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Self-Regulation in Preschool Children's Everyday Life: Exploring Day-to-Day Variability and the Within- and Between-Person Structure

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Abstract

Objective: Self-regulation - the ability to regulate one's own behavior, emotions, and cognition - is fundamental for achieving personal goals and successful socio-emotional adaptation. Individual differences in self-regulation and associations with correlates important in early childhood (e.g. school readiness) are well studied at a between-person level. This is the first study investigating intra-individual variation in self-regulation in the everyday life of a sample of preschool children using an intensive longitudinal design. Moreover, the study explores the dimensionality of self-regulation at both the between- and within-person level. **Method:** Over a period of seven consecutive days including weekend days, 106 parents (84.3% mothers) rated their preschool children's self-regulation every evening either by an online questionnaire or via a phone interview. **Results:** Preschoolers' self-regulation varied substantially within persons over the measurement period as indicated by intra-individual standard deviations and intraclass correlation coefficients. Multilevel confirmatory factor analyses revealed best model fit for a model with three correlated but empirically distinct factors at both the within- and between-person level that can be labeled as "emotional self-regulation", "behavioral self-regulation", and "attentional self-regulation". **Conclusion:** The study is the first demonstrating that self-regulation varies within, and not only between, individuals from day to day in a sample of healthy preschool children. Preschoolers' self-regulation can be described by three related but distinct factors at the within- and between-person level, supporting the conceptualization of self-regulation as a construct with multiple interrelated but separable facets.

Keywords

self-regulation, daily, preschool, intensive longitudinal design, within-person

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Self-Regulation in Preschool Children's Everyday Life: Exploring Day-to-Day Variability and the Within- and Between-Person Structure

Katja Ludwig, Amelie Haindl, Ruth Laufs, Wolfgang A. Rauch[1]

1 Introduction

Self-regulation is the ability to adaptively regulate one's own emotions, cognition, and behavior in order to respond effectively to internal as well as environmental demands (McClelland/Cameron 2012; Raffaelli et al. 2005). Early childhood is a sensitive stage for the development of self-regulation. In longitudinal studies, self-regulation increases substantially during infancy and the preschool years, with individual variability in growth rates (e.g. Fuhs/Day 2011; Moilanen et al. 2009; Raffaelli et al. 2005; Raikes et al. 2007). Inter-individual differences in self-regulation in early childhood are predictive of numerous outcomes across the lifespan (Fergusson et al. 2013; Moffitt et al. 2011), including school readiness (Blair/Raver 2015; Suchodoletz et al. 2013), literacy and math skills (Becker et al. 2014; Sawyer et al. 2015a), behavioral problems in the classroom (Sawyer et al. 2015b), and building as well as maintaining positive peer relationships (Holmes et al. 2016). The present study is the first investigating whether there is also *intra*-individual, day-to-day variability in preschoolers' self-regulation besides inter-individual differences, and how the factor structure of self-regulation can be described at the within-person (intra-individual) and between-person (inter-individual) level.

1.1 Within- and Between-Person Variability in Self-Regulation

So far, research on self-regulation in childhood has concentrated on inter-individual differences. However, some studies have already demonstrated intra-individual variability in related constructs: Miller and colleagues (2015) experimentally investigated the relationship between acute sleep restriction and different self-regulation strategies during an unsolvable puzzle task in a sample of two- and three-year old children. The experimental group was deprived of sleep by not having their usual afternoon nap, while the children of the control group were allowed to sleep. During the unsolvable puzzle task, the experimental group showed significantly less adaptive, self-regulatory behaviors (e.g. insistence on completing an unsolvable puzzle, self-soothing behaviors) compared to the control group. Even if these findings have to be interpreted with caution due to the small sample size (n = 12), the study provides first evidence for the influence of factors subjected to change from day to day (i.e. sleep time) on self-

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regulation in early childhood. Using an intensive longitudinal design with ambulatory-assessed (i.e. smartphone-based) working memory tasks three times a day over four consecutive weeks, Dirk and Schmiedek (2016) demonstrated substantial day-to-day fluctuations, as well as fluctuations throughout the day in elementary school children's working memory. Likewise, two studies with adolescent samples within the clinical context recently showed substantial day-to-day fluctuations in self-regulation failures (Berg et al. 2014; Schmid et al. 2016). Thus, besides the fact that some children generally show better self-regulation skills compared to other children (inter-individual differences or between-person level), day-to-day fluctuations in self-regulation should be present in younger samples as well; the individual child might also intra-individually experience days on which his or her self-regulation is better or worse compared to other days (within-person level). This dynamic nature of self-regulation was already mentioned by Thompson (1994), who concluded in his basic review about emotional self-regulation that "there is no necessary reason why individuals should exhibit deficiencies in all aspects of emotion regulation or in all situations" (p. 45) and highlighted the need for future research to focus on (emotional) self-regulation "much less globally and in a manner that is far more situationally specific" (p. 47). The present study addresses Thompson's challenge and contributes to closing this research gap by empirically investigating whether within-person variability in self-regulation is also present in the everyday life of healthy preschool children, as it was previously shown in older and clinical samples (Berg et al. 2014; Dirk/Schmiedek 2016; Schmid et al. 2016). For this purpose, the study applies an intensive longitudinal design over a measurement period of seven consecutive days, enabling us to differentiate between within- (intra-individual) and between-person (inter-individual) effects.

