRL strategies and non-SRL strategies. In order to a) develop items of adequate item difficulty, a more explorative proceeding could be fruitful. One way to generate adequate SRL+ and SRL- items could be to ask preschoolers openly for strategies to solve the problem scenarios presented in the narrative of “Lennie the Lion.” These open responses could help to revise the initial items. A second way to revise the item formulations could be the execution of an expert survey whereby as many research experts dealing with SRL in young children as possible would be questioned. In order to b) counteract the assumed acquiescence phenomenon, the wording of all items could be reformulated with “can” (e.g., “Lennie *can* paint all the ideas he can think of.” instead of “Lennie paints all the ideas he thinks of.”). The change of wording could stress that the presented SRL+ items are always supposed to be *action alternatives* to the presented SRL- items. It is not to be supposed to be the case that the protagonist uses both SRL strategies (+ and -) to solve the respective problem. (2) A second improvement could concern test instruction. The measurement tool should include elements that check whether the preschoolers are actively listening to the story and thinking carefully about the solution strategies presented. Possibly, it could be useful to invite the children to repeat the problem scenarios presented regularly. This also would increase the active participation of the preschoolers and, therefore, the test compliance (Stephenson & Hanley, 2010). (3) A third improvement could be the replication of the results with a sample of first-graders to check if the test format

is troublesome for the preschoolers' age cohort but not potentially for older age groups. The background for this assumption is the positive results of the test tool for first-graders developed by Lockl et al. (2016), which is of a similar structure to the SRL measurement tool in Study 1. (4) A more general improvement refers to the applicability of the underlying cyclical model of SRL (Zimmerman, 2000), which has to be proven empirically in future research. Possibly, a small-stepped proceeding would be helpful in this context. Research in this field could focus on the assessment of single SRL learning strategies in preschoolers, which can be integrated into a holistic model in a later step.

Studies 2 and 3 have important implications for further research. There are various implications for optimizing future SRL intervention studies. In the context of optimization, the consideration of heterogeneity in SRL precursor abilities represents an important aspect and allows for the development of adaptive intervention programs that are suitable to the individual ability level.

The results of Study 2 imply that future SRL intervention studies may modify the experimental design. It is recommended that a passive control group be additionally implemented to investigate the efficacy of an SRL intervention. In Study 2, only an active control group was implemented to allow for comparisons with the experimental groups. Because the active control group showed significantly better results than the experimental groups, the question was raised of whether the intervention was simply ineffective or if the SRL input in the active control group (execution of the SRL manipulation checks) was too strong. "Too strong" means that the SRL input may have positively impacted the development of SRL learning strategies in preschoolers because the manipulation checks contain a compact presentation of SRL learning strategies, which may have led to implicit conclusions (Christiansen, 2019). The consideration of a too strong control group would have been invalidated if an additional passive control group had been implemented.

The results of Study 3 indicate that there are four well-defined homogeneous subgroups of preschoolers that differ regarding their ability level in SRL precursors. Since there no further research studies have examined heterogeneity in the ability areas of interest (gSR, EF, and speech competence) in preschoolers, a replication of the profiles found is essential to drawing valid, scientific conclusions (Shrout & Rodgers,

2018). In the context of a replication, it would be useful to collect data from different regions with comparable preschool education systems to draw more universal conclusions. The underachieving Profile 4, if replicable, is of high relevance. Study 3 resulted in the finding that Profile 4 showed less progress in SRL compared to the other three profiles with higher precursor ability levels. Profile 4 should be scientifically analyzed in more detail because it possibly represents a subgroup with special needs concerning intervention programs. This should include the examination of further impact factors that may present mediators, such as the migration background (e.g., Waldfogel, 2015). Furthermore, longitudinal analyses that additionally record the transition to elementary school are called for when considering the results of Mägi et al. (2016), who found a similar percentage of high and low self-regulated first-graders. If the deficit in the school-relevant abilities, gSR and speech competence, cannot be made up by the children during preschool, further problems could appear in the course of their education (Landmann et al., 2015; McClelland et al., 2007; Rimm-Kaufman et al., 2009). Early support for preschool children with certain weaknesses is essential to creating more equal conditions for the transition from preschool to school (Slaby et al., 2005).