1.2 The Structure of Self-Regulation

Present theories about the structure of self-regulation in children are built on assumptions at the between-person level. Many researchers from multiple research fields have addressed (inter-individual) self-regulation, yet have emphasized slightly different aspects, such as effortful control (Rothbart et al. 2001), self-control (Moffitt et al. 2011), emotion regulation (Carlson/Wang 2007), or executive functioning (Miyake/Friedman 2012).

Summarizing the different approaches and perspectives on children's self-regulation by independent researchers, self-regulation integrates three processes: cognitive, behavioral, and emotional regulation. Cognitive self-regulation refers to executive functions such as updating (working memory), inhibition, and flexible attentional shifting (Garon et al. 2008; Miyake/Friedman 2012). To concentrate one's attention and to stay focused is an important self-regulation skill in children's everyday life, especially with regards to academic performance (Blair et al. 2015; McClelland/Wanless 2012). From a cognitive perspective, executive functions constitute the underlying, higher-order neurocognitive ("top down") process subserving cognitive self-regulation (Blair/Ursache 2011; Bridgett et al. 2015; Hofmann et al. 2012). Behavioral regulation refers to self-control abilities and compliance, that is, the ability to internalize rules and standards as well as to inhibit predominant behavioral responses that do not conform to those rules and standards or that do not fit the demands of the environment (Denham et al. 2012; Tangney et al. 2004). Children's behavioral self-

regulation describes behaviors such as adhering to rules, listening to others without interrupting them, or being able to wait until one's turn. Thus, behavioral self-regulation is linked to positive and desired social outcomes, such as positive peer relations (Ramani et al. 2010) and socially appropriate behavior (Eisenberg et al. 1997). Emotional regulation refers to the experience and expression of emotions (Gross 2014). Emotional regulation emerges in early childhood as the employment of regulation strategies shifts more and more from an extrinsic (i.e. parent-monitored) to an internal (i.e. self-monitored) process during the preschool years (Bridgett et al. 2015). During development, children acquire an increasing number of emotion-regulation strategies: from early strategies such as regulation of visual attention by two or three months of age or physical self-soothing behaviors (e.g. thumb sucking) between four and ten months of age (Bridges/Grolnick 1995) to more complex strategies such as cognitive reappraisal (Gross 2014; Gullone et al. 2010). From a functionalist perspective, the ability to regulate emotions is important for building and maintaining social relationships as well as meeting situational demands and social expectations (e.g. in the school context) or achieving goals (Thompson, 1994). For instance, children with good emotional self-regulation skills would not be easily frustrated when things did not work out as well as expected (i.e. starting crying, tossing toys, etc.).

However, it is still unclear whether cognitive, behavioral, and emotional self-regulation are so strongly interrelated that they form a unidimensional self-regulation factor or whether they can be empirically separated from each other despite their interrelation. Therefore, up to now there exist different, competing structural models of preschoolers' self-regulation, including three-factor, two-factor, and single-factor models. According to Bridgett and colleagues (2015), a two-factor structure of self-regulation is assumed with a conglomerate of cognitive and behavioral self-regulation on the one hand and emotional self-regulation on the other hand. A conceptually similar two-factor structure of preschoolers' self-regulation is also assumed by researchers who differentiate between "hot" versus "cool" self-regulation (e.g. Willoughby et al. 2011). While hot self-regulation describes affective and motivational processes (i.e. self-regulation in the presence of emotionally arousing and/or appetitive demands), cool self-regulation describes cognitive, emotionally neutral regulatory processes (i.e. executive functions). Besides a two-factor structure of self-regulation, past research found also evidence for the conceptualization of self-regulation as a global, single-factor construct and – in contrast – as a rather differentiated, three-factor construct. Studies supporting a three-factor model argue that the regulation of cognition, emotion, and behavior describes three related but empirically distinct constructs (Denham et al. 2012; Jahromi/Stifter 2008). Studies supporting a unidimensional, single-factor model of self-regulation argue that the factor correlations between the two or three latent factors are so high that a global self-regulation factor is most appropriate (Allan/Lonigan 2014; Raffaelli et al. 2005).

In sum, there is no consensus about whether preschoolers' self-regulation is best described by a unidimensional construct or whether self-regulation consists of related but empirically distinct subcomponents. Overall, few studies have investigated the factor structure at a between-person level in samples of preschool children, and there is no study yet investigating the factor structure of children's self-regulation at a within-person level and testing whether the factor structure differs between the within- and between-person levels.

1.3 The Present Study

The aim of the present study was twofold: a) to investigate the amount of daily fluctuations in self-regulation within individuals over the course of several days and b) to explore which factor structure best describes preschoolers' self-regulation at both the within- and between-person level. The current lack of research in this area might be mostly due to a lack of instruments assessing daily self-regulation. We therefore developed a short parental questionnaire capturing self-regulation in preschool children on a daily basis (see below). This questionnaire was then applied to a larger sample in the present study to investigate the two research aims.

Since there is no prior research investigating self-regulation in preschool children on a daily basis, our approach to examine the second research question is grounded on model assumptions obtained in past between-level studies. Therefore, three nested models were tested against each other: a global single-factor model (i.e. global self-regulation), a two-factor model (i.e. cognitive-behavioral self-regulation vs. emotional self-regulation), and a three-factor model (i.e. cognitive vs. behavioral vs. emotional self-regulation). Multilevel confirmatory factor analyses (CFA) were conducted in order to test the assumed factor structures at both the within- and between-person level.

2 Method

2.1 Participants

The present study was part of a larger research project investigating potential influences on self-regulation at the individual, family, and preschool levels. The sample consisted of 106 parents with their children aged four to six years (M_{age} = 4.83, SD_{age} = 0.72) from eight different preschools in the south of Germany. Gender was almost equally distributed (44.3% female children). On average, participants' socio-economic status was in the middle-to-upper regions as indicated by education and income: The highest maternal school qualifications were 60% who had qualified for university entrance, 31.8% middle school, and 4.7% lower secondary school (3.5% missing values). The average net family income per month was distributed as follows: 17.9% above €5,000, 15.1% between €4,000-€5,000, 18.9% between €3,000-€4,000, 12.3% between €2,000-€3,000, 4.7% between €1,000-€2,000, and 0.9% below €1000 (30.2% missing values). 73.6% of the sample spoke German as their mother tongue at home, 9.4% spoke German at home most of the time, and 12.3% spoke German at home at least part of the time (4.7% missing values). Parents and their children were recruited by flyers and information letters in different preschools; parents gave written informed consent to participation. The study was approved by the local research ethics committee.

2.2 Procedure

When completing the parental consent form to participate in the study, the parents had to indicate whether they wished to answer the daily questions about their child's self-regulation by phone or by an online questionnaire. 41.5% chose the telephone interview. For seven consecutive days, the parents were called every evening at about 7pm and were asked about their child's self-regulation on the particular day. The parents who chose the online questionnaire received an email, every evening at about

7pm, with an individualized link to the questionnaire of the particular day. Out of the persons who answered the daily questions 84.3% were mothers. Families received €50 for their participation in the complete study.

2.3 Daily Self-Regulation Measure

The child's daily self-regulation was assessed with a short parental questionnaire developed in a preliminary study within our research group. The initial questionnaire was developed in two steps. First, an initial item pool was built based on the definition of self-regulation as the ability to control or direct one's attention, thoughts, emotions, and behaviors (McClelland/Cameron 2012). According to McClelland and Cameron (2012), instruments measuring self-regulation should capture aspects of self-regulation that are relevant in the context of interest. We aimed at creating a measure that captures self-regulation on a daily basis in the everyday life of preschool children. Hence, the items of the questionnaire should imply behaviors that can be observed in children aged four to six in their natural environments. For this purpose, we selected items from preexisting, validated parental questionnaires measuring general self-regulation in normal preschool children. These were the Behavior Rating Inventory of Executive Function – Preschool Version (BRIEF-P, German version by Daseking/Petermann 2013), the effortful control scale of the Children's Behavior Questionnaire (CBQ, Rothbart et al. 2001), and the Child Behavior Rating Scale (CBRS, Bronson et al. 1990). We also created several additional items in an attempt to capture all facets (i.e. cognitive, behavioral and emotional) of self-regulation equally well. The initial item pool consisted of 22 items. Since the purpose was to measure day-to-day self-regulation, the item wording was adjusted so that the parents were asked to what extent their child showed the self-regulatory behaviors *on the particular day*. This item pool was empirically tested (administered in German) in a sample of 20 parents with children aged four to six years (M_{age} = 4.65, SD_{age} = 0.81) who took part in an unrelated study at our laboratory. In the evening after the laboratory visit, parents were contacted by phone and responded to each item using a 5-point rating scale ranging from 1 "this is not true" to 5 "this is very true". At the end there was also one open question where the parents were asked to make critical comments to the items in order to adapt the wording of the questions if necessary. Next, items with item selectivity less than .30, item difficulty less than .20 or greater than .80, and items which had been indicated as difficult to understand were excluded. This procedure resulted in 10 items selected and partially adapted for use in the main study. All items with descriptive statistics can be seen in Table 1 (see below).

2.4 Data Analyses

The data gathered for our two research questions are hierarchically structured: Repeated measurements (level 1 or L1) are nested within persons (level 2 or L2) in our study. As the children were nested in eight different preschools, we tested whether there was the need to account for dependency at a third level (i.e. the preschool). However, the design effect (i.e. a function of both the intraclass correlation coefficient (ICC) and cluster size: design effect = 1+ (average cluster size-1)*ICC) for the preschool level (L3) was smaller than 2 (Lai/Kwok 2015; Muthén/Satorra 1995), indicating that there is no data dependency on a third level.

To answer the first research question whether preschoolers' self-regulation varies from day to day, the average intra-individual standard deviation (ISD) and the ICC were calculated for each item. The ISD reflects each participant's individual standard deviation in self-regulation responses across the seven assessment days. The average ISD is the mean intra-individual standard deviation for each item across all participants. The ICC refers to the proportion of between-person variance relative to overall variance (Snijders/Bosker 2012). Thus, small values can be seen as an indicator for substantial within-person variability.