The studies in this thesis reveal a further important research topic, which refers to the fundamental relationship between SRL and speech competence in preschool children. The studies intended to assess the abilities mentioned as efficiently as possible in the context of a field study. In the sense of basic research, many more studies are needed to illuminate the relationship between SRL and speech competence in children of five to six years of age. Study 2 revealed that speech competence plays an important role in the development of SRL. This relationship between both constructs should be examined in detail in further research that focuses more intense on the ability of speech and considers more speech facets than was possible within the study of this thesis. Research on this topic would complement existing findings, which mainly investigate the relationship between gSR and speech competence (see Section 2.3.2) and may be fruitful for developing efficient SRL interventions.

6.4 Practical Implications

Apart from the above mentioned scientific implications, the results of this thesis also make a contribution to practice.

Study 1 represents the first attempt to assess SRL “online” and directly on the child level. The further development of this SRL measurement tool is of high practical relevance because it may build a solid foundation for the compliance of adaptive educational tasks in kindergartens where no standardized preschool curriculum exists. The standardized, time-efficient SRL measurement tool is easy to apply for external trainers as well as kindergarten teachers. There is no need for particular equipment or particular spatial conditions. Furthermore, direct SRL measurement tools are most necessary for developing and optimize SRL interventions (Hoyle & Dent, 2018).

Study 2 aimed to develop and evaluate a combined SRL intervention for preschoolers and their kindergarten teachers. Unfortunately, the effectiveness of this intervention could not be empirically documented. Nevertheless, scientific activity in the area of fostering SRL in preschool is of relevance for educators because the fundamental role of preschool in education is stressed (Barnett, 2008). It may have an impact on the further development of professional training for kindergarten teachers. In addition, the sensitization concerning SRL could lead to greater use of SRL strategies in the teachers’ professional lives, which could result in positive effects for preschoolers due to their function as models of behavior (Bandura, 1986).

Study 3 revealed that there are different subgroups of preschoolers that differ with regard to their ability level in SRL-relevant abilities. It was demonstrated that the ability level (particularly the “ability combination” of speech competence and gSR) affects the development of SRL in a positive manner. Practitioners should keep this finding in mind when fostering the learning competencies of preschoolers. Furthermore, the findings of Study 3 indicate that there is a need for the development and application of adaptive SRL interventions, which allow for the consideration of special needs for particular groups of preschoolers.

6.5 Conclusion

This thesis makes a contribution to the investigation of SRL in the special cohort of preschoolers. The first steps were taken to develop a valid measurement tool to assess SRL directly at the level of preschool children and to develop an SRL intervention for preschoolers and their kindergarten teachers. Additionally, interindividual differences in the context of preschool were considered in a further study. Although the

results concerning the assessment and fostering of SRL did not turn out as satisfactorily as expected, the studies have important implications for future research.

It is of high relevance to bring SRL in preschoolers into research and public focus (Chan, 2012; Landmann et al., 2015). On the one hand, there are scientific reasons to do so. Evidentially, the preschool years are a sensitive time slot for the development of abilities that are required within the three phases of SRL, such as goal setting, attention focusing, and reflection on the own learning process (Blaye & Chevalier, 2011; Bronson, 2000; Lewis et al., 2017; Zelazo, 2015). The concept of EF shows overlap with the required competencies for the acquisition of SRL (Garner, 2009; Gaskins et al., 2007). Also, speech competence is crucial and could facilitate the acquisition and application of SRL learning strategies (Bono & Bizri, 2014; Day & Smith, 2013; Whitebread, 2015).

On the other hand, there are political reasons to investigate SRL earlier, namely in preschool. Preschool is increasingly regarded as a formative educational institution where individuals enter the educational system. As requested in the educational program for kindergartens (Der Minister für Bildung und Kultur, 2018), independent, self-regulated learning is an important objective of preschool education with far-reaching consequences for the children's later school and academic careers (Kim & Nor, 2019; McClelland et al., 2007; Rimm-Kaufman et al., 2009).

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8 Appendix

Publication I

Jacob, L., Dörrenbächer, S., & Perels, F. (2019). A pilot study of the online assessment of self-regulated learning in preschool children: Development of a direct, quantitative measurement tool. *International Electronical Journal of Elementary Education*, 12(2), 115-126. <http://dx.doi.org/10.26822/iejee.2019257655>

Publication II

Jacob, L., Benick, M., Dörrenbächer, S., & Perels, F. (2020). Promoting self-regulated learning in preschoolers. *Journal of Childhood, Education and Society*, 1(2), 116-140. <https://doi.org/10.37291/2717638X.20201237>

Publication III

Jacob, L., Dörrenbächer, S., & Perels, F. (2019). The influence of interindividual differences in precursor abilities for self-regulated learning in preschoolers. *Early Child Development and Care*, 1-17. <https://doi.org/10.1080/03004430.2019.1705799>