To answer the second research question concerning the within- and between-person factor structure of self-regulation in preschool children, several multilevel CFAs were conducted. We started with one global self-regulation factor at the within- and between-person level (Model 1). Next, in Model 2, two latent factors were differentiated at each level, namely emotional self-regulation (with factor loadings from items 1, 3, 5, 9) versus cognitive-behavioral self-regulation (with factor loadings from items 2, 4, 6, 7, 8, 10). Finally, a further differentiated model with three latent factors at each level (i.e. four items measuring emotional self-regulation: items 1, 3, 5, 9; four items measuring behavioral self-regulation: items 2, 7, 8, 10; and two items measuring cognitive self-regulation: items 4, 6; also see Figure 1 below) was tested (Model 3). Only two items capturing cognitive aspects of self-regulation met the criteria to be included in the final questionnaire during item development. However, these two items reflect in particular the attentional aspect of executive function (i.e. cognitive self-regulation) but not cognitive shifting and inhibition (Miyake/Friedman 2012). Therefore, in the following, we refer to this factor as *attentional* self-regulation instead of cognitive self-regulation. The factor loadings of the first indicator per factor were fixed to one; no other constraints were imposed. In order to evaluate model fit, several fit indices were used with regards to the criteria proposed by Schermelleh-Engel and colleagues (2003): the Root Mean Square Error of Approximation (RMSEA: good fit: ≤ .05, acceptable fit: ≤ .08), the Comparative Fit Index (CFI: good fit: ≥ .97, acceptable fit: ≥ .95), and the Standardized Root Mean Square Residual for the within- and between-person level ($SRMR_w$/$SRMR_b$: good fit: ≤ .05, acceptable fit: ≤ .10). However, it has to be noted that these fit indices were established for single-level factor analyses and their application to two-level models is questionable (Hsu 2009). To compare the models, χ^2-difference tests were calculated (Satorra/Bentler 2001); Akaike's Information Criterion (AIC) was additionally used as a descriptive index with lower values indicating better model fit. All models were estimated with Mplus 7 (Muthén/Muthén 1998-2012) using a maximum likelihood estimation with robust standard errors (MLR). Reliability of the final retained factor(s) was considered separately for the within- and between-person level using the reliability coefficients by Cranford and colleagues (2006) (based on variance decomposition within the framework of multilevel models) as well as two-level alpha (based on multilevel CFA) by Geldhof and colleagues (2014)[2]. While within-person estimates reflect sensitivity to change (i.e. reliability of daily fluctuations in self-regulation), between-person estimates reflect sensitivity to differences between persons across the seven measurement days.

2 An additional two-level reliability estimate (based on multilevel CFA) is McDonald's omega (Geldhof et al. 2014). However, it was not possible to calculate omega since model identification failed for the attentional self-regulation factor due to the small number of indicators.

The amount of missing observations per item was small (range: 0.07 to 1.2%). Missing data were managed with a full maximum likelihood approach (FIML) used in Mplus by default. There were no missing data at level 2 (i.e. aggregated responses per person across days). In five cases there were missings on all items. That is, five persons only answered the questions on six instead of seven days. These (complete) missings could not be managed with FIML and hence could not be included in the analyses.

Table 1: Descriptive Statistics of Self-Regulation Items

Items[b]	Original item number	Factor[c]	*M* (*SD*)[d]	*Average ISD (SD)*	*ICC*
Today, my child was frustrated when things did not work out as well as expected.[a]	1	e	3.96 (0.64)	0.91 (0.38)	.21
Today, my child was easily depressed when she/he did not accomplish a task.[a]	3	e	4.39 (0.61)	0.66 (0.47)	.30
Today, my child had strong mood swings.[a]	5	e	4.21 (0.62)	0.84 (0.50)	.21
Today, my child had difficulties shifting between tasks.[a]	9	e	4.56 (0.53)	0.50 (0.42)	.34
Today, my child was able to listen to others without interrupting them.	2	b	3.40 (0.62)	0.76 (0.33)	.29
Today, my child easily waited until his/her turn.	7	b	3.44 (0.58)	0.78 (0.39)	.23
Today, my child had difficulties following rules.[a]	8	b	3.96 (0.62)	0.85 (0.36)	.24
Today, my child blurted out answers without waiting until it was his/her turn.[a]	10	b	3.93 (0.63)	0.84 (0.40)	.25
Today, my child concentrated easily.	6	a	3.80 (0.60)	0.65 (0.33)	.35
Today, my child followed a task through.	4	a	4.00 (0.60)	0.69 (0.41)	.29

Notes. ISD = intra-individual standard deviation (within-person); *ICC* = intraclass correlation coefficient. [a]Items are recoded (higher values mean higher self-regulation). [b]For all items, the full range of scale values (1 to 5) was used. [c]e = emotional, b = behavioral, a = attentional self-regulation. [d]Standard deviation of the group-means of individuals (between-person).

Source: Own representation.

3 Results

3.1 Preliminary Analyses

Since some parents chose the phone interview and some parents the online questionnaire to answer the daily questions, we first tested for differences between these two groups with regards to demographic background. There were no differences in children's gender ($\chi^2(1) = 1.45$, $p = .243$), age ($t(104) = -0.69$, $p = .493$), and family net income ($\chi^2(5) = 6.75$, $p = .240$). However, those who chose the online questionnaire had a significantly higher maternal educational degree ($\chi^2(3) = 15.05$, $p = .002$). Descriptive statistics of the self-regulation items can be seen in Table 1. Parents mainly used the upper categories of the self-regulation ratings, with item means (L2) ranging from $M = 3.41$ to $M = 4.56$.

3.2 Variability of Daily Self-Regulation

The average ISDs and ICCs for all items are displayed in Table 1. Although parents mainly used the upper categories for rating their child's self-regulation, the ratings still varied considerably from day to day as indicated by the ISDs and ICCs. The ICCs ranged from .21 to .35, that is, between-person variance was two to four times smaller than within-person variance in all items. Values of the average ISDs ranged from .50 to .91, indicating substantial variability of self-regulation within persons from day to day; in fact, ISDs were larger than the between-person SDs for nine out of ten items.

3.3 Within- and Between-Person Factor Structure of Self-Regulation

Model fit results for the series of different models with factor combinations ranging from one to three factors at the two data levels are displayed in Table 2. Model fit was worst in Model 1, implying an undifferentiated, single-factor solution at the within- and between-person level. With greater differentiation at each level, model fit improved (see Model 2 and 3). The model with three latent factors at both the within- and between-person level (Model 3) showed best model fit compared to the other factor structures. However, the inter-factor correlation between the factors attentional self-regulation and behavioral self-regulation was relatively high at the between-person level ($r = .87$) compared to the within-person level ($r = .60$). Hence a fourth model with three factors at the within-level but two factors at the between-level was tested (Model 4). The multilevel CFA produced a quite similar but slightly worse model fit for Model 4 in comparison to Model 3 with regards to the descriptive fit indices. A χ^2-difference test (Satorra/Bentler 2001) revealed a significantly smaller deviance of Model 3 compared to Model 4 ($\chi^2(2) = 6.10$, $p = .047$). Hence, Model 3 was finally accepted with three latent factors that can be labeled as "attentional self-regulation", "behavioral self-regulation", and "emotional self-regulation"[3]. Factor loadings of the final model can be seen in Figure 1.

3 We thank a reviewer for suggesting Ryu and West's (2009) approach for level-specific model fit evaluation in which each level is separately evaluated by defining partially saturated models. We estimated two partially saturated theoretical models and two partially saturated baseline models for each level. Similar to the SRMRwithin and SRMRbetween provided by Mplus (Table 2), the χ^2 estimates and CFIs showed that the model fitted worse at the between-person level.

Table 2: Model fit indices for the measurement models (multilevel CFA)

Model (factors)	*χ^2 (df)*	*AIC*	*RMSEA*	*CFI*	*SRMR (within/between)*
1. 1 within-1 between	393.15 (70)	18436.63	.08	.77	.08/.24
2. 2 within-2 between	201.57 (68)	18241.99	.05	.90	.05/.13
3. 3 within-3 between	164.34 (64)	18210.03	.05	.93	.04/.12
4. 3 within-2 between	170.53 (66)	18212.87	.05	.93	.04/.13

Notes. CFA = confirmatory factor analysis; *df* = degrees of freedom; *AIC* = Akaike Information Criterion; *RMSEA* = Root Mean Square Error of Approximation; *CFI* = Comparative Fit Index; *SRMR* = Standardized Root Mean Square Residual. *Source:* Own representation.

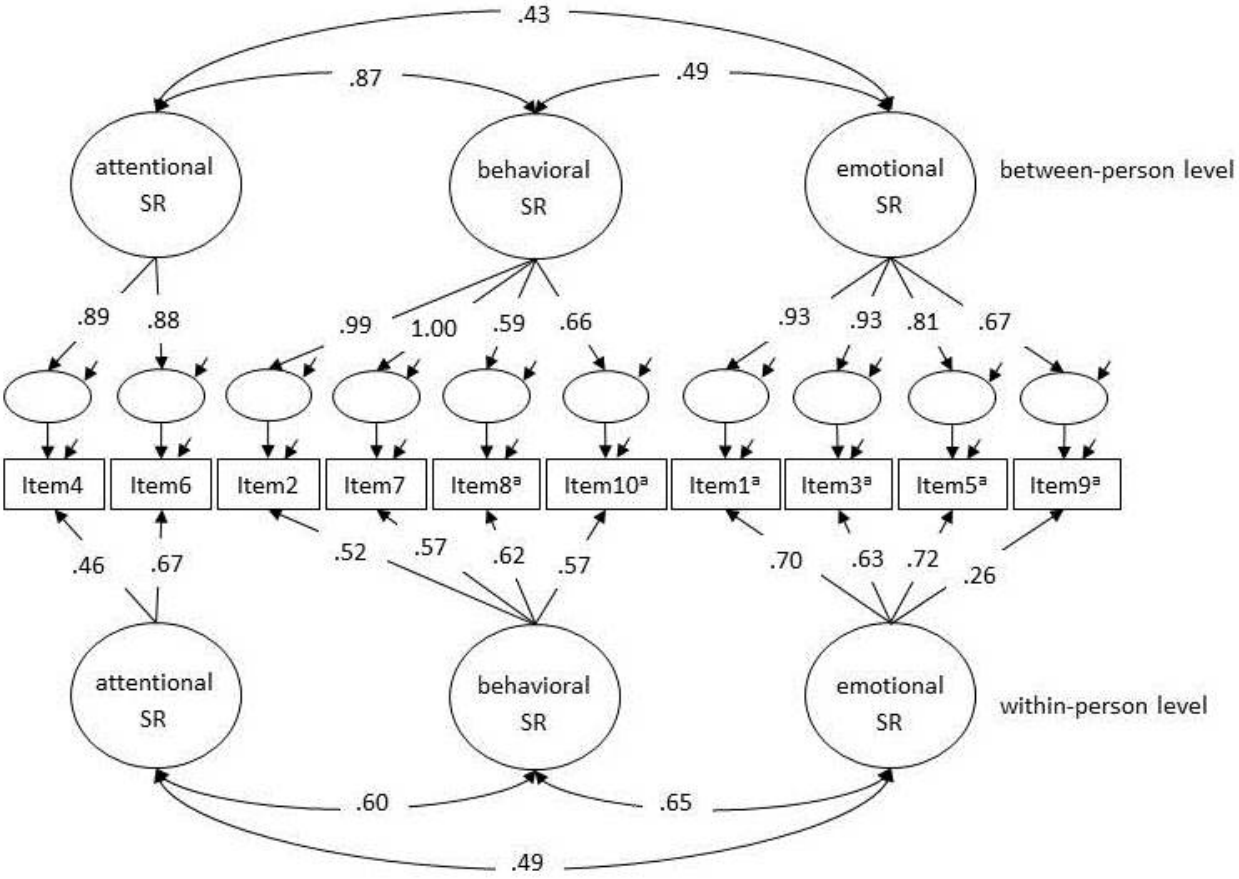
Two-level alphas (Geldhof et al. 2014) at the within-/between-person level were .66/.91 for the emotional self-regulation scale, .65/.89 for the behavioral self-regulation scale and .47/.87 for the attentional self-regulation scale. Within-/between-person reliability according to the coefficients by Cranford and colleagues (2006) were .66/.92 (emotional self-regulation), .65/.91 (behavioral self-regulation), and .46/.89 (attentional self-regulation). These values are comparable with multilevel reliability coefficients reported in previous diary studies (e.g. Schmid et al. 2016).

4 Discussion

4.1 Day-to-Day Fluctuations

For the first time we showed that self-regulation varies substantially within individuals in a sample of healthy preschool children on a daily basis. The ICCs, which indicate the proportion of between-person variance, ranged between .21 and .35. Thus, between 65% and 79% of the overall variance was due to within-person variance but not to between-person variance. For nine out of ten items of our self-regulation measure, the daily variability of self-regulation as indicated by the averaged ISDs (within-person level; range: .50 to .91) was greater than the standard deviations of the group-means (between-person level; range: .53 to .64). That is, in the present sample, self-regulation varied stronger *intra*-individually than *inter*-individually. Similar values were obtained when studying children's affect – a construct well-known for its state component (Leonhardt et al. 2016). This finding emphasizes the dynamic nature of self-regulation by empirically showing that the ability to self-regulate cognitive, behavioral, and emotional processes in preschool children fluctuates from day to day besides relatively stable differences in average self-regulation abilities between individuals.

Figure 1: Factor structure, standardized factor loadings, and inter-factor correlations of the final model (Model 3)



Note: Short arrows reflect residual variances. All factor loadings are significant (p < .001). SR = self-regulation. [a]Items are recoded. *Source:* Own representation.

The study extends findings from previous research investigating individual differences in preschool children's self-regulation at a between-person level (e.g. Jahromi/Stifter 2008; Sawyer et al. 2015b) and intra-individual variability in similar constructs and older samples (Berg et al. 2014; Dirk/Schmiedek 2016; Schmid et al. 2016). This result calls into question the results of one-time assessments of self-regulation, because one-time assessments fail to take intra-individual variability into account and in the worst case might represent one of the extreme points (best or worst performance intra-individually) rather than typical performance (cf. Toplak et al. 2013). Moreover, it is not yet clear whether there are inter-individual differences in intra-individual variability. In emotion research, there is a vivid debate how to measure such inter-individual differences in variability (Wang et al. 2012), and different methods of measuring inter-individual differences in variability are differentially related to relevant outcomes (Houben et al. 2015; Wang et al. 2012).

In addition to analyses of inter-individual differences in intra-individual variability, daily correlates of self-regulation using longitudinal study designs could be investigated as a next step. Becker and colleagues (2014) recently found first evidence for the influence of moderate to vigorous physical activity on preschool children's self-regulation skills. Although the study investigated this question at the between-person

level, physical activity seems to be a promising influencing factor on children's self-regulation on a daily basis; it varies within individuals from day-to-day (and within shorter time intervals; e.g. Ridgers et al. 2015) and is through its motivating nature a fun and relatively simple approach to positively influence children's self-regulation skills in their natural, everyday life. Another promising daily correlate of self-regulation is positive affect. Positive affect enables effective self-regulation by facilitating cognitive processes (i.e. efficient processing of information) and providing psychological resources (i.e. energy, motivation) that are essential for self-regulatory processes (Aspinwall 1998; Isen 2000; Muraven/Baumeister 2000). Since previous research already showed that positive affect varies within children on a daily basis (Leonhardt et al. 2016), the question remains whether daily variations in preschoolers' self-regulation could be explained by preceding variations in positive affect. The identification of within-person correlates and which situations are conducive to preschoolers' self-regulation in their everyday life enables the creation of more specific interventions enhancing preschool children's self-regulation skills. The focus on this young age group is hereby in particular important since an enhancement of self-regulation is advisable before the children transition into school.

4.2 Factor Structure of Self-Regulation

Multilevel CFAs revealed that the factor structure of daily self-regulation was best described by a model with three latent factors (i.e. emotional, attentional, and behavioral self-regulation) at both the within- and between-person level. With regards to the measurement of daily self-regulation in the present study, the factor "attentional self-regulation" consists of items describing cognitive self-regulation, or executive function, such as focusing the attention and staying focused for a while, or being able to concentrate. Attentional self-regulation (cf. executive function) is particularly essential for variables within the school context, such as school readiness and success in school (see for a short review Blair/Raver 2015). However, the factor "attentional self-regulation" has only two indicators, thus reducing reliability of the scale (Marsh et al. 1998). The factor "behavioral self-regulation" reflects inhibitory, compliant behaviors such as being able to wait for something (i.e. until someone finished speaking, until it is one's turn etc.) or following the rules. This part of self-regulation is a developmentally important aspect of self-regulation in particular with regards to social interactions (e.g. Eisenberg et al. 1997; Ramani et al. 2010). The factor "emotional self-regulation" describes the regulation of affect and emotions, especially in case of negative emotions (e.g. frustration) when things do not work out as expected. The development of emotional self-regulation also has important implications for social relationships. Both cross-sectional and longitudinal studies showed significant associations between children's emotional self-regulation (e.g. self-distraction during a delay task) and their popularity with peers (Raver et al. 1999; Spinrad et al. 2006; Trentacosta/Shaw 2009). With the exception of attentional self-regulation, two-level reliability estimates showed satisfactory coefficients in the present study at both the between- and within-person level for emotional and behavioral self-regulation.

Besides empirical evidence in the present study for the three-factor model in comparison to other factor structures (i.e. single-factor or two-factor models), the conceptualization of self-regulation as a differentiated construct with three distinct processes

(i.e. cognitive/attentional, behavioral, emotional) is also in accordance with findings from previous research. On the one hand, there is evidence for discriminant validity of multifaceted self-regulation in children. That is, different facets of self-regulatory processes uniquely predict different outcome variables, such as cognitive self-regulation being a dominant predictor above behavioral and emotional self-regulation in predicting false belief (Jahromi/Stifter 2008), or behavioral self-regulation mediating the association between emotional self-regulation and academic achievement (Howse et al. 2003), thus supporting the assumption that self-regulation consists of different interrelated processes. On the other hand, some of the previous factor-analytic studies investigating the latent factor structure of preschoolers' self-regulation (at a between-person level) also received best model fit for a model with three factors similar in content to the factors identified in the present study (Denham et al. 2012; Raffaelli et al. 2005). However, it has to be noted that within the study of Raffaelli and colleagues (2005), a single-factor model was yet accepted because of very high correlations among the three identified latent factors. In the present study, the inter-factor correlation between behavioral and cognitive self-regulation was quite high at the between-person level as well (r = .87). This seems to support previous studies postulating a two-factor model of self-regulation such as the segmentation of self-regulation into a "hot" (i.e. emotional) versus "cool" (i.e. cognitive-behavioral) self-regulation factor (Willoughby et al. 2011). However, previous research is only based on data at the between-person level. By disaggregating the within- and between-person level, the present study shows that a more differentiated factor structure is true for both levels while controlling for the respective data level. At the within-person level, the inter-factor correlations are much smaller compared to the between-person level, ranging from .49 to .65 in the present study. The inter-factor correlations at the between-person level range from .43 to .87, but are smaller compared to the study by Raffaelli and colleagues (2005) who also measured preschoolers' self-regulation by parent-report and obtained inter-factor correlations ranging from .74 to .95 at the between-person level. The possibility of a two-factor structure at the between-person level was empirically tested in the present study: a difference test revealed a significant better model fit of the model with three distinct factors at the within- and between-person level compared to the model with three factors at the within- but two factors at the between-person level. However, the inter-factor correlations between behavioral and attentional self-regulation were clearly greater than the respective correlations with emotional self-regulation at the between-person level, indicating that the "cool" processes of cognitive and behavioral self-regulation are more strongly related with one another than each is with the "hot" process of emotional self-regulation (cf. Bridgett et al. 2015).

In sum, the present study contributes to the understanding of self-regulation as a diverse construct whose regulatory processes (i.e. emotional, attentional, behavioral) are related but distinct. However, more research is needed to support this initial finding and provide further insights into the factor structure, for instance by investigating discriminant predictive validity of the three factors (e.g. academic and social relationship outcomes, see above).

4.3 Limitations and Future Directions

Some limitations of the present research must be acknowledged: First, daily self-regulation was assessed by parent-report (particularly mothers) rather than by self-report. Within clinical research, several studies only show limited convergence between child- and parent-reported symptoms (Achenbach et al. 1987; De Los Reyes/Kazdin 2005). However, in research with children under the age of six, parent-reports are nonetheless the method of choice, since applying self-reports is difficult within this young age group as the children have difficulties in representing complex internal experiences (Luby et al. 2007). Moreover, the problem of convergence between child and parent reports seems to be of more concern in the case of internal processes such as the investigation of children's depressive or anxious symptoms (De Los Reyes/Kazdin 2005). Although self-regulation means the self-monitored regulation of different emotional, behavioral, and attentional – and thus internal – processes, the outcome of these regulatory processes (i.e. successful or non-successful self-regulation) is visible for external observers, such as showing *no* frustration reaction when things did not work out as well as expected or being able to complete a game or keep on task. Therefore, we assume the measurement of preschool children's self-regulation by an external person as adequate. However, one could further argue whether the measurement by parent's report or rather by preschool teacher's report is more appropriate. Since the children spend a large part of their waking hours in the preschool, the preschool teacher might see more situations demanding self-regulation, especially in socially interactive situations. However, during the day, one preschool teacher has to supervise multiple children; thus, focusing on one child in order to adequately rate its self-regulation throughout the day is quite difficult in practice. Moreover, the data of the present study also included weekend days where there would be missing data in the case of preschool teacher-reports. We therefore chose parents' reports to measure preschoolers' daily self-regulation. Nevertheless, for future research it would be interesting to combine preschool teachers' reports and parents' reports to get further insights into children's self-regulation in different contexts. In addition, the present study only investigated children's intra-individual self-regulation on a daily basis. Dirk and Schmiedek (2016) already showed that children's working memory performance varies not only from day to day, but also from occasion to occasion (i.e. morning, noon, afternoon). Thus, a study design with multiple measurement bursts throughout the day is recommended to further investigate preschoolers' intra-individual self-regulation within shorter time intervals.

Second, the sample is limited in representativity, as the sample was self-selected with a middle-to-high socio-economic background. The elaborate review by Bridgett and colleagues (2015) underlines the key role that parental influence factors play for children's self-regulation. Parental (mostly maternal) and children's self-regulatory abilities are usually correlated in part because of intergenerational transmission processes such as parenting behavior (e.g. caregiving), inter-parent relations (e.g. marital conflict), and rearing context (e.g. socio-economic background) (Bridgett et al. 2015). Concerning the ceiling effects in the present study partially represented in the relatively high item means of the aggregated self-regulation scores, a more heterogeneous sample might enhance individual differences in self-regulation thus enhancing between-person variance. To what extent this might affect within-person variance is as

yet unclear. Although the children scored relatively high on the self-regulation items on average, there was still substantial variation within and between individuals. Hence, future research is needed including more diverse samples regarding family background and using longitudinal study designs to disaggregate within- and between-person level effects.

Third, it should be noted that while the $SRMR_{within}$ met Schermelleh-Engel and colleagues' (2003) criteria for good model fit, the RMSEA and CFI of the three-factor model only showed acceptable model fit according to conventional cut-off criteria (e.g. Hu/Bentler 1999; Schermelleh-Engel et al. 2003). However, it must be remarked that the use of conventional cut-off criteria such as Hu and Bentler (1999) as golden rules for evaluating model fit has been criticized (Marsh et al. 2004). Marsh and colleagues (2004) instead recommend the comparison of nested models as more adequate. In the present study, besides the comparatively better descriptive fit indices, a difference test revealed a significant smaller deviance of the three-factor model. Therefore the three-factor model was accepted. Moreover, there exist no general cut-off criteria yet for two-(or more)level model fit, and the application of current cut-off criteria for single-level models to multilevel models has to be done with caution (Hsu 2009; Wagner 2008) - simulation studies showed that global fit indices are more sensitive to the within-level than the between-level (Hsu 2009; Wagner 2008). Here, level-specific model fit evaluations revealed better model fit at the within-person level and worse model fit at the between-person level according to the $SRMR_{between}$ provided by Mplus and the partially saturated model approach by Ryu and West (2009). Future research should include more items for further exploration of the source of misfit at the between-person level and the reliability estimates of the scales (i.e. additionally calculating McDonald's omega, see Geldhof et al. 2014).

4.4 Conclusion

The present study provides evidence that preschoolers' parent-reported self-regulation skills substantially vary from day to day. Similar results have been found for related constructs in older samples. This finding emphasizes the dynamic nature of self-regulation and highlights the need for a prospective focus on intra-individual (within-person) self-regulatory processes besides common investigations at the between-person level. Here, potential antecedents and consequences of within-person variability in self-regulation should be investigated as a next step as well as variability within shorter time intervals (i.e. morning, noon, afternoon).

By disaggregating the two-level data, the study provides further insights into the factor structure at both the within- and between-person level: Best model fit was found for a three-factor model including behavioral, emotional, and attentional self-regulation. This finding further contributes to the understanding of self-regulation as a diverse construct with distinct but related processes.

